

## A Study on Iron Nutritional Status and Anemia of Middle School Girls in Ulsan Metropolitan City

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### ABSTRACT

This study was designed to assess the iron nutritional status and anemia of middle school girls in Ulsan City, who were evaluated with a questionnaire, measurement of hematological indices. The average height and weight of respondents were  $154.81 \pm 6.28$ cm and  $48.51 \pm 8.80$ kg, respectively. Mean daily energy intake was  $1815.72 \pm 328.04$ kcal and iron intake was  $15.13 \pm 4.50$ mg. The average hemoglobin concentration of subjects was  $11.98 \pm 0.78$ g/dl, and the average hematocrit level was  $36.62 \pm 2.21$ %. Transferrin saturation TS (%) was  $25.58 \pm 9.82$ %, and the ferritin level was  $40.45 \pm 23.03$ ng/ml. Iron deficiency anemia among the subjects was estimated as 54.2% by using hemoglobin ( $< 12$ g/dl), 33.9% by hematocrit ( $< 36$ %). The clinical symptoms relating anemia were measured with 4 Likert scale (1 : never, 4 : often), 'tired out easily ( $2.34 \pm 0.92$ )' was the highest, followed by 'feel dizzy always ( $2.26 \pm 0.85$ )', 'decreasing ability to concentrate ( $2.23 \pm 0.77$ )', 'get a cold easily ( $2.19 \pm 0.82$ )', 'have a headache ( $2.10 \pm 0.79$ )', 'poor memory ( $2.09 \pm 0.83$ )', 'no appetite ( $1.99 \pm 0.85$ )'. As for the correlation between iron parameter and clinical symptoms related to anemia, the hematocrit rate was negatively correlated with 'get a cold easily', 'pale face', 'feeling blue', 'difficult digestion' ( $p < 0.05$ ). The level of iron was negatively correlated with 'tired out easily', 'get a cold easily' ( $p < 0.05$ ) and TS (%) were negatively correlated with 'tired out easily' ( $p < 0.05$ ), 'get a cold easily' ( $p < 0.01$ ). Our study resulted that the prevalence of a iron deficiency of a middle school girl is very high, therefore the guidelines for iron supplementation and nutritional education to improve their iron status should be provided. (*J Community Nutrition* 6(2) : 86~90, 2004)

**KEY WORDS :** iron nutrition · iron deficient anemia · hemoglobin · hematocrit · serum ferritin.

### Introduction

During the adolescent period, physical and mental growth are so fast that it is very important for the adolescents to have appropriate nutritional intake for the development of growth, and the nutrition during this period can significantly affect their lifetime health conditions (Spear 1996 ; William, Worthington 1992). Irregular eating habits in this period impair their growth and health, and their eating behaviors in this period controls them for their lifetime ; likewise, bad eating habits hamper emotional and mental conditions as well as physical development (Lifshitz 1993).

Especially, iron deficiency has been one of the nutritional

problems around the world, and it has been demonstrated that the middle school girls are poor in nutritional status for iron content due to the sudden physical growth and loss of blood caused by menstruation (Mortenson 1993). According to the National Health and Nutrition Survey (1998), daily iron intake of women between 13 and 19 years old was 10.8mg that is just 67.2% of the Recommended Dietary Allowance (RDA) for Koreans. Therefore, it may be pointed out as a nutritional problem in the period of adolescence having high iron demand. The primary factors for iron-deficient anemia are the lack of iron intake and its low absorption, and the coefficient of utilization is influenced by the storage condition of iron in the body, the form of dietary iron content and other dietary factors (Du 2000).

The importance in the nutritional status for iron content has been fairly well recognized, knowing that the middle school girls have to preserve enough iron content in their body due to their blood loss by menstruation so that they are primary groups required to have iron content ; however, its relevant

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study has not been yet conducted to figure out the relationship between the iron status and the diet intake. Therefore, in this study, we will focus on the conditions of anemia among the middle school girls in Ulsan metropolitan city and will suggest basic data for the improvement of their iron nutrition and precaution of anemia by means of analyzing several factors in relation to their eating habits.

## Methods

### 1. Subjects

This study was carried out with 193 subjects in the first grade of the girl's middle school in Ulsan Metropolitan city.

### 2. Anthropometric characteristics

The height and weight were measured with automatic instruments (Fanocs model : Fa-95) and body mass index (BMI) was calculated  $\text{weight (kg)}/\text{height (m)}^2$  (BMI,  $\text{kg}/\text{m}^2$ ). PIBW (percent ideal body weight) was percentage of ideal body weight which was measured using the Broca method [ $\text{Height (cm)} - 100 \times 0.9$ ]

### 3. Nutritional intake, eating habit and clinical symptoms relating anemia

Nutrient intakes were measured with a convenient method which was developed by Moon (9). Calculated nutrients were compared with Recommended Dietary Allowance (Korean nutrition society, 7th ed. 2000).

Food frequency and eating habit were investigated using a questionnaire. Eleven items complemented on the basis of clinical symptoms investigated from the previous study were used (Hong 2001). Each item had four scales ; 'never,' 'seldom' 'sometimes' and 'often' These variables were measured by 1-, 2-, 3-, and 4-point Likert type scales.

### 4. Measurement of iron status parameter

Hemoglobin, serum iron, total iron binding capacity (TIBC) and serum ferritin were measured. The hemoglobin, red blood cell hematocrit and RDW (red cell distribution width) were measured with Automatic Blood Cell Counter (Sysmex NE 8000, Toa Medical Electronics Co., Japan). Serum iron and TIBC were measured with Automatic Chemistry Analyzer (Hitachi 747, Hitachi Co., Japan). Serum ferritin concentration were measured with a Chemiluminescence Immunoassay (CLIA) Analyzer (ACS 180, Bayer Diagnostics Co., USA). Transferrin saturation (TS (%)) was calculated by dividing the

concentration of serum iron by TIBC.

## 5. Statistical analysis

All data collected were statistically analyzed, using a SPSS PC<sup>+</sup> package. For each variable, the values of average and standard deviation were measured. The correlation between hematological indices and clinical symptoms was identified for significance by measuring the Spearman's correlation coefficient.

## Result and Discussion

### 1. Physical characteristics

Table 1 shows the anthropometric characteristics of the subjects. The height and weight were  $154.81 \pm 6.28\text{cm}$ ,  $48.51 \pm$

**Table 1.** Physical characteristics of subjects

	Mean $\pm$ S.D	Range
Age (year)	12.63 $\pm$ 0.58	11 - 14
Height (cm)	154.81 $\pm$ 6.28	127 - 167
Body weight (kg)	48.51 $\pm$ 8.80	25.2 - 88
BMI ( $\text{kg}/\text{m}^2$ ) <sup>1)</sup>	20.15 $\pm$ 2.97	14.5 - 28.2
PIBW <sup>2)</sup>	98.44 $\pm$ 14.61	71.5 - 148

1) BMI : Body mass index

2) PIBW : Percent ideal body weight, ideal body weight = (height (cm)-100)  $\times$  0.9

**Table 2.** Eating habit of the subject

Valuables	N (%)	
Meal frequency per day	1time	2 ( 1.1)
	2times	52 (27.5)
	3times	132 (69.8)
	4times	3 ( 1.6)
Skipping meals	Breakfast	92 (48.9)
	Lunch	12 ( 6.4)
	Dinner	33 (17.6)
	None	51 (27.1)
The reason for skipping meals	No appetite	37 (23.7)
	Dislike side dish	14 ( 9.0)
	Difficulty to digestion	8 ( 5.1)
	Having snacks	11 ( 7.1)
	To control weight	8 ( 5.1)
	No time	55 (35.3)
Meal time	Just habit	12 ( 7.7)
	Etc.	11 ( 7.1)
	Irregular	24 (12.7)
	Generally irregular	45 (23.8)
	Generally regular	93 (49.2)
	Regular	27 (14.3)

**Table 3.** Average daily intake and %RDA of subjects

	RDA <sup>1)</sup>	Mean ± S.D	%RDA
Protein(g)	70	69.32 ± 18.50	98.57
Fat(g)		42.94 ± 9.81	
Carbohydrate(g)		287.96 ± 50.39	
Fe(mg)	16	15.13 ± 4.50	94.56
P(mg)	800	1015.21 ± 275.56	126.92
Ca(mg)	800	634.18 ± 218.85	79.27
Vitamin A(R.E.)	700	1054.61 ± 432.88	150.57
Vitamin B <sub>1</sub> (mg)	1.1	0.98 ± 0.28	89.09
Vitamin B <sub>2</sub> (mg)	1.3	1.46 ± 0.43	112.30
Niacin(mg)	14	16.16 ± 4.59	115.42
Vitamin C(mg)	70	123.71 ± 51.65	176.7
Total Energy(kcal)	2100	1815.72 ± 328.04	86.46

1) RDA : Recommended dietary allowance (2000)

8.80kg respectively. BMI (kg/m<sup>2</sup>) was 20.15 ± 2.97 and PIBW (percent ideal body weight) was 98.44 ± 14.61%. The study of Kwon et al. (2001) of middle school girls of urban reported that the average height and weight were 155.9cm which is slightly higher than that measured in this study.

## 2. Dietary habit and nutritional intake of the subjects

Table 2 shows the dietary habit of the subjects. One-hundred thirty two students (69.8%) who were the majority of the subjects of study have three meals and 52 students (27.5%) had two meals a day. In terms of the regularity of their meal-times, it has been shown that 93 students (49.2%) say that it is 'generally regular', 45 students (23.8%) 'generally irregular', 24 students 'irregular (12.7%)' and 27 students (14.3%) 'regular.' According to Skinner's study (1985), the meal pattern of adolescents are irregular, and the most irregular meal is breakfast because of their lack of time, loss of appetite, indigestion and snack. It had been shown that subjects who skipped their breakfast were 92 students (48.9%) ; those who skipped their dinner were 33 students (17.6%) ; and those who skipped their lunch were 12 students (6.4%). The first reason for skipping meal was that there is 'no time for eating' for 55 students (35.3%) and it is followed by the reason that there is 'no appetite' and 'dislike side dish' for 37 students (23.7%) and 14 students (5.2%), respectively. Also in previous study (2000), 44.4% of female high school students skipped their breakfast, and the reasons for their doing so were that they 'no appetite' and 'oversleeping.'

The nutritional intake of subjects are shown in Table 3. The total energy intake of the subjects were 1815.72 ± 328.04kcal

**Table 4.** Food frequency of subjects

Food	Mean ± S.D.
Fruit	4.67 ± 2.13
Kimchi	4.64 ± 2.42
Oils and fat	4.25 ± 1.87
Milk	4.22 ± 2.41
Vegetables	3.71 ± 2.15
Meat	3.45 ± 1.77
Eggs	3.37 ± 2.05
Seaweed	2.97 ± 2.07
Fish	2.87 ± 1.89
Bean or tofu	2.73 ± 2.00
Chicken	2.64 ± 1.71

Score : No = 1, 1 - 2times/week = 2, 3 - 4times/week = 3, 5 - 6 times/week = 4, always = 5

**Table 5.** Hematological indices and prevalence rates of iron deficiency in the blood of the subjects

	Mean ± S.D.	Criteria for deficiency	%iron deficiency anemia
Hb(g/dl) <sup>1)</sup>	11.98 ± 0.78	<12	54.2%
Hct(%) <sup>2)</sup>	36.62 ± 2.21	<36	33.9%
TIBC(μg/dl) <sup>3)</sup>	343.66 ± 35.55	>400	5.7%
TS(%) <sup>4)</sup>	25.58 ± 9.82	<14	12%
Ferritin(ng/ml)	40.45 ± 23.03		
Fe(μg/dl)	86.72 ± 31.90	<12	4.2%

1) Hb : Hemoglobin, 2) Hct : Hematocrit, 3) TIBC : Total iron binding capacity, 4) TS : Transferrin saturation

(86.46% of RDA) and protein intake was 69.32 ± 18.50g (98.57% of RDA). It has been investigated that calcium intake was 79.27% of RDA and iron intake was 94.56% of RDA, that was higher than previous study of high school girls (Hong et al. 2001).

As shown in Table 4, the average score of the subjects' habit for eating fruit(4.67 ± 2.13), Kimchi(4.64 ± 2.42) oil and fat(4.25 ± 1.87) and milk(4.22 ± 2.41) is more than 5 to 6 times a week, while that for eating seaweed(2.97 ± 2.07), fish(2.87 ± 1.89), bean and tofu(2.73 ± 2.00), chicken(2.64 ± 1.71) intakes were low. In National Health and Nutrition Examination Survey in 1998, it is reported that 78.4% of the total amount of intake is taken from vegetable food and 21.6% from animal food in women aged 13 to 19.

## 3. Iron parameter in serum of subjects

Table 5 showed iron parameter in serum of subjects and prevalence of anemia. The hemoglobin levels was 11.98g/dl and the iron deficiency rate (<12g/dl) was 54.2%. The hematocrit rate was 36.6%, iron deficiency rate (<36%) was 33.9%. In the study of Kwon et al. (2001) for agricultural areas, the

middle school students with the rate for hematocrit below the standard level were 37.9% and slightly higher than this study.

Serum ferritin concentration is an index reflecting well the amount of iron storage in vivo. It is known that serum ferritin concentration of less than 20ng/ml is considered to be iron deficiency (Herbert 1988 ; Gibson 1990). In this study, the subjects who have the concentration of ferritin with less than 12ng/ml were 4.2% of the subject and those who have TS (%) with less than 14% were 12% of the subjects.

TIBC is measured by the amount of iron to be bonded to transferrin and it increases quickly when iron is deficient (Gibson 1990). The total iron binding capacity (TIBC) reaches  $343.66 \pm 35.55 \mu\text{g/dl}$  and it is more or less higher than the results ' $327 \pm 45.2 \mu\text{g/dl}$ ' reported by Lee et al. (1999) who studied the female students in their puberty.

TS (%) is calculated by dividing the concentration serum iron by TIBC. It has been presented as a more reliable criterion for iron deficiency anemia since the value of serum iron

decreases but TIBC increases when there is an iron deficiency. In this study, it has been investigated that TS (%) is  $25.58 \pm 9.80\%$ , and it is higher than the result of study ( $20.4 \pm 9.3\%$ ) with the female middle school students in Seoul (Choi et al. 1997).

#### 4. Clinical symptoms of the subjects

Table 6 show the clinical symptoms of the subjects. 'tired out easily ( $2.34 \pm 0.92$ )' was the highest, followed by 'feel dizzy always ( $2.26 \pm 0.85$ )', 'decreasing ability to concentrate ( $2.23 \pm 0.77$ )', 'get a cold easily ( $2.19 \pm 0.82$ )', 'have headache ( $2.10 \pm 0.79$ )', 'poor memory ( $2.09 \pm 0.83$ )', 'no appetite ( $1.99 \pm 0.85$ )', 'difficult digestion ( $1.88 \pm 0.79$ )', 'feeling blue ( $1.82 \pm 0.84$ )', 'inflamed inner mouth ( $1.67 \pm 0.75$ )', 'pale face ( $1.32 \pm 0.63$ )'. The previous study (Hong 2003) reported that 'decreased ability to concentrate', 'tired out easily', 'be dizzy usually', 'get a cold easily' were frequent symptoms in urban middle school girls.

As for the correlation between iron parameter and clinical symptoms related to anemia, the hematocrit rate was negatively correlated with 'get a cold easily ( $r = -0.166$ )', 'pale face ( $r = -0.154$ )', 'feeling blue ( $r = -0.148$ )', 'difficult digestion ( $r = -0.147$ )' ( $p < 0.05$ ). The level of iron was negatively correlated with 'tired out easily ( $r = -0.169$ )', 'get a cold easily ( $r = -0.187$ )' ( $p < 0.05$ ) and TS (%) was negatively correlated with 'tired out easily ( $r = -0.187$ ,  $p < 0.05$ )', 'get a cold easily ( $r = -0.201$ ,  $p < 0.01$ )'. In this study, iron status of middle school girls were poor, and there was correlation between iron parameter and clinical symptoms. Therefore, it is absolutely necessary to have nutritional education and publicity for the recognition of the problems with their nutritional status for iron and its subsequent improve-

**Table 6.** Clinical symptoms of subjects

Symptoms	Score <sup>1)</sup> (Mean $\pm$ S.D.)
Tired out easily	$2.34 \pm 0.92$
Feel dizzy always	$2.26 \pm 0.85$
Decreased ability to concentrate	$2.23 \pm 0.77$
Get a cold easily	$2.19 \pm 0.82$
Have headache	$2.10 \pm 0.79$
Poor memory	$2.09 \pm 0.83$
No appetite	$1.99 \pm 0.85$
Difficult digestion	$1.88 \pm 0.79$
Feeling blue	$1.82 \pm 0.84$
Inflamed inner mouth	$1.67 \pm 0.75$
Pale face	$1.32 \pm 0.63$

1) Score : never = 1, seldom = 2, sometimes = 3, often = 4

**Table 7.** Correlation between hematologic indices and clinical symptoms

Clinical symptoms	Hb <sup>1)</sup>	Hct <sup>2)</sup>	Fe	TIBC <sup>3)</sup>	Ferritin	TS <sup>4)</sup>
Tired out easily	-.084	-.118	-.169*	-.026	.027	-.187*
Feel dizzy always	-.014	-.065	-.057	-.010	.023	-.077
Decreased ability to concentrate	-.062	-.070	-.035	-.021	-.033	-.022
Get a cold easily	-.112	-.166*	-.187*	.121	-.132	-.201**
Have headache	-.046	-.098	-.044	-.006	.011	-.014
Poor memory	-.070	-.082	-.044	.092	-.013	-.059
No appetite	-.079	-.094	.126	-.107	.050	.125
Difficult digestion	-.127	-.147*	.042	.065	-.037	.015
Feeling blue	-.096	-.148*	-.034	.013	-.045	-.081
Inflamed inner mouth	-.046	-.015	-.010	-.013	.047	-.064
Pale face	-.109	-.154*	.066	.092	-.078	.028

\* :  $p < 0.05$ , \*\* :  $p < 0.01$

1) Hb : Hemoglobin, 2) Hct : Hematocrit, 3) TIBC : Total iron binding capacity, 4) TS : Transferrin saturation

ment. In case of serious nutritional status for iron, there is a need for iron supplementation for promoting nutrition as well as balanced diet.

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### Summary

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This study was performed to investigate the iron nutritional status and anemia of middle school girls in Ulsan metropolitan city. Physical characteristics, nutrient intake, food frequency, iron parameter of serum, anemic symptoms were measured.

1) The height and weight were  $154.81 \pm 6.28$ cm,  $48.51 \pm 8.80$ kg respectively. BMI ( $\text{kg}/\text{m}^2$ ) was  $20.15 \pm 14.61$  and PIBW (percent ideal body weight) was  $98.44 \pm 14.61\%$ .

2) The total energy intake of the subjects were  $1815.72 \pm 328.04$  kcal (86.46% of RDA) and protein intake was  $69.32 \pm 18.50$ g (98.57% of RDA). It has been investigated that calcium intake was 79.27% of RDA and iron intake was 94.56% of RDA.

3) As for eating habit of subjects fruit ( $4.67 \pm 2.13$ ), Kimchi ( $4.64 \pm 2.42$ ), greenish yellow vegetables ( $3.38 \pm 2.21$ ) and milk ( $4.22 \pm 2.41$ ) was more than 5 to 6 times a week, while that for eating seaweed ( $2.97 \pm 2.07$ ), bean and tofu ( $2.73 \pm 2.00$ ) is low.

4) The hemoglobin levels subjects was 11.98g/dl and the iron deficiency rate ( $< 12\text{g}/\text{dl}$ ) was 54.2%, and the hematocrit rate was 36.6%. And, 33.9% of the subjects was less than iron deficiency standard ( $< 36\%$ ), The total iron binding capacity (TIBC) reached  $343.66 \pm 35.55 \mu\text{g}/\text{dl}$  and TS (%) was  $25.58 \pm 9.80\%$ .

5) As for clinical symptoms of the subjects, 'tired out easily ( $2.34 \pm 0.92$ )' was the highest, followed by 'feel dizzy always ( $2.26 \pm 0.85$ )', 'decreasing ability to concentrate ( $2.23 \pm 0.77$ )', 'get a cold easily ( $2.19 \pm 0.82$ )', 'have headache ( $2.10 \pm 0.79$ )', 'poor memory ( $2.09 \pm 0.83$ )', 'no appetite ( $1.99 \pm 0.85$ )', 'difficult digestion ( $1.88 \pm 0.79$ )', 'feeling blue ( $1.82 \pm 0.84$ )', 'inflamed inner mouth ( $1.67 \pm 0.75$ )', 'pale face ( $1.32 \pm 0.63$ )'.

6) As for the correlation between iron parameter and clinical symptoms related to anemia, the hematocrit rate was negatively correlated with 'get a cold easily', 'pale face', 'feeling blue', 'difficult digestion' ( $p < 0.05$ ). The level of iron was negatively correlated with 'tired out easily', 'get a cold easily' ( $p < 0.05$ ) and TS (%) was negatively correlated with 'tired out easily' ( $p < 0.05$ ), 'get a cold easily' ( $p < 0.01$ )

Our study resulted that the iron intake of middle school

girls have risen comparing to the previous research (Hong et al. 2001). However the rate of anemia was higher than high school girls. It shows that middle school girls have the highest level of iron requirement due to the blood loss by physical growth and menstruation. It is required, therefore, to continuously plan and provide nutritional education to develop proper habits of eating habits and lifestyle for adolescent girls, and to take active measures, such as the supplementation of nutrition and iron, if their iron nutrition is poor.

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