The Iron Status of Korean Pregnant Women

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We surveyed Korean pregnant women who participated in the Maeil mothers' club and factory tour from March to April, 2004 and assessed volunteers' hemoglobin (Hb) levels. The average Hb level of 747 subjects was 11.5±1.5 g/dl and anemic subjects were 268 women, 35.9% of total subjects. The ratio of anemic subjects was 42.9% in the first trimester, 43.6% in the second trimester and 29.1% in the third trimester. About 87.9% of subjects began to take health foods after conception. Seventy nine percent of subjects took iron supplement as one of health foods and 73.8% of them began it in the second trimester. The results of this study showed that health foods were more effective than iron supplement alone in improving the iron status of Korean pregnant women. Therefore, the better improvement effects are expected when pregnant women begin health food-based approaches as early as possible before pregnancy to improve pre-pregnancy iron reserve.

INTRODUCTION

Body iron is classified into functional iron, storage iron and transport iron. The functional component is found largely in circulating hemoglobin and a smaller quantity in myoglobin and enzymes. The storage component, found as ferritin and hemosiderin in liver, spleen and bone marrow, serves as a reserve source for the functional component. The transport component is found in circulating transferrin.[1]

When the dietary iron intake is low (low iron intake), or when the iron requirement suddenly increases in a specific period such as infancy, adolescence or pregnancy (increased demands), or when the ingested iron is not appropriately absorbed or lost by chronic stomach hemorrhage, malaria or intestinal parasites (inadequate absorption and utilization), the iron balance is in disequilibrium and then iron deficiency occurs.[2]

Iron deficiency is one of the most common nutrient deficiencies. It affects 4~5 billion people, 66~80% of the world's population. Two billion people, over 30% of the world's population, are anemic mainly due to iron deficiency.[3] Iron deficiency anemia delays psychomotor development and impairs cognitive development in infants and children. Also, it reduces the ability to perform physical exercise and productivity in adults. Maternal anemia results in intrauterine growth retardation, low birth weight, increased perinatal mortality and increased maternal morbidity and mortality.[2,4]

The most sensitive index to assess the iron deficiency is serum ferritin level. However, its measurement is difficult and expensive. Therefore, researchers usually evaluate the iron status by hemoglobin and hematocrit levels that are measured easily, although they are not as sensitive and specific as the serum ferritin level.[5-7]

Although pregnant women are particularly vulnerable to iron deficiency, there are few researches on their iron status in Korea. Especially, the studies that assessed the Hb levels of Korean pregnant women have restricted to specific hospitals or public health centers. Yu and Yoon have recruited their subjects in the public health center in Ulsan.[8] Kim and Lee performed their research in the subjects of pregnant women in the general hospital of Gangneung.[6]

The objective of this research was to investigate the general iron status of Korean pregnant women and to find out more effective strategies to maintain good iron status during pregnancy. We surveyed the pregnant women participating in the Maeil mothers' club and factory tour in 2004 and assessed the volunteers' Hb levels.

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MATERIALS AND METHODS

1. Subjects

The subjects of this study were the Korean pregnant women who participated in the Maeil mothers' club and factory tour from March to April, 2004.

We explained the objective and significance of this study and distributed survey sheets before the event. Then, we collected the survey sheets after the event. Among 1,536 respondents, 747 volunteers had their Hb levels measured.

2. Data Management

The following information was extracted from the survey sheets: age, education level, household monthly income, residence, parity, height, self-reported weight, case history, dietary habits and gestational week.

3. Measurement of Hb Level

We assessed the volunteers' Hb levels by Astrim/SU peripheral blood vessel monitoring device (Sysmex Co. Ltd., Japan).

We used WHO criteria for anemia during pregnancy. With these criteria, the hemoglobin cutoff used to define anemia during pregnancy was 11 g/dl.

4. Data Analysis

Statistical analysis was performed by SPSS-PC program. All values were expressed as mean and standard deviation (SD) or frequency distribution and the percentage. Statistical differences were examined using the analysis of variance and Student-Nerman-Keuls' test.

RESULTS AND DISCUSSION

1. Backgrounds of the Subjects

The average age of the subjects was 28.7±3.0 years old (Table 1). Approximately 69.7% of the subjects were college graduates and the average household monthly income was 235.6±90.2 (₩10,000). Two hundred and fifty eight people in the subjects (34.5%) lived in Seoul, 185 (24.8%) in Gyeonggi-do, 114 (15.3%) in Busan, 73 (9.8%) in Incheon, 56 (7.5%) in Gwangju and 52 (7.0%) in Cheongju. The subjects with parity 0 are 679 people (90.9%). The average gestational week was 26.8±7.1 weeks. Their average height was 161.8±4.5 cm and average present weight was 61.7±8.5 kg (Table 2).

The participants in this study were healthy enough to

Table 1. The social characteristics of subjects

Age (y)	N (%)	Education (Graduation)	N (%)	Household monthly income (₩10,000)	N (%)	Residence	N (%)	Parity	N (%)
~19	1 (0.1)	Middle school	2 (0.3)	~100	18 (2.4)	Seoul	258 (34.5)	0	679 (90.9)
20~24	42 (5.6)	High school	190 (25.4)	101~200	331 (44.3)	GyeongGi-do	185 (24.8)	1	65 (8.7)
25~29	422 (56.5)	College	521 (69.7)	201~300	212 (28.4)	Busan	114 (15.3)	2	3 (0.4)
30~34	256 (34.3)	Beyond postgraduate	29 (3.9)	301~400	51 (6.8)	Incheon	73 (9.8)		
35~39	25 (3.3)	No response	5 (0.7)	401~	19 (2.5)	Gwangju	56 (7.5)		
40~	1 (0.1)			No response	116 (15.5)	Cheongju	52 (7.0)		
						Others	3 (0.4)		
						No response	6 (0.8)		
Total	747 (99.9)		747 (100.0)		747 (99.9)		747 (100.1)		747 (100.0)
Average	28.7±3.0[1]				235.6±90.2				

1) Mean±SD

Table 2. The pregnant women's height, weight and BMI

Factor Group Trimester (weeks)	Height (cm)		Past (Before conception)				Present (After conception)				Weight gain (kg)		BMI gain (kg/m²)	
			Weight (kg)		BMI (kg/m²)		Weight (kg)		BMI (kg/m²)					
	N	Average	N	Average	N	Average	N	Average	N	Average	N	Average	N	Average
First (0~13)	28	161.6 ±4.1[1]	27	54.6±7.0	27	20.9±2.4	27	56.5±7.7	27	21.6±2.6	299	1.9±3.3	298	0.7±1.2
Second (14~26)	315	161.6±4.6	311	54.7±8.2	310	20.9±2.9	301	59.0±8.3	299	22.6±2.9	371	4.6±3.4	367	1.7±1.3
Third (27~40)	387	162.0±4.4	382	53.9±7.5	378	20.5±2.7	375	64.2±7.8	370	24.5±2.7	697	10.6±4.0	692	4.0±1.5
Total	730	161.8±4.5	720	54.2±7.8	715	20.7±2.8	703	61.7±8.5	696	23.5±3.0		7.7±4.9		2.9±1.8

1) Mean±SD

participate in the event. Most of the respondents (86.5%) had not experienced any special disease before conception (Table 3). The most frequent symptoms caused by conception were constipation and nausea.

2. Food Habits of the Subjects

About 65.9% of the total respondents decided to take care of their food intake when they knew their conception. They chose alcohol, caffeine, convenience foods as the avoided foods and milk and dairy foods, fruits and vegetables, soybeans, nuts as the preferred foods.

The meal, which the subjects most frequently skipped, was breakfast (Table 4). The most common reasons of skipping a meal in our subjects were 'late rising' and

Table 3. The subjects' case history

Before conception			After conception		
Disease	Subjects		Symptoms by pregnancy	Subjects	
	N	%		N	%
Hypertension	2	0.3	Hypertension	4	0.6
Diabetes	0	0.0	Diabetes	8	1.1
Hypercholesterolemia	0	0.0			
Anemia	51	7.8	Anemia	114	15.8
			Swelling	183	25.3
			Benumbed hands and feet	200	27.7
			Nausea	250	34.6
			Constipation	269	37.2
The others	41	6.3	The others	55	7.6
Nothing	566	86.5	Nothing	120	16.6
Total	654		Total	723	

Table 4. The ratio of skipping per meal and the causes

The ratio of skipping per meal				The causes of skipping a meal			
Meal	Subjects (%)	Results of Report[1] (%)		Causes	Subjects (%)	Results of Report[1] (%)	
		20~29 year old women	30~49 year old women			20~29 year old women	30~49 year old women
Breakfast	31.2	45.8	22.5	Late rising	44.8	21.9	10.7
Lunch	5.4	6.9	5.3	No appetite	28.8	12.8	20.0
Dinner	2.6	7.4	4.3	Indigestion	21.0	2.0	4.2
				Snacks	16.4	1.9	5.2
				For weight loss	2.7	4.9	6.4
				For saving	0.2	0.2	0.2
				No enough time	2.2	29.9	20.1
				Habitually	12.7	23.8	26.8
				The others	4.2	2.7	6.4

1) Report on 2001 National Health and Nutrition Survey

Table 5. The pregnant women's dietary pattern

The frequency of eating out				The frequency of snack per day				The kinds of snacks			
Frequency	Subjects (%)	Results of Report[1] (%)		Times/day	Subjects (%)	Results of Report[1] (%)		Reasons	Subjects (%)	Results of Report[1] (%)	
		20~29 year old women	30~49 year old women			20~29 year old women	30~49 year old women			20~29 year old women	30~49 year old women
≥twice/day	0.8	9.1	3.6	0	5.2	15.3	21.2	Fruit /Fruit juice	74.9	41.3	58.0
once/day	9.8	29.6	15.2	1	30.3	44.3	41.3	Milk/Dairy products	41.2	6.8	5.2
≥once/week	63.3	32.9	29.8	2	49.4	28.2	26.2	Bakery /Cake	32.9	7.5	7.2
≥once/month	22.1	19.5	29.1	≥ 3	15.1	12.1	11.3	Cookie /Snacks	28.0	20.4	7.0
Almost never	4.5	8.9	22.3					Rice cake/Roasted rice	8.5	3.6	2.4
								Beverages	6.7	15.1	17.7
								Noodles	5.0	0.2	0.7
								Ramyun	4.4	3.0	1.5
								Crispy fried food	0.8	2.1	0.3

1) Report on 2001 National Health and Nutrition Survey

'no appetite'. The ratios of 'indigestion' and 'snacks' were higher than those of the Korean 20~49 year old women in the Report on 2001 National Health and Nutrition Survey (2001 Nutrition Survey).[9] On the other hand, the ratios of 'not enough time' and 'habitually' were lower than those of the Korean 20~49 year old women in the 2001 Nutrition Survey.

The frequency of eating out was decreased and the frequency of snack per day was increased in our subjects compared with the results in the Korean 20~49 year old women in the 2001 Nutrition Survey (Table 5). The most frequently eating snacks in the subjects were fruit/fruit juice and milk/dairy products although milk/dairy products were unpopular snacks to common Korean women of 20~49 year old.[9]

3. The Iron Status of Korean Pregnant Women

In this study, the average Hb level of pregnant women was 11.5±1.5 g/dl and 35.9% of the subjects were anemic (Table 6). Yu and Yoon[8] reported similar data: the average Hb level of pregnant women in Ulsan was 11.5±1.1 g/dl and the ratio of anemic women was 32.9%. Later, Kim and Lee[6] reported more serious iron deficiency data: the average Hb level of pregnant women in Gangneung was 10.90±1.43 g/dl and 48.5% of the subjects were anemic.

The average Hb level of subjects was 11.4±1.5 g/dl in the first trimester, 11.1±1.4 g/dl in the second and 11.9±1.6 g/dl in the third. The ratio of anemic pregnant women was 42.9% in the first trimester, 43.6% in the second and 29.1% in the third. The average Hb level of the subjects in the third trimester was significantly higher than those of subjects in the first and second trimesters. Also the ratio of anemic women in the third trimester was lower than those of subjects in the first and second trimester.

The factors that affected the subjects'Hb level significantly were household monthly income, residence and trimester (Fig. 1, 2). When the pregnant subjects were wealthier, their Hb levels were statistically increased. Subjects' economic status might make their access to information and health care service much easier. Also, this situation has been observed in the comparative studies between developed and developing countries, and urban and rural population.

4. The Relationship between Supplements and Hb Levels

In our study, 87.9% of subjects began to take health foods including iron supplement after conception (Table 7). Seventy nine percent of subjects took iron supplement as one of health foods and 73.8% of them began their

Table 6. The relationship between trimesters of pregnant women and Hb level

Gestational stage (weeks)	Average gestation week (weeks)	Total subjects			Anemic subjects		
		N	%	Average Hb level (g/dl)	N	%	Average Hb level (g/dl)
First (0~13 weeks)	10.8±2.6[1]	28	3.7	11.4±1.5[a2]	12	42.9	10.1±0.9
Second (14~26 weeks)	21.3±3.3	321	43.0	11.1±1.4[a]	140	43.6	9.9±0.9
Third (27~40 weeks)	32.4±3.4	398	53.3	11.9±1.6[b]	116	29.1	10.0±0.7
Total	26.8±7.1	747	100.0	11.5±1.5	268	35.9	

1) Mean±SD
2) The a and b indicate statistically significant difference (P < 0.05) using analysis of variance and Student-Neuman-Keuls' test

Fig. 1 The relationship between household monthly income and Hb level
* The asterisk indicates statistically significant difference (P < 0.05) using analysis of variance and Student-Neuman-Keuls' test.
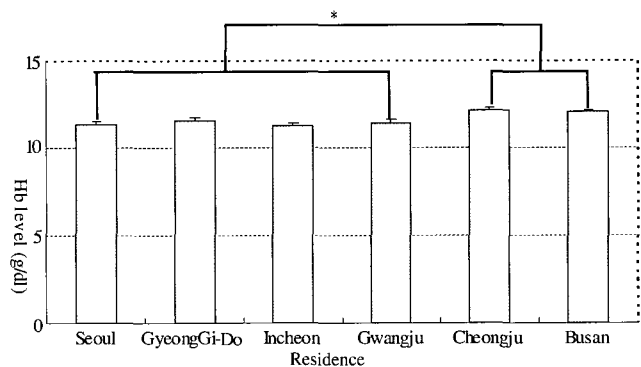

Fig. 2 The relationship between residence and Hb level
* The asterisk indicates statistically significant difference (P < 0.05) using analysis of variance and Student-Neuman-Keuls' test.

Table 7. The relationship between iron supplement and Hb level

Kinds of supplement for pregnancy	Subjects		Average Hb level (g/dl)
	N	%	
Take iron supplement	579	79.0	11.6±1.5
Only iron supplement	434	59.2	11.5±1.5
More than 2 health foods including iron supplement	145	19.8	11.8±1.7
Not take iron supplement	154	21.0	11.3±1.6
Vitamins	144	19.6	11.8±1.7
Health foods	33	4.5	12.0±1.6
Foods to aid physically	6	0.8	11.8±1.1
Chinese medicine	12	1.6	10.7±1.5
No supplement	89	12.1	11.1±1.5
Total	733		

Table 8. The iron supplementary products

Name	Manufacturer	Form	The type of iron	The content of iron	The other nutrients	N
F-1		Pill	Ferric Hydroxide Polymaltose Complex 357 mg	100 mg as Fe^{3+}		66
F-2	C	Pill	Ferric Hydroxide Polymaltose Complex 178.50 mg	50 mg as Fe^{3+}	Folic acid 0.175 mg 33% Pydoxine hydrochloride 3.03 mg	50
F-3		Liquid 5 ml	Ferric Hydroxide Polymaltose Complex 357 mg	100 mg as Fe^{3+}		7
M	W	Pill		60 mg	12 vitamins including folic acid 12 minerals including iron	55
H	D	Chewable pill	Iron proteinsuccinylate 400 mg			34
		Liquid 15 ml	Iron proteinsuccinylate 800 mg	40 mg as Fe^{3+}		
I	A	Pill		10 mg	Spinachconcentrate Orange-peel powder Folic acid 133 μg	27
F	B	Pill	Dried ferrous sulfate 256 mg	80 mg as Fe^{2+}	Ascorbic acid 30 mg L-Glutamine 30 mg	18
		Capsule	Ferrous gluconate 200 mg	23.16 mg	5 Vitamins including folic acid	

iron intervention in the second trimester (16~23 gestational weeks). Among the subjects who did not take any iron supplement (21%), some subjects would plan to take iron supplement if they reached at certain gestational age. This ratio was much higher than those in other studies. Yu and Yoon[4] reported 26.5% and Kim and Lee[6] reported 23.0% in ratios of the subjects who took iron supplement. Table 8 shows the characteristics of products which the subjects in this study were taking as iron supplementation.

The average Hb level of pregnant women taking iron supplement alone was 0.4 g/dl higher than that of subjects with no supplement. This result showed that iron supplementation was effective in improving the iron status of pregnant women. When pregnant women took more than two health foods including iron supplement or vitamins or other health foods in the exception of iron supplement, their average Hb levels were higher than those of the subjects with only iron supplement as well as those of the subjects with no supplement. It recommended that iron supplementation was effective and the other health

food intake was more effective in improving the iron status of pregnant women.

Iron supplementation during pregnancy has been a common practice throughout the world. In fact, it has been considerably effective in clinical trials strictly controlled by researchers. However, it has been less effective in large-scale community programs.[10,11] Researchers have pointed out several factors that can limit the effectiveness of iron interventions; availability of iron tablets, access to health care, care provider's behavior and mother's compliance.

The ratio of subjects taking iron supplement in this study was 79%, relatively high compared to those of similar studies. The subjects in this study were well-educated and well-to-do metropolitan residents. It means they were easy to access the health care system which provided the health care service including education about the significance of iron and supply of iron tablet and so on. The most significant factor to limit the effectiveness of iron supplementation in this study might be the lack of mother's compliance.

Noncompliance is the result of an aversion to the side

effects of taking iron supplement. Therefore, various strategies have been adopted to reduce the side effects of iron supplements. Researchers have reduced the iron dosage.[11] Also, they have developed other supplement methods such as gastro delivery system (GDS)[12] and intravenous injections. New approach in iron supplementation is intermittent, preventive supplementation, the weekly administration of iron.[13,14] Otherwise, iron supplementation programs still have the drawback of delivery system and compliance.

Now, researchers have become concerned in more fundamental strategies. Some researchers indicated the possibility that the iron requirement during pregnancy should be overestimated and the potential of diet-based approaches should be underestimated. When the women of childbearing age can have sufficient iron pool at the onset of pregnancy and take sufficient dietary iron during pregnancy, they might not need to take excessive iron supplementation during pregnancy.[15] It is becoming more evident that pre-pregnancy iron stores are the most important determinant of iron status at term. Therefore, iron reserves should be built prior to pregnancy.

We were concerned in the health food intake which was more effective than iron supplementation in improving the iron status of pregnant women in this study. The subjects began their health food intake after they had recognized their conception. The better improvement effects are expected when they begin their intake as soon as possible before pregnancy. As things are, this approach might be primarily a preventive program. In other words, it is not proper to treat severe anemiain large sections of population and it should be combined with supplementation in the condition of severe anemia.

CONCLUSION

This study was performed to investigate the iron status of Korean pregnant women and to improve effective strategies to maintain good iron status during pregnancy. We surveyed Korean pregnant women who participated in the Maeil mothers' club and factory tour from March to April, 2004 and assessed volunteers' Hb levels.

The results of our study showed that the ratio of Korean anemic pregnant women was still high by 35.6%, despite the high ratio of subjects with iron supplementation by 79%. It reconfirms that iron supplement is effective in improving the iron status of Korean pregnant women. At the same time, it shows that the health food intake is further effective than iron supplementation alone. Therefore, our

researchers would expect much more improvement effect than the results of this study when pregnant women begin health food intakes as early as possible and ideally for several months before conception to improve pre-pregnancy iron reserve. Future studies should focus on the effectiveness and beginning time of health food-based approaches in improving the iron status of Korean pregnant women.

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