Nutrition Research and Practice (*Nutr Res Pract*) 2013;7(3):199-206
http://dx.doi.org/10.4162/nrp.2013.7.3.199
pISSN 1976-1457 eISSN 2005-6168

Comparison of dietary food and nutrient intakes by supplement use in pregnant and lactating women in Seoul

Hyesook Kim[1], Won Jang[1], Ki-Nam Kim[2], Ji-Yun Hwang[3], Hae-Kyung Chung[4], Eun-Ju Yang[5], Hye-Young Kim[6], Jin-Hee Lee[7], Gui-Im Moon[8], Jin-Ha Lee[7], Tae-Seok Kang[7] and Namsoo Chang[1§]

[1]*Department of Nutritional Science and Food Management, Ewha Womans University, Daehyeon-dong, Seodaemun-gu, Seoul 120-750, Korea*
[2]*Department of Food and Nutrition, Daejeon University, Daejeon 300-716, Korea*
[3]*Graduate School of Education, Sangmyung University, Seoul 110-743, Korea*
[4]*Department of Food Science and Nutrition, Hoseo University, Asan 336-795, Korea*
[5]*Department of Culinary Science, Honam University, Gwangju 506-714, Korea*
[6]*Department of Food and Nutrition, Yongin University, Yongin 449-714, Korea*
[7]*Nutrition and Functional Food Research Team, Ministry of Food and Drug Safety, Cheongwon 363-700, Korea*
[8]*Nutrition Safety Policy Division, Ministry of Food and Drug Safety, Cheongwon 363-700, Korea*

Abstract

This study was performed to compare the dietary food and nutrient intakes according to supplement use in pregnant and lactating women in Seoul. The subjects were composed of 201 pregnant and 104 lactating women, and their dietary food intake was assessed using the 24-h recall method. General information on demographic and socioeconomic factors, as well as health-related behaviors, including the use of dietary supplements, were collected. About 88% and 60% of the pregnant and lactating women took dietary supplements, respectively. The proportion of dietary supplements used was higher in pregnant women with a higher level of education. After adjusting for potential confounders, among the pregnant women, supplement users were found to consume 45% more vegetables, and those among the lactating women were found to consume 96% more beans and 58% more vegetables. The intakes of dietary fiber and β-carotene among supplement users were higher than those of non-users, by 23% and 39%, respectively. Among pregnant women, the proportion of women with an intake of vitamin C (from diet alone) below the estimated average requirements (EAR) was lower among supplement users [users (44%) vs. non-users (68%)], and the proportion of lactating women with intakes of iron (from diet alone) below the EAR was lower among supplement users [usesr (17%) vs. non-users (38%)]. These results suggest that among pregnant and lactating women, those who do not use dietary supplements tend to have a lower intake of healthy foods, such as beans and vegetables, as well as a lower intake of dietary fiber and β-carotene, which are abundant in these foods, and non-users are more likely than users to have inadequate intake of micro-nutrient such as vitamin C and iron.

Key Words: Dietary intake, supplement, pregnant women, lactating women

Introduction

Dietary supplement usage has been increasing along with the rapid economic growth in the general population of Korea [1], and supplemental usage may be regarded as common among some subgroups, including pregnant and lactating women [2]. Current knowledge regarding the benefits of dietary supplements has led to recommendations and guidelines for their use within specific population subgroups, for example, iron and folic acid supplementation has been advised for pregnant women [3,4]. The use of dietary supplements during pregnancy may provide an important contribution to nutrient intake [5]. Maternal nutrition is an important factor which is responsible not only for the health of the baby, but also for the baby's long term growth [6-8]. Like pregnancy, lactation represents a period of the life cycle which is characterized by increased nutrient requirements which may or may not be easily achieved by diet alone [9]. Thus, many women opt for dietary supplements so as to ensure the supply of a number of micronutrients, such as iron and folic acid. However, the use of dietary supplements during lactation is even less well documented than that during pregnancy.

Several studies conducted among the US general population have reported that factors related to higher supplement use included being female, older, more educated, non-Hispanic white,

This study was supported by a grant (12162KFDA157) from Ministry of Food and Drug Safety in 2012 and the Brain Korea 21 project.
§ **Corresponding Author:** Namsoo Chang, Tel. 82-2-3277-3468, Fax. 82-2-3277-2862, Email. nschang@ewha.ac.kr
Received: February 13, 2013, Revised: April 3, 2013, Accepted: April 3, 2013

physically active, normal or underweight, nonsmokers, and having a higher intake of nutrients from food [10-12]. Although correlation does not infer causality, it is likely that these factors, all of which tend to be related to positive health practices, drive supplement use, and that individuals at greater risk of poor health are generally less likely to take supplements. Interestingly, however, even in developed countries such as the US, less is known about the association between supplement use and the dietary food and nutrient intakes in pregnant and lactating women than that which is known of the general population.

Recently, from the third Korean National Health and Nutrition Survey data, it has been reported that there was difference in the nutrient intake from natural food sources, socio-demographic factors such as age, income and education level, and lifestyle factors among supplement users and non-user in Korean general population [1]. However, to our knowledge, no study has been carried out to investigate the association between supplement use and the dietary food and nutrient intakes of Korean pregnant and lactating women. Therefore, the aim of the present study was to compare the dietary food and nutrient intakes according to supplement use among pregnant and lactating women living in Seoul, South Korea.

Subjects and Methods

Study Subjects

This study was performed through face to face interview of 201 pregnant (> 12 weeks of gestation) and 104 lactating (< 12 months of lactation) women, who agreed to the survey after receiving a full explanation of the nature of the study. The subjects included those who visited the public health center at Y district, one of the 25 districts in Seoul, South Korea, from May to July of 2012. They were women who visit public health center regularly to receive the nutritional supplements such as iron, folic acid tablets or to vaccinate their children or etc., and were not women who participate in the Nutri Plus program (Korean Supplemental Nutrition Program for Women, Infants, and Children). This study protocol was approved by the Institutional Review Board of Ewha Womans University (IRB NO. IRB 2012-1-2).

General characteristics

All of the participants were interviewed by trained interviewers, so as to obtain general information on demographic factors, socioeconomic factors, and health-related behaviors, including age, height, weight (pre-pregnancy and present), education, family income, employment status, alcohol consumption, and exposure to passive smoking. BMI was calculated as weight (pre-pregnancy and present) in kilograms divided by the square of height in meters, using self-reported height and weight data. Education levels were categorized as follows: ≤ high school (not educated, dropped out of primary school, graduated from primary school but dropped out of middle school, graduated from middle school but dropped out of high school, or graduated from high school), ≤ university (graduated from a 2-y university program or dropped out of a 4-y university program), and > university (graduated from a 4-y university program or graduated from graduate school or higher). Family monthly income was categorized as follows: < US$ 2,000, US$ 2,000-4,000, and > US$ 4,000. Employment status was classified as: employed (full-time), and non-employed (part-timer or unemployed). Alcohol consumption was classified as drinker and non-drinker. Exposure to passive smoking was defined as being exposed to someone else's cigarette smoke either at home or at work.

Dietary supplement use

The study participants were asked whether they currently used any vitamin or mineral supplements. Users were also asked to report, in detail, information regarding the brand names of dietary supplements and frequencies of consumption. Daily nutrient intakes from dietary supplements were calculated by using these frequencies and the nutrient contents of the supplements. The dietary folate equivalent (DFE) was calculated based on 1.0 μg DFE being equivalent to 1.0 μg of food folate, or 0.6 μg of folic acid for supplemental folic acid taken with meals [13].

Dietary assessment

Dietary intake data were estimated by a trained dietitian using a 24-h recall method. The food items most frequently eaten were prepared as defined units and were shown to the subjects to help them report their volume of intake with greater accuracy. The subjects' dietary intakes of food and nutrient were assessed using a computerized nutrient-intake assessment software program (CAN-Pro 3.0, Korean Nutrition Society, Seoul, Korea). Nutrient intake data of diet only and diet including supplements were compared with the Estimated Average Requirements (EAR) of Korean Dietary Reference Intake [14]. We also assessed the proportions of subjects who met the two guidelines (Have dairy products more than 3 times a day / Eat meat, fish, vegetables and fruits every day) that are available to assess from the 24-h recall data among the six guidelines of "Dietary Guidelines for Pregnant and Lactating Women, Korea". Among these guidelines, "Eat meat, fish, vegetables and fruits every day" was classified into three categories as follows: meat, fish, eggs or beans; vegetables, fruits, and it was assessed whether the amount of consumption for each food exceeded the 1 serving/day. Serving sizes of representative food items in each food groups were defined according to the Korean Dietary Reference Intake [14].

Statistical analysis

Food and nutrient intakes in the subjects were log transformed to normalize the distributions. The data are expressed as mean ± SD values (continuous variables) or as numbers and percentages (categorical variables). Subjects were divided into two groups [below the EAR/above the EAR] according to their levels of dietary nutrient intake. Student's *t*-test was used to compare anthropometric parameters between supplement user and non-user. The χ^2 test and fisher's exact test was used to compare demographic and socioeconomic factors, as well as health-related behaviors, including nutrient intake groups [below the EAR/above the EAR] according to supplement use. Daily food intakes and daily nutrient intakes according to supplement use were evaluated using the general linear model (GLM) test after adjusting for potential confounders such as age, pre-pregnancy BMI, education level and energy intake. All analyses were performed using SPSS software (version 18.0, SPSS, Chicago, IL, USA). All reported probability tests were two-tailed and the differences were considered significant at the 5% level.

Results

General characteristics according to supplement use of the subjects

Pregnant and lactating women were aged 31.4 ± 3.8 years and 31.2 ± 4.1 years, respectively (Table 1). About 88% and 60% of pregnant and lactating women took dietary supplements, respectively. Additional analyses of the type of supplements used showed that 63% of the pregnant women and 11% of the lactating women used a supplement containing both iron and folic acid, while about 6% and 65% of the pregnant and lactating women, respectively, used iron supplements without folic acid, and about 6% and 5% of the pregnant and lactating women, respectively, used folic acid supplements without Iron. Almost 80% of the pregnant women and 76% of the lactating women took only one supplement, while 2% of the pregnant and 5% of the lactating women took more than three (data not shown).

The proportion of dietary supplement user was higher in those pregnant women with a higher level of education. Except for education level, general information on demographic and socioeconomic factors as well as health-related behaviors did not differ significantly between supplement users and non-users (Table 1).

Table 1. General characteristics according to supplement use in the subjects

	Pregnant women				Lactating women			
	All (n = 201)	User (n = 176)	Non-user (n = 25)	*P*-value	All (n = 104)	User (n = 62)	Non-user (n = 42)	*P*-value
Age (yrs)	31.4 ± 3.8[1)]	31.5 ± 3.8	30.1 ± 3.0	0.080[2)]	31.2 ± 4.1	31.5 ± 4.0	30.9 ± 4.2	0.503
Height (cm)	161.9 ± 4.6	162.0 ± 4.7	160.9 ± 4.0	0.237	161.4 ± 4.5	161.4 ± 4.6	161.3 ± 4.4	0.881
Pre-pregnancy weight (kg)	55.2 ± 10.6	54.9 ± 10.9	56.8 ± 8.7	0.406	53.9 ± 8.8	54.0 ± 9.5	53.9 ± 7.9	0.963
Pre-pregnancy BMI (kg/m^2)	21.0 ± 3.9	20.9 ± 3.9	22.0 ± 3.5	0.199	20.7 ± 3.0	20.7 ± 3.4	20.6 ± 2.4	0.949
Education[4)]								
≤ High school	28 (13.9)	19 (10.8)	9 (36.0)	0.004[3)]	19 (18.3)	12 (19.4)	7 (16.7)	0.659
≤ University	146 (72.6)	131 (74.4)	15 (60.0)		146 (72.6)	131 (74.4)	15 (60.0)	
> University	27 (13.4)	26 (14.8)	1 (4.0)		27 (13.4)	26 (14.8)	1 (4.0)	
Family income (10,000 won/month)[5)]								
< 200	31 (15.4)	25 (14.2)	6 (24.0)	0.583	24 (23.1)	14 (22.6)	10 (23.8)	0.282
200-400	116 (57.7)	103 (58.5)	13 (52.0)		54 (51.9)	29 (46.8)	25 (59.5)	
> 400	52 (25.9)	46 (26.1)	6 (24.0)		24 (23.1)	18 (29.0)	6 (14.3)	
Employed	59 (29.4)	52 (29.5)	7 (28.0)	1.000	27 (26.0)	18 (29.0)	9 (21.4)	0.495
Current drinker	1 (0.5)	0 (4.0)	1 (4.0)	0.124	6 (5.8)	3 (4.8)	3 (7.1)	0.683
Passive smoker	44 (21.9)	39 (22.2)	5 (20.0)	1.000	24 (23.1)	12 (19.4)	12 (28.6)	0.391
Percent of supplement use	87.6				59.6			
Type of supplements used								
Iron only	-	10 (5.7)	-		-	40 (64.5)	-	
Folic acid only	-	10 (5.7)	-		-	3 (4.8)	-	
Iron + Folic acid	-	111 (63.1)	-		-	7 (11.3)	-	
Multivitamin / mineral	-	66 (37.5)	-		-	20 (32.3)	-	

[1)] Values are mean ± SD or number (%).
[2)] From Student's t-test.
[3)] From χ^2-test or fisher's exact test, as appropriate.
[4)] ≤ high school (not educated, dropped out of primary school, graduated from primary school but dropped out of middle school, graduated from middle school but dropped out of high school, or graduated from high school); ≤ university (graduated from a 2-y university program or dropped out of a 4-y university program); > university (graduated from a 4-y university program or graduated from graduate school or higher).
[5)] Data for 199 pregnant women and 102 lactating women.

Table 2. Dietary food intakes according to supplement use in the subjects

	Pregnant women				Lactating women			
	All (n = 201)	User (n = 176)	Non-user (n = 25)	*P*-value	All (n = 104)	User (n = 62)	Non-user (n = 42)	*P*-value
Cereals and cereal products (g)	246.9 ± 108.8[1)]	247.8 ± 111.3	240.6 ± 91.1	0.464[2)]	261.2 ± 89.7	264.7 ± 80.9	255.9 ± 102.4	0.675
Potatoes and starch products (g)	38.8 ± 83.4	39.7 ± 87.0	32.6 ± 52.3	0.459	43 ± 112.5	40.6 ± 123.7	46.6 ± 94.5	0.824
Beans and beans products (g)	46.3 ± 69.7	46.5 ± 69.2	44.8 ± 74.2	0.844	130.1 ± 179.6	161.6 ± 193.4	82.5 ± 146.3	0.010
Vegetables (g)	267.5 ± 183.5	278.3 ± 187.2	192.3 ± 136.3	0.048	303.5 ± 292.5	355.2 ± 332.7	225.3 ± 197.3	0.006
Fruits (g)	514.5 ± 530.2	531.1 ± 551.8	397.8 ± 327.6	0.714	321.6 ± 412.1	326.5 ± 430.4	314.3 ± 387.9	0.672
Total plant food (g)	1,146.9 ± 587.6	1,176.6 ± 600.8	939.1 ± 440.9	0.711	1,100.6 ± 595.2	1,194.5 ± 620.1	958.6 ± 531.6	0.086
Meats and meat products (g)	100.4 ± 121.4	101.1 ± 124.6	95.6 ± 97.8	0.886	145.8 ± 213.9	152.0 ± 222.0	136.3 ± 203.3	0.954
Eggs and egg products (g)	30.0 ± 38.1	30.4 ± 38.6	27.3 ± 34.8	0.554	21.1 ± 34.8	19.2 ± 35.0	23.9 ± 34.8	0.845
Fish and shell fish (g)	54.5 ± 73.4	54.6 ± 73.5	53.6 ± 74.2	0.531	61.2 ± 93.8	67.3 ± 109.5	51.8 ± 63.4	0.716
Milk and dairy products (g)	187.8 ± 175.6	192.2 ± 179	156.9 ± 149.1	0.801	146.9 ± 198.6	126.2 ± 151.0	178.4 ± 253.2	0.481
Total animal food (g)	372.7 ± 213.3	378.3 ± 218.3	333.4 ± 172.4	0.447	375.0 ± 302.9	364.7 ± 275.1	390.4 ± 343.7	0.270
Total food intakes (g)	1,611.3 ± 659.5	1,645 ± 675.8	1,375.7 ± 479.1	0.712	1,561.1 ± 678.7	1,631.3 ± 721.6	1,454.9 ± 601.2	0.812

[1)] Values are mean ± SD.
[2)] From GLM test including age, pre-pregnancy BMI, education level and energy intake as covariates.

Table 3. Proportions of subjects who met the "Dietary Guidelines for Pregnant and Lactating Women, Korea" according to supplement use

	Pregnant women				Lactating women			
	All (n = 201)	User (n = 176)	Non-user (n = 25)	*P*-value	All (n = 104)	User (n = 62)	Non-user (n = 42)	*P*-value
Have dairy products more than 3 times a day								
0 serving[1)]/day	77 (38.3)[2)]	63 (35.8)	14 (56.0)	0.163[3)]	57 (54.8)	34 (54.8)	23 (54.8)	0.542
1 serving/day	65 (32.3)	59 (33.5)	6 (24.0)		29 (27.9)	19 (30.6)	10 (23.8)	
2 serving/day	44 (21.9)	39 (22.2)	5 (20.0)		12 (11.5)	7 (11.3)	5 (11.9)	
≥ 3 serving/day	15 (7.5)	15 (8.5)	0 (0.0)		6 (5.8)	2 (3.2)	4 (9.5)	
Eat meat, fish, vegetables and fruits every day								
< 1 serving/day	87 (43.3)	72 (40.9)	15 (60.0)	0.112	51 (49.0)	27 (43.5)	24 (57.1)	0.246
≥ 1 serving/day	114 (56.7)	104 (59.1)	10 (40.0)		53 (51.0)	35 (56.5)	18 (42.9)	
Meat or fish or eggs or beans								
< 1 serving/day	32 (15.9)	27 (15.3)	20 (80.0)	0.561	9 (8.7)	3 (4.8)	6 (14.3)	0.153
≥ 1 serving/day	169 (84.1)	149 (84.7)	5 (20.0)		95 (91.3)	59 (95.2)	36 (85.7)	
Vegetables								
< 1 serving/day	34 (16.9)	25 (14.2)	9 (36.0)	0.018	13 (12.5)	5 (8.1)	8 (19.0)	0.174
≥ 1 serving/day	167 (83.1)	151 (85.8)	16 (64.0)		91 (87.5)	57 (91.9)	34 (81.0)	
Fruits								
< 1 serving/day	35 (17.4)	33 (18.8)	2 (8.0)	0.262	37 (35.6)	20 (32.3)	17 (40.5)	0.516
≥ 1 serving/day	166 (82.6)	143 (81.3)	23 (92.0)		67 (64.4)	42 (67.7)	25 (59.5)	

[1)] Serving sizes of representative food items in each food groups was defined according to the Korean Dietary Reference Intake.
[2)] Values are number (%).
[3)] From χ^2-test or fisher's exact test, as appropriate.

Dietary food intakes according to supplement use of the subjects

Pregnant women who used supplements were found to consume 45% more vegetables (278.3 ± 187.2 g/day vs 192.3 ± 136.3 g/day) than non-users, after adjustment for age, pre-pregnancy BMI, education level and energy intake. In lactating women, supplement users had significantly higher intake levels of beans (96%, 161.6 ± 193.4 g/day vs 82.5 ± 146.3 g/day), vegetables (58%, 355.2 ± 332.7 g/day vs 225.3 ± 197.3 g/day), and fruits and vegetables (21%, 681.7 ± 553.4 g/day vs 539.5 ± 485.9 g/day) than non-users (Table 2).

When we assessed the proportions of subjects who met the "Dietary Guidelines for Pregnant and Lactating Women, Korea", only 7% of the pregnant women and 6% of the lactating women met the guidelines for "Have dairy products more than 3 times a day" (Table 3). Among the pregnant and lactating women, the proportions of women consuming dairy products of less than 1 serving/day were 38% and 55%, respectively. Only half of the pregnant and lactating women met the guidelines for "Eat meat, fish, vegetables and fruits every day", while the percentage of pregnant women consuming less than 1 serving/day of vegetables was 14% among supplement users which was lower than 36% in non-users ($P < 0.05$). Among the pregnant and lactating

Table 4. Dietary nutrient intakes according to supplement use in the subjects

	Pregnant women				Lactating women			
	All (n = 201)	User (n = 176)	Non-user (n = 25)	*P*-value	All (n = 104)	User (n = 62)	Non-user (n = 42)	*P*-value
Energy (kcal)	1,872.1 ± 547.2[1)]	1,892.7 ± 547.8	1,727.5 ± 531.0	0.264[2)]	1,924.2 ± 546.5	1,975.2 ± 503.7	1,848.9 ± 602.5	0.189
Carbohydrate (g)	273.8 ± 82.8	276.6 ± 82.1	253.8 ± 87.1	0.857	273.6 ± 80.1	282.5 ± 76.4	260.5 ± 84.5	0.601
Protein (g)	74.5 ± 27.3	75.3 ± 28	68.6 ± 21	0.358	79.6 ± 30.8	84.0 ± 31.8	73.2 ± 28.3	0.193
Fat (g)	56.0 ± 27.5	56.6 ± 27.8	51.4 ± 25.3	0.823	57.3 ± 29.8	57.4 ± 28.5	57.2 ± 32	0.367
Fiber (g)	21.4 ± 9.8	21.8 ± 9.9	18.4 ± 8.9	0.773	22.0 ± 11.5	23.8 ± 11.3	19.4 ± 11.4	0.041
Calcium (mg)	610.8 ± 301.6	626.8 ± 305	498.8 ± 254.2	0.296	662.1 ± 381.1	682.2 ± 377.1	632.3 ± 389.6	0.967
Iron (mg)	14.0 ± 5.5	14.3 ± 5.6	11.6 ± 3.7	0.486	15.6 ± 7.4	16.5 ± 7.6	14.3 ± 7.1	0.371
Zinc (mg)	10.4 ± 11.8	9.9 ± 6.3	14.1 ± 29.2	0.074	10.5 ± 6.3	11.4 ± 7.4	9.3 ± 3.7	0.429
Folate (μg DFE)	375.5 ± 145	378 ± 145.9	358.3 ± 139.8	0.260	406.7 ± 188.3	437.9 ± 187.7	360.7 ± 181.8	0.111
Vitamin C (mg)	126.1 ± 81.1	126.3 ± 72.0	125.2 ± 130.3	0.762	107.3 ± 83.1	118.6 ± 89.7	90.6 ± 70.2	0.109
Vitamin E (mg α-TE)	17.1 ± 10.1	17.2 ± 10.0	16.2 ± 11.1	0.901	17.9 ± 11.0	19.0 ± 11.5	16.4 ± 10.1	0.629
β-carotene (μg)	4,043.7 ± 4,256.4	4,228.3 ± 4,432.8	2,743.7 ± 2,383.4	0.179	3,320.0 ± 3,038.7	3,745.9 ± 2,873.6	2,691.4 ± 3,198.7	0.034

[1)] Values are mean ± SD.
[2)] From GLM test including age, pre-pregnancy BMI, education level and energy intake as covariates.

Table 5. Proportions of subjects with nutrient intake (diet only & diet including supplement) below the estimated average requirements (EAR) according to supplement use

	Pregnant women				Lactating women			
	All (n = 201)	User (n = 176)	Non-user (n = 25)	*P*-value	All (n = 104)	User (n = 62)	Non-user (n = 42)	*P*-value
Diet only								
Calcium								
Below the EAR	151 (75.1)[1)]	130 (73.9)	21 (84.0)	0.395[2)]	72 (69.2)	41 (66.1)	31 (73.8)	0.538
Above the EAR	50 (24.9)	46 (26.1)	4 (16.0)		32 (30.8)	21 (33.9)	11 (26.2)	
Iron								
Below the EAR	163 (81.1)	139 (79.0)	24 (96.0)	0.053	27 (26.0)	11 (17.7)	16 (38.1)	0.036
Above the EAR	38 (18.9)	37 (21.0)	1 (4.0)		77 (74.0)	51 (82.3)	26 (61.9)	
Zinc								
Below the EAR	98 (48.8)	81 (46.0)	17 (68.0)	0.065	67 (64.4)	37 (59.7)	30 (71.4)	0.308
Above the EAR	103 (51.2)	95 (54.0)	8 (32.0)		37 (35.6)	25 (40.3)	12 (28.6)	
Folate								
Below the EAR	168 (83.6)	147 (83.5)	21 (84.0)	1.000	68 (65.4)	36 (58.1)	32 (76.2)	0.090
Above the EAR	33 (16.4)	29 (16.5)	4 (16.0)		36 (34.6)	26 (41.9)	10 (23.8)	
Vitamin C								
Below the EAR	95 (47.3)	78 (44.3)	17 (68.0)	0.045	80 (76.9)	47 (75.8)	33 (78.6)	0.927
Above the EAR	106 (52.7)	98 (55.7)	8 (32.0)		24 (23.1)	15 (24.2)	9 (21.4)	
Diet including supplement								
Calcium								
Below the EAR	133 (66.2)	112 (63.6)	21 (84.0)	0.074	66 (63.5)	35 (56.5)	31 (73.8)	0.110
Above the EAR	68 (33.8)	64 (36.4)	4 (16.0)		38 (36.5)	27 (43.5)	11 (26.2)	
Iron								
Below the EAR	38 (18.9)	14 (8.0)	24 (96.0)	< 0.001	18 (17.3)	2 (3.6)	16 (38.1)	< 0.001
Above the EAR	163 (81.1)	162 (92.0)	1 (4.0)		86 (82.7)	60 (96.8)	26 (61.9)	
Zinc								
Below the EAR	72 (35.8)	55 (31.3)	17 (68.0)	0.001	56 (53.8)	26 (41.9)	30 (71.4)	0.006
Above the EAR	129 (64.2)	121 (68.8)	8 (32.0)		48 (46.2)	36 (58.1)	12 (28.6)	
Folate								
Below the EAR	38 (18.9)	17 (9.7)	21 (84.0)	< 0.001	44 (42.3)	12 (19.4)	32 (76.2)	< 0.001
Above the EAR	163 (81.1)	159 (90.3)	4 (16.0)		60 (57.7)	50 (80.6)	10 (23.8)	
Vitamin C								
Below the EAR	70 (34.8)	53 (30.1)	17 (68.0)	< 0.001	66 (63.5)	53 (30.1)	17 (68.0)	0.015
Above the EAR	131 965.2)	123 (69.9)	8 (32.0)		38 (36.5)	123 (69.9)	8 (32.0)	

[1)] Values are number (%).
[2)] From χ^2-test or fisher's exact test, as appropriate.

women, the proportions of women who met all 2 guidelines of "Have dairy products more than 3 times a day" and "Eat meat, fish, vegetables and fruits every day" were 4.5% and 2.9%, respectively, and these proportions did not differ significantly between the supplement user and non-user (data not shown).

Dietary nutrient intakes according to supplement use of the subjects

After adjusting for potential confounders, the intakes of dietary fiber by 23% (23.8 ± 11.3 g/day vs 19.4 ± 11.4 g/day) and β -carotene by 39% (3,745.9 ± 2,873.6 μg/day vs 2,691.4 ± 3,198.7 μg/day) among supplement users were higher than those of non-users in the lactating women (Table 4).

From diet alone, the proportion of pregnant women with intakes of iron and folate below the EAR were 81% and 83%, respectively (Table 5). However, when the contribution of supplements to total nutrient intake is considered, these proportions were dramatically decreased to 19%. The proportion of lactating women with intakes of iron (from diet alone) below the EAR was significantly lower among supplement users (17%) than non-users (38%) ($P < 0.05$). About 65% of all lactating women had a dietary (from diet alone) folate intake below the EAR, and this proportion was decreased to 42% through the inclusion of folate supplements. Among pregnant women, the proportion of women with an intake of vitamin C (from diet alone) below the EAR was lower among supplement users (44%) than among non-users (68%) ($P < 0.05$).

Discussion

The present study found that about 88% and 60% of pregnant and lactating women living in Seoul took dietary supplements, respectively. The proportion of supplement use found in this study is similar to the figure of 89% reported recently in South Korea [15] and the 78% in the US [16], as well as those of other countries studies, where 70% of pregnant women in Switzerland reported use of some sort of vitamin or mineral supplement [17], 85% of the pregnant women took some type of supplement in Finland [18], and 81% of the pregnant Norwegian women were found to use one or more food supplements [5]. Similar to our study result, in a recent report in the US, Stultz *et al*. [19] suggested that most (73%) breastfeeding women took a multivitamin supplement, with fewer reporting the use of calcium (11%), folic acid (7%), or iron (4%). Also their data suggested that in this relatively small non-representative sample, significantly more women reported taking dietary supplements during pregnancy than during lactation. Representative sample was studied using data from NHANES III support the notion that overall dietary supplement usage is lower during lactation than during pregnancy [2].

In our study, supplement users among pregnant women were found to consume more vegetables, and supplement users among the lactating women were found to consume more beans and vegetables. Although most studies were conducted among the general population not among pregnant and lactating women, in agreement with our study, many researchers have reported that supplement use was associated with the consumption of certain foods which are important sources of antioxidant nutrients. A population based cohort study of adults in the US demonstrated that supplement users, compared to non-users, generally had higher average intakes of foods which are important sources of vitamin C and carotenoids (i.e., fruits and certain vegetables) [12]. Looker *et al*. also showed that non-pregnant, non-lactating adults who were regular users of any type of supplement consumed more vegetables and fruits, especially those high in vitamin C [20]. In the present study, among pregnant women, the proportion of women with an intake of vitamin C (from diet alone) below the EAR was significantly higher among supplement non-users (68%) than among users (44%). Furthermore, in lactating women of this study, the intakes of dietary β-carotene, antioxidant nutrient, among supplement users were higher than non-users. Simply put, the deficiency of antioxidant nutrients consumption among supplement non-users has become a concern.

During pregnancy, even normal pregnancy, oxidative stress is known to increase [21,22]. Pregnant women can easily be exposed to oxidative stress, possibly as a result of conception itself. Therefore, a higher intake of antioxidant micronutrients is required by pregnant women. If the intakes of these antioxidant nutrients are inadequate, exaggerated oxidative stress within both the placenta and maternal circulation occurs, resulting in pregnancy complications, such as preeclampsia [23] and diabetes [24], as well as a variety of undesirable pregnancy outcomes, including preterm birth [25] and fetal growth restriction [26].

In the present study, we found that only 7% of pregnant women and 6% of lactating women met the guideline for "Have dairy products more than 3 times a day", and the proportions of women who met all 2 guidelines, "Have dairy products more than 3 times a day" and "Eat meat, fish, vegetables and fruits every day" were 4.5% in pregnant women and 2.9% in lactating women. Moreover, even diet alone as well as diet including supplement, nearly two thirds of pregnant and lactating women had a clacium intake below the EAR. Several studies suggested that dairy product intake among pregnant women had a positive effect on fetal growth, and attributed this to the calcium content of dairy foods. Rao *et al*. [27], in a study of pregnant Indian women, observed that the frequency of consumption of milk and green leafy vegetables was positively associated with birth dimensions of the baby. Chang *et al*. [28] suggest that among pregnant African-American adolescents, consumption of < 2 servings of dairy products/day may negatively affect fetal bone development by limiting the amount of calcium provided to the fetus. A Cochrane review illustrated the benefits of calcium supplementation during pregnancy on reducing pre-eclampsia, death and serious morbidity [29].

When the contribution of supplements to nutrient intakes is considered, in our pregnant and lactating women, the proportion of women with intakes of iron (19% of pregnant women; 17% of lactating women) and folate (19% of pregnant women; 42% of lactating women) below the EAR was relatively low, while the proportion of women with intakes of calcium (66% of pregnant women; 64% of lactating women) and zinc (36% of pregnant women; 54% of lactating women) below the EAR were relatively high. For iron and folic acid, the proportion of women with intakes below the EAR were dramatically decreased in intake from diet plus supplement compared to that of intake from diet alone; however, in the case of calcium and zinc, even when the contribution of supplements to nutrient intakes is considered, the proportion with intakes below the EAR did not change greatly. This is because Korean pregnant and lactating women mainly use dietary supplements of iron and folic acid. During pregnancy and lactation, the requirements for all nutrients increases, for the support of fetal and infant growth and development, as well as for maternal metabolism and tissue development specific to reproduction [30]. For this reason, in Western countries, most pregnant and lactating women are advised to consume multivitamin and mineral prenatal supplements, which contain all nutrients, including iron and folic acid. However, in South Korea (in our data), only 29.9% and 11.5% of pregnant and lactating women, respectively, took multivitamin/mineral prenatal supplements (data not shown). At present, the Ministry of Health and Welfare in Korea has a policy of giving pregnant and lactating women either iron by self or combined with folate, but in the future, this should be changed to a policy of providing prenatal supplements including, multivitamin and minerals to those pregnant and lactating women in need.

The limitations of our study include the following. First, daily supplement intake was calculated using an indirect method which assumed that supplement use could be applied to a single 24-h period. This calculation may not represent daily amounts for those who do not take supplements consistently. Second, we depended on the collection of maternal dietary intake data only from a 24-h recall, which may be less dependable than the 3-day dietary recall. However, our dietary interviewers were well-trained, which minimized potential errors in assessing dietary intakes. Third, the sample size was too small among some groups for the elucidation of a meaningful result; therefore, our data may not be extrapolated to other populations of Korean pregnant and lactating women. However, we believe that this is the first report to compare the dietary food and nutrient intakes according to supplement use among pregnant and lactating women in South Korea.

In conclusion, we found that pregnant women who used supplements consumed more vegetables, and lactating women who used supplements consumed more beans and vegetables, as well as dietary fiber and β-carotene. The findings of this study also suggest that, compared with supplement users among pregnant and lactating women, non-users tend to have a lower intake of healthy food, such as beans, vegetables, as well as dietary fiber and β-carotene, which are abundant in these foods. Therefore, public health interventions for pregnant and lactating women should not only focus on recommendations to take supplements but also on improving the general diet, including promoting an increase in healthy food consumption, as part of a development of healthier eating habits.

References

1. Lee YO, Song Y. Sociodemographic Characteristics, Lifestyle factors, and nutrient intake by taking vitamin/mineral supplements. Korean J Food Culture 2010;25:480-6.
2. Cogswell ME, Kettel-Khan L, Ramakrishnan U. Iron supplement use among women in the United States: science, policy and practice. J Nutr 2003;133:1974S-7S.
3. Institute of Medicine. Nutrition during pregnancy. Washington, DC: National Academy Press; 1990.
4. Zavaleta N, Caulfield LE, Garcia T. Changes in iron status during pregnancy in Peruvian women receiving prenatal iron and folic acid supplements with or without zinc. Am J Clin Nutr 2000; 71:956-61.
5. Haugen M, Brantsaeter AL, Alexander J, Meltzer HM. Dietary supplements contribute substantially to the total nutrient intake in pregnant Norwegian women. Ann Nutr Metab 2008;52:272-80.
6. Jackson AA, Robinson SM. Dietary guidelines for pregnancy: a review of current evidence. Public Health Nutr 2001;4:625-30.
7. Ramón R, Ballester F, Iñiguez C, Rebagliato M, Murcia M, Esplugues A, Marco A, García de la Hera M, Vioque J. Vegetable but not fruit intake during pregnancy is associated with newborn anthropometric measures. J Nutr 2009;139:561-7.
8. Rodríguez-Bernal CL, Rebagliato M, Iñiguez C, Vioque J, Navarrete-Muñoz EM, Murcia M, Bolumar F, Marco A, Ballester F. Diet quality in early pregnancy and its effects on fetal growth outcomes: the Infancia y Medio Ambiente (Childhood and Environment) Mother and Child Cohort Study in Spain. Am J Clin Nutr 2010;91:1659-66.
9. Picciano MF, McGuire MK. Use of dietary supplements by pregnant and lactating women in North America. Am J Clin Nutr 2009;89:663S-7S.
10. Radimer K, Bindewald B, Hughes J, Ervin B, Swanson C, Picciano MF. Dietary supplement use by US adults: data from the National Health and Nutrition Examination Survey, 1999-2000. Am J Epidemiol 2004;160:339-49.
11. Yu SM, Kogan MD, Huang Z. Vitamin-mineral supplement use among US women, 2000. J Am Med Womens Assoc 2003; 58:157-64.
12. Lyle BJ, Mares-Perlman JA, Klein BE, Klein R, Greger JL. Supplement users differ from nonusers in demographic, lifestyle, dietary and health characteristics. J Nutr 1998;128:2355-62.
13. Institute of Medicine. Dietary reference intakes for thiamin, riboflavin, niacin, vitamin B6, folate, vitamin B12, panthothenic acid, biotin, and choline. Washington, DC: National Academy Press. pp. 196-305. 2000.
14. The Korean Nutrition Society (2005). Dietary reference intakes of Koreans. The Korean Nutrition Society, Seoul, Republic of Korea. pp.119-126.
15. Bae HS, Kim SY, Ahnv HS, Cho YK. Comparison of nutrient

intake, life style variables, and pregnancy outcomes by the depression degree of pregnant women. Nutr Res Pract 2010;4: 323-31.
16. Mirel LB, Curtin LR, Gahche J, Burt V. Characteristics of Pregnant Women from the 2001-06 National Health and Nutrition Examination Survey. JSM 2009;2592-602.
17. Hess SY, Zimmermann MB, Torresani T, Burgi H, Hurrell RF: Monitoring the adequacy of salt iodization in Switzerland: a national study of school children and pregnant women. Eur J Clin Nutr 2001;55:162-6.
18. Arkkola T, Uusitalo U, Pietikainen M, Metsala J, Kronberg-Kippila C, Erkkola M, Veijola R, Knip M, Virtanen SM, Ovaskainen ML: Dietary intake and use of dietary supplements in relation to demographic variables among pregnant Finnish women. Br J Nutr 2006;96:913-20.
19. Stultz EE, Stokes JL, Shaffer ML, Paul IM, Berlin CM. Extent of medication use in breastfeeding women. Breastfeed Med 2007;2:145-51.
20. Looker A, Sempos CT, Johnson C, Yetley EA. Vitamin-mineral supplement use: association with dietary intake and iron status of adults. J Am Diet Assoc 1988;88:808-14.
21. Myatt L, Kossenjans W, Sahay R, Eis A, Brockman D. Oxidative stress causes vascular dysfunction in the placenta. J Matern Fetal Med 2000;9:79-82.
22. Myatt L, Cui X. Oxidative stress in the placenta. Histochem Cell Biol 2004;122:369-82.
23. Rumbold A, Duley L, Crowther CA, Haslam RR. Antioxidants for preventing pre-eclampsia. Cochrane Database Syst Rev 2008;(1):CD004227.
24. Coughlan MT, Vervaart PP, Permezel M, Georgiou HM, Rice GE. Altered placental oxidative stress status in gestational diabetes mellitus. Placenta 2004;25:78-84.
25. Dani C, Cecchi A, Bertini G. Role of oxidative stress as physio-pathologic factor in the preterm infant. Minerva Pediatrica 2004; 56:381-94.
26. Fall CH, Yajnik CS, Rao S, Davies AA, Brown N, Farrant HJ. Micronutrients and fetal growth. J Nutr 2003;133:1747S-56S.
27. Rao S, Yajnik CS, Kanade A, Fall CH, Margetts BM, Jackson AA, Shier R, Joshi S, Rege S, Lubree H, Desai B. Intake of micronutrient-rich foods in rural Indian mothers is associated with the size of their babies at birth: Pune Maternal Nutrition Study. J Nutr 2001;131:1217-24.
28. Chang SC, O'Brien KO, Nathanson MS, Caulfield LE, Mancini J, Witter FR. Fetal femur length is influenced by maternal dairy intake in pregnant African American adolescents. Am J Clin Nutr 2003;77:1248-54.
29. Hofmeyr GJ, Lawrie TA, Atallah AN, Duley L. Calcium supplementation during pregnancy for preventing hypertensive disorders and related problems. Cochrane Database Syst Rev 2010;(8):CD001059.
30. Picciano MF. Pregnancy and lactation: physiological adjustments, nutritional requirements and the role of dietary supplements. J Nutr 2003;133:1997S-2002S.