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Dietary changes in Vietnamese marriage immigrant women: The KoGES follow-up study

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BACKGROUND/OBJECTIVES: The immigrant population has grown considerably in South Korea since the early 1990s due to international marriages. Dietary changes in immigrants are an important issue, because they are related to health and disease patterns. This study was conducted to compare changes in dietary intake between baseline and follow-up periods.
SUBJECTS/METHODS: Two hundreds thirty three Vietnamese female married immigrants. Baseline data were collected during 2006-2009, and the follow-up data were collected during 2008 and 2010. Food consumption was assessed using a 1-day 24-hour recall.
RESULTS: The amount of the total food consumed ($P < 0.001$) including that of cereals ($P = 0.004$), vegetables ($P = 0.003$), and fruits ($P = 0.002$) decreased at follow-up compared to that at baseline, whereas consumption of milk and dairy products increased ($P = 0.004$). Accordingly, the overall energy and nutrient intake decreased at follow-up, including carbohydrates ($P = 0.012$), protein ($P = 0.021$), fiber ($P = 0.008$), iron ($P = 0.009$), zinc ($P = 0.006$), and folate ($P = 0.002$). Among various anthropometric and biochemical variables, mean skeletal muscle mass decreased ($P = 0.012$), plasma high density lipoprotein-cholesterol increased, ($P = 0.020$) and high sensitivity C-reactive protein decreased at follow-up ($P < 0.001$).
CONCLUSIONS: A long-term follow-up study is needed to investigate the association between changes in food and nutrient intake and anthropometric and biochemical variables in these Vietnamese female marriage immigrants.

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INTRODUCTION

The immigrant population through international marriage has grown considerably in South Korea since the early 1990s, and the international marriage rate for all marriages was as high as 10.5% in South Korea in 2010. The number of foreign women marrying Korean men has increased by nearly four times, from 6,945 immigrants to 26,274 between 2000 and 2010 [1]. Of these, Vietnamese women represent the highest proportion [2].

Immigrants are in the process of acculturation and must cope with a language barrier, economic problems [3-6], discrimination, and cultural differences, including social habits and dietary changes to adapt to the new environment [7-10]. In particular, dietary changes are an important issue, because they are related to health and disease status [11-15]. Unlike other types of immigrants, women who immigrate through marriage are predominantly responsible for preparing meals for the entire family. However, they lack access to nutritionally adequate and culturally acceptable foods, in part, because they have not yet become accustomed to Korean food and have limited access to Vietnamese food [16-21]. Choi *et al*. [16] found that almost 50% of Vietnamese female marriage immigrants experience food insecurity because of factors such as economic problems and the lack of appetizing food. In addition to food insecurity, nutrient intake in Vietnamese female marriage immigrants is inadequate [22-24] compared to recommended dietary allowances for Vietnamese [25] and the Dietary References Intake for Koreans [26]. A previous study showed an association between nutritional status and length of residence in Korea in a cross-sectional study, but no significant differences based on the length of residence in Korea were observed for nutritional status except vitamin C [22]. Because it is difficult to identify the causal relationships between nutrient intake and the length of residence in a cross-sectional study, a follow-up study is needed to investigate dietary changes over time. However, no studies have been conducted on nutritional status changes between baseline and follow-up in Vietnamese female marriage immigrants. The purpose of this study was to investigate baseline and follow-up

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changes in dietary intake in Vietnamese female marriage immigrants.

SUBJECTS AND METHODS

Study subjects

The participants were Vietnamese female marriage immigrants who voluntarily participated in the Cohort of Intermarried Women in Korea. The Cohort of Intermarried Women in Korea is an ongoing, prospective, epidemiological study as part of the Korean Genome and Epidemiology Study (KoGES) established in November 2006 [22-24]. Baseline data were collected during 2006-2009, and follow-up data were collected in 2008 and 2010. A total of 274 subjects participated during both periods (baseline and follow-up) from clinical centers in Seoul, Busan, Daegu, Danyang, Gimhea, Gwangju, Gyeongju, Gongju, Jinju, Sangju, Masan, Okcheon, and Pohang. Among the 274 subjects, those with missing dietary intake (n = 37), energy consumption < 400 kcal (n = 1) or > 3,500 kcal (n = 1), and those who were pregnant (n = 1) or used chronic disease medications (n = 1) were excluded. Therefore, 233 immigrants were finally eligible for this study.

General characteristics

Subjects were individually interviewed by trained personnel using standard protocols at baseline and follow-up. Vietnamese translators helped in the process whenever needed. The study instrument used was the KoGES questionnaire, which included age, current alcohol consumption, exercise, education, and income. Alcohol drinking was classified into current and non-drinkers. A regular exerciser was defined as a person who performed exercise currently and regularly enough to induce sweating. Educational status was categorized as $\leq$ elementary school, middle school, and $\geq$ high school. Household monthly income was classified as < 1,000, 1,000-1,500, and > 1,500 thousand Korean Won.

Dietary intake

Dietary changes after immigration are inevitable because it is difficult for Vietnamese female marriage immigrants to obtain some foods that they had before immigration because of their relatively higher price (pork, fish, and rice noodles), limited access to markets (rice noodles), and unavailability of Vietnamese food in Korea (vegetables such as swamp cabbage and yam and fruits such as papaya, longan, and guava). In contrast, dairy products are relatively less expensive in Korea [24]. A Mini Dietary Assessment (MDA) was used at baseline and follow-up to evaluate diet quality and was validated previously [27]. Ten questions were asked regarding meal regularity, diet diversity, intake frequency of each food group, intake frequency of snacks, and preference for salty taste. For each question, 5, 3, or 1 points were given for answers of "always", "generally", or "seldom", respectively. However, 1, 3, or 5 points were given to answers of "always", "generally", and "seldom", respectively, for questions on frequency of eating snacks and high-fat foods as well as on preference for salty taste. The total MDA score was 50. A higher MDA score indicates higher diet quality.

Food consumption was assessed using a 1-day, 24-hour recall by a trained dietitian. Food models were used to estimate portion size. Energy and nutrient intake data were analyzed using the Computer Aided Nutritional Analysis program version 3.0 software (CAN-Pro 3.0, Nutritional Assessment Program, 2006, The Korean Nutrition Society, Seoul, Korea) [28]. Energy and nutrient intake data were compared with the estimated energy requirements (EER) and estimated average requirements of the Korea Dietary Reference Intakes for women in the subject's age range [26].

Anthropometric parameters, blood pressure, and blood biochemical profiles

Anthropometric variables and blood pressures were obtained by trained nurses or medical personnel during both periods. Standing height and body weight were measured using an automatic height/weight measuring instrument (Dong Sahn Jenix Co., Seoul, Korea). Body mass index was calculated as kg/m^2. Waist and hip circumferences were measured with a tape measure (anthropometric tape; Preston 5193, Seoul, Korea). Body composition was assessed with the Inbody 230 (Biospace Co., Seoul, Korea). These measurements were taken once. Systolic and diastolic blood pressures were measured using the FT0500R automatic blood pressure calculator (Jawon Medical, Gyeongsan, Korea) and read by attending medical doctors after a 10-minute rest in the sitting position; the average of two measurements was used.

Blood samples were drawn by medical technologists after an 8-hour overnight fast, collected in EDTA-containing tubes, and centrifuged at 3,500 rpm for 10 minutes at 4℃. The plasma samples were stored at -70℃ until analysis. Serum albumin and protein, hemoglobin, and hematocrit were measured using an autoanalyzer (ADVIA 120, Bayer Diagnostics, Tarrytown, NY, USA). Fasting blood sugar level, total cholesterol, high density lipoprotein (HDL)-cholesterol, and triglycerides were also measured with an autoanalyzer (ADVIA 1550, Bayer Diagnostics). Low density lipoprotein (LDL)-cholesterol was calculated as total cholesterol-HDL-cholesterol-(triglycerides/5) [29]. Serum high sensitivity C-reactive protein (hs-CRP) was measured with an ADVIA 1650 using a hs-CRP-Latex (II) X2 kit (Seiken Laboratories Ltd., Tokyo, Japan).

Statistical analysis

Data are expressed as means and standard deviations (continuous) or as frequencies and percentages (categorical). Categorical variables were evaluated using the chi-square or Fisher's exact tests to investigate differences between groups. The paired *t*-test was used to compare general characteristics, anthropometric parameters, daily nutrient and food intakes, MDA scores, and blood profiles between the baseline and follow-up periods. All analyses were performed using SAS 9.2 software (SAS Institute, Cary, NC, USA). All reported probability tests were two-sided, and differences were considered significant at the 5% level.

RESULTS

General characteristics and anthropometric variables

The cohort observation period of the 233 Vietnamese subjects

Table 1. General characteristics and anthropometric variables of Vietnamese female marriage immigrants at baseline and follow-up[1)]

	Baseline (n = 233)	Follow-up (n = 233)
Age (yrs)	23.0 ± 3.8	25.7 ± 3.8
Duration of follow-up (month)	28.1 ± 7.8	
Height (cm)	154.7 ± 4.9	154.9 ± 4.9
Weight (kg)	50.5 ± 7.3	50.9 ± 7.5
Body mass index (kg/m^2)	21.1 ± 2.7	21.2 ± 2.9
Waist circumference (cm)	70.1 ± 7.1	69.8 ± 7.7
Waist to hip ratio	0.82 ± 0.05	0.82 ± 0.06
Skeletal muscle mass (kg)	20.1 ± 5.7	19.2 ± 2.6
Body fat (%)	15.1 ± 4.9	15.1 ± 5.3
Pregnancy history		
No	44 (19.1)	7 (3.0)
Yes	186 (80.9)	223 (97.0)
No-response	3 (1.3)	3 (1.3)
Alcohol drinking		
Non-drinker	173 (75.9)	166 (86.9)
Current drinker	55 (24.1)	25 (13.1)
No-response	5 (2.1)	42 (18.0)
Smoking status		
Non-smoker	184 (80.0)	206 (99.0)
Current smoker	46 (20.0)	2 (1.0)
No-response	3 (1.3)	25 (10.7)
Exercise		
No	171 (74.0)	180 (78.6)
Yes	60 (26.0)	49 (21.4)
No-response	2 (0.9)	4 (1.7)
Physical activity		
Sedentary	76 (39.6)	67 (29.8)
Active	116 (60.4)	158 (70.2)
No-response	41 (17.6)	8 (3.4)
Employment		
No	214 (95.1)	165 (80.5)
Yes	11 (4.9)	40 (19.5)
No-response	8 (3.4)	28 (12.0)
Education		
≤ Elementary school	91 (39.1)	91 (39.1)
Middle school	78 (33.5)	78 (33.5)
≥ High school	59 (25.3)	59 (25.3)
No-response	5 (2.1)	5 (2.1)
Household monthly income (1,000 Korean Won)		
< 1,000	45 (21.3)	43 (19.1)
1,000 - 1,500	66 (31.3)	73 (32.4)
> 1,500	100 (47.4)	109 (48.4)
No-response	22 (9.4)	8 (3.4)
Change in alcohol drinking		
Drank during study	-	4 (1.7)
Quit at follow-up	-	43 (18.5)
Began drinking at follow-up	-	21 (9.0)
Never drank during study	-	119 (51.1)
No-response	-	46 (19.7)
Change in smoking status		
Smoked during study	-	0 (0.0)
Quit at follow-up	-	42 (18.0)
Began smoking at follow-up	-	2 (0.9)
Never smoked during study	-	161 (69.1)
No-response	-	28 (12.0)
Change in exercise		
Exercised during study	-	15 (6.4)
Quit at follow-up	-	44 (18.9)
Began exercising at follow-up	-	33 (14.2)
Never exercised during study	-	135 (57.9)
No-response	-	6 (2.6)
Change in physical activity		
Decreased	-	31 (13.3)
No change in 'sedentary'	-	20 (8.6)
No change in 'active'	-	81 (34.8)
Increased	-	54 (23.2)
No-response	-	47 (20.2)
Change in employment		
Employed during study	-	3 (1.3)
Quit at follow-up	-	6 (2.6)
Began employment at follow-up	-	34 (14.6)
Never employed during study	-	157 (67.4)
No-response	-	33 (14.2)
Change in household monthly income (1,000 Korean Won)		
Decreased	-	42 (18.0)
No change in < 1,000	-	17 (7.3)
No change in 1,000~1,500	-	25 (10.7)
No change in > 1,500	-	69 (29.6)
Increased	-	52 (22.3)
No-response	-	28 (12.0)

[1)] Values are mean ± SD or frequency (%).

Table 2. Daily food intake of Vietnamese female marriage immigrants at baseline and follow-up[1-2)]

	Baseline (n = 233)	Follow-up (n = 233)	*P*-value
Cereal and cereal products (g/d)	249.0 ± 96.9	224.7 ± 76.6	0.004
Potatoes (g/d)	21.2 ± 62.2	24.5 ± 93.5	0.668
Vegetables (g/d)	249.7 ± 147.9	209.6 ± 145.1	0.003
Fruits (g/d)	275.7 ± 360.4	189.4 ± 251.5	0.002
Seaweeds (g/d)	2.5 ± 4.9	3.6 ± 8.4	0.078
Mushrooms (g/d)	1.6 ± 8.3	4.2 ± 16.7	0.030
Legume (g/d)	29.7 ± 70.4	22.9 ± 57.3	0.240
Nuts (g/d)	0.5 ± 2.0	0.5 ± 3.0	0.814
Sugar (g/d)	4.4 ± 7.0	3.5 ± 5.3	0.065
Oil and Fat (g/d)	7.5 ± 7.1	7.4 ± 9.0	0.908
Beverages (g/d)	21.4 ± 56.8	18.9 ± 54.4	0.618
Total plant food (g/d)	863.2 ± 432.9	709.2 ± 335.5	< 0.001
%Total plant food	80.9 ± 13.1	77.3 ± 15.1	0.006
Meats (g/d)	73.3 ± 136.1	54.3 ± 76.2	0.058
Fishes (g/d)	68.2 ± 98.0	52.4 ± 62.2	0.030
Eggs (g/d)	21.3 ± 40.8	21.2 ± 45.7	0.963
Milk and dairy products (g/d)	43.9 ± 89.4	75.0 ± 136.7	0.004
Total animal food (g/d)	206.8 ± 191.1	202.8 ± 166.2	0.807
%Total animal food	19.1 ± 13.1	22.7 ± 15.1	0.006
Total food intakes (g/d)	1,070.0 ± 496.4	912.0 ± 371.9	< 0.001

[1)] Values are means ± standard deviations.
[2)] Measured by paired *t*-test between baseline and follow-up.

Table 3. Daily nutrient intake and changes in proportion below the EER[1] or EAR[2] in Vietnamese female marriage immigrants[3-5]

	Baseline (n = 233)	Follow-up (n = 233)	*P*-value[4]	Changes in proportion below EER or EAR (n = 233)				
				Below EER from baseline to follow-up	Below EER at baseline and above EER at follow-up	Above EER at baseline and below EER at follow-up	Above EER from baseline to follow-up	*P*-value
Energy (kcal/d)	1,517.8 ± 478.3	1,431.3 ± 422.5	0.028	188 (80.7)	13 (5.6)	26 (11.2)	6 (2.6)	0.023[6]
Carbohydrate (g/d)	240.7 ± 70.7	225.1 ± 63.9	0.012					
Protein (g/d)	59.5 ± 30.1	54.2 ± 22.9	0.021	17 (7.3)	43 (18.5)	39 (16.7)	134 (57.5)	0.466
Plant protein (g/d)	28.7 ± 11.6	26.1 ± 9.5	0.007					
Animal protein (g/d)	30.8 ± 26.2	28.1 ± 20.2	0.190					
Fat (g/d)	35.0 ± 22.9	34.3 ± 19.6	0.684					
Plant fat (g/d)	15.1 ± 10.3	15.7 ± 11.3	0.536					
Animal fat (g/d)	19.9 ± 18.4	18.6 ± 15.8	0.376					
Cholesterol (mg/d)	246.8 ± 260.1	220.9 ± 214.6	0.207					
Fiber (g/d)	16.1 ± 7.7	14.4 ± 7.0	0.008					
Calcium (mg/d)	411.6 ± 339.3	396.6 ± 260.1	0.597	149 (64.0)	43 (18.5)	30 (12.9)	11 (4.7)	0.684
Plant calcium (mg/d)	221.4 ± 124.3	202.6 ± 116.2	0.087					
Animal calcium (mg/d)	190.2 ± 292.5	194.0 ± 218.5	0.876					
Iron (mg/d)	11.0 ± 5.1	10.0 ± 4.0	0.009	87 (37.3)	46 (19.7)	65 (27.9)	35 (15.0)	1.000
Plant iron (mg/d)	8.2 ± 3.7	7.5 ± 3.2	0.028					
Animal iron (mg/d)	2.8 ± 2.9	2.4 ± 1.9	0.078					
Phosphorus (mg/d)	853.2 ± 430.0	784.2 ± 333.4	0.044	17 (7.3)	41 (17.6)	42 (18.0)	133 (57.1)	0.528
Zinc (mg/d)	7.9 ± 3.3	7.1 ± 2.6	0.006	57 (24.5)	51 (21.9)	68 (29.2)	57 (24.5)	0.908
Vitamin A (μg RE/d)	555.3 ± 583.8	536.7 ± 422.4	0.696	70 (30.0)	61 (26.2)	56 (24.0)	46 (19.7)	0.928
Vitamin B_1 (mg/d)	1.1 ± 0.5	1.0 ± 0.5	0.092	54 (23.2)	50 (21.5)	68 (29.2)	61 (26.2)	1.000
Vitamin B_2 (mg/d)	0.9 ± 0.5	0.9 ± 0.4	0.678	107 (45.9)	52 (22.3)	46 (19.7)	28 (12.0)	0.535
Vitamin B_6 (mg/d)	1.6 ± 0.8	1.5 ± 0.6	0.027	42 (18.0)	40 (17.2)	47 (20.2)	104 (44.6)	0.004
Vitamin C (mg/d)	87.7 ± 69.8	85.9 ± 81.6	0.788	73 (31.3)	52 (22.3)	61 (26.2)	47 (20.2)	0.871
Vitamin E (mg/d)	11.9 ± 7.7	11.9 ± 7.7	0.967					
Niacin (mg NE/d)	12.5 ± 6.7	11.5 ± 6.0	0.055	70 (30.0)	43 (18.5)	62 (26.6)	58 (24.9)	0.147
Folate (μg DFE/d)	348.0 ± 172.4	300.9 ± 137.8	0.002	76 (32.6)	43 (18.5)	61 (26.2)	53 (22.8)	0.141
Energy distribution								
% Carbohydrate	65.0 ± 11.7	64.0 ± 10.2	0.279					
% Protein	15.2 ± 4.2	15.0 ± 4.0	0.586					
% Fat	19.6 ± 9.0	20.7 ± 7.9	0.175					

[1] Estimated energy requirements.
[2] Estimated average requirements.
[3] Values are means ± standard deviations or frequencies (%).
[4] Measured by paired t-test between baseline and follow-up.
[5] Measured by chi-square test.
[6] Measured by Fisher's exact test.

was 11-41 months, with a mean follow-up of 28.1 ± 7.8 months (Table 1). The mean age was 23.0 ± 3.8 years at baseline. Nearly 40% of subjects had graduated from elementary school. Mean height and weight were 154.7 ± 4.9 cm and 50.5 ± 7.3 kg at baseline and 154.9 ± 4.9 cm and 50.9 ± 7.5 kg, respectively.

Daily food intake

Daily food intake of Vietnamese subjects is described in Table 2. Overall food intake decreased from baseline to follow-up. The consumption of cereal and cereal products ($P = 0.004$), vegetables ($P = 0.003$), fruits ($P = 0.002$), and fishes ($P = 0.030$) decreased significantly, whereas consumption of mushrooms ($P = 0.030$), milk and dairy products ($P = 0.004$) increased significantly. Total food intakes were 1,070.0 ± 496.4 g/d and 912.0 ± 371.9 g/d at baseline and follow-up, respectively, and decreased significantly by the follow-up period.

Daily nutrient intake

Daily nutrient intakes of Vietnamese subjects are presented in Table 3. Overall nutrient intake decreased over time. The intakes of total energy ($P = 0.028$), carbohydrates ($P = 0.012$), protein ($P = 0.021$), fiber ($P = 0.008$), iron ($P = 0.009$), phosphorus ($P = 0.044$), zinc ($P = 0.006$), vitamin B_6 ($P = 0.027$), and folate ($P = 0.002$) decreased significantly over time. Most of the Vietnamese subjects (80.7%) had energy intake below the EER at both the baseline and follow-up, whereas only 5.6% of subjects had improved energy intake from baseline to follow-up ($P = 0.023$).

Table 4. Changes in Mini Dietary Assessment (MDA) scores of Vietnamese female marriage immigrants at baseline and follow-up[1-5)]

	Changes in MDA scores (n = 233)						*P*-value
	Decreased	No change in 'Seldom'	No change in 'Generally'	No change in 'Always'	Increased	No-response	
1. I drink 1 or more bottles of milk or its products daily.	59 (25.3)	51 (21.9)	14 (6.0)	20 (8.6)	64 (27.5)	25 (10.7)	0.039
2. For each meal, I consume foods made up of a combination of meat, fish, eggs, beans, tofu, etc.	65 (27.9)	4 (1.7)	32 (13.7)	44 (18.9)	63 (27.0)	25 (10.7)	0.951
3. For each meal, I consume vegetables other than Kimchi.	62 (26.6)	2 (0.9)	15 (6.4)	74 (31.8)	53 (22.7)	27 (11.6)	0.206
4. I consume at least 1 fruit or fruit juice (1 glass) daily.	66 (28.3)	7 (3.0)	25 (10.7)	60 (25.8)	49 (21.0)	26 (11.2)	0.133
5. I consume fried or stir-fried foods at least 2 times per week.	65 (27.9)	48 (20.6)	23 (9.9)	15 (6.4)	54 (23.2)	28 (12.0)	0.032
6. I consume high fat content meats (bacon, ribs, eel, etc.) at least 2 times per week.	62 (26.6)	13 (5.6)	23 (9.9)	39 (16.7)	71 (30.5)	25 (10.7)	0.551
7. I tent to add extra salt or soy sauce while taking my meal.	63 (27.0)	19 (8.2)	9 (3.9)	43 (18.5)	72 (30.9)	27 (11.6)	0.825
8. I have three regular meals a day.	64 (27.5)	19 (8.2)	16 (6.9)	60 (25.8)	47 (20.2)	27 (11.6)	0.090
9. I consume ice cream, cake, biscuit varieties, carbonated beverages, etc. as snack at least 2 times per week.	71 (30.5)	31 (13.3)	14 (6.0)	27 (11.6)	65 (27.9)	25 (10.7)	0.949
10. I tend to consume a wide range of foods evenly (I have a balanced diet.).	55 (23.6)	4 (1.7)	10 (4.3)	77 (33.0)	59 (25.3)	28 (12.0)	0.224
	Decreased		No change	Increased		No-response	*P*-value
Total score of MDA	88 (37.8)		23 (9.9)	86 (36.9)		36 (15.5)	-[4)]

[1)] Minimum and maximum scores for each component are 1 to 5. Total score is 50.
[2)] Values are frequencies (%).
[3)] Measured by the chi-square test.
[4)] Statistical tests were not conducted.

Table 5. Blood profiles and blood pressure of Vietnamese female marriage immigrants at baseline and follow-up[1-3)]

	Baseline (n = 233)	Follow-up (n = 233)	*P*-value
Hemoglobin (g/dL)	13.0 ± 1.1	12.9 ± 1.0	0.568
Hematocrit (%)	39.3 ± 3.2	39.4 ± 3.0	0.564
Total protein (g/dL)	7.8 ± 0.5	7.9 ± 0.5	0.033
Albumin (g/dL)	4.7 ± 0.3	4.6 ± 0.3	< 0.001
Fasting blood sugar (mg/dL)	83.9 ± 9.2	88.8 ± 11.4	< 0.001
Total cholesterol (mg/dL)	181.0 ± 41.5	177.5 ± 39.0	0.216
Triglyceride (mg/dL)	101.3 ± 66.5	95.4 ± 58.6	0.331
LDL-cholesterol (mg/dL)	113.6 ± 32.9	110.1 ± 32.6	0.059
HDL-cholesterol (mg/dL)	47.1 ± 11.1	48.5 ± 9.7	0.020
HDL/LDL ratio	0.44 ± 0.14	0.47 ± 0.16	0.002
MCV (fL)	87.4 ± 7.2	89.6 ± 7.2	< 0.001
MCH (pg)	28.9 ± 2.8	29.4 ± 2.6	< 0.001
MCHC (g/dL)	33.0 ± 0.9	32.8 ± 0.8	< 0.001
CRP (mg/dL)	1.7 ± 2.8	1.3 ± 2.0	< 0.001
Systolic blood pressure (mmHg)	108.2 ± 13.4	109.1 ± 10.7	0.348
Diastolic blood pressure (mmHg)	62.3 ± 9.9	63.4 ± 9.3	0.155

[1)] Blood profile data are log transformed.
[2)] Values are means ± standard deviations.
[3)] Measured by paired *t*-test between baseline and follow-up.

MDA scores

The MDA scores changed between baseline and follow-up. Milk and dairy product consumption increased in 27.5% of Vietnamese subjects, whereas it decreased in 25.3% of subjects ($P = 0.039$). Fried or stir-fried food consumption decreased in 27.9% of subjects but increased in 23.2% of subjects ($P = 0.032$) (Table 4).

Blood profiles and blood pressure

The blood profiles and blood pressure of Vietnamese subjects are shown Table 5. Total protein ($P = 0.033$), fasting blood sugar ($P < 0.001$), HDL-cholesterol ($P = 0.020$), HDL/LDL ratio ($P = 0.002$), mean corpuscular volume ($P < 0.001$), and mean corpuscular hemoglobin ($P < 0.001$) increased, whereas albumin ($P < 0.001$), mean corpuscular hemoglobin concentration, and hs-CRP ($P < 0.001$) decreased during the follow-up period.

DISCUSSION

This study is the first prospective report of the KoGES study. Our results suggest that dietary intake of Vietnamese marriage immigrants changed from baseline to follow-up. Consumption of cereal, vegetables, fruits, and total food decreased over time, whereas consumption of milk and dairy products increased. Many studies have reported that dietary patterns in immigrants change through acculturation. Regev-Tobias *et al*. [30] showed that intake of fruits, vegetables, and dairy products is negligible, whereas simple sugar consumption is high in Ethiopian women living in Israel. Rosenmöller *et al*. [31] reported that > 50% of Chinese immigrants increase their consumption of healthy foods such as fruits, and vegetables, white meats, and dairy products and decrease consumption of deep-fried, high fat foods, and soft drinks after immigrating to Canada [31]. Several studies have reported an association between acculturation and healthy dietary habits in immigrants [32]. Mexican immigrants to the United States change their diet over time, and an increase in fat intake and decrease in consumption of fruits and vegetables are observed with an increase in the duration of residency and greater acculturation [33].

However, food consumption of subjects is not sufficient. According to the 2009 Korea Health and Nutrition Examination

Survey IV [34], total food intake by Korean women aged 19-29 years was 1,304.4 g/d, whereas total food intake of Vietnamese subjects was less than that of Korean women of the same age, at both baseline (1,070.0 g/d) and at follow-up (912.0 g/d). Furthermore, milk and dairy product consumption was lower in Vietnamese subjects (75.0 g/d at follow-up) than that in Korean women (119.2 g/d), although milk and dairy product consumption increased significantly from baseline to follow-up. Similarly, overall nutrient intake, including energy, carbohydrates, protein, fiber, iron, zinc, and folate decreased over time and a high proportion of subjects had energy intake below the EER at both the baseline and follow-up. Although a previous cross-sectional study using KoGES data reported that nutrient intake in Vietnamese female marriage immigrants does not differ by the length of residence in Korea [22], the cross-sectional nature of that study limited conclusions on cause-and-effect without regard to duration.

Changes in dietary behavior may be related to health condition of international immigrants. In a study of first-generation Korean-Americans, dietary changes were associated with length of residence in the United States and frequency of chronic diseases [15]. Tunisian immigrants who maintain their traditional diet have a lower risk of disease compared with natives living in France [35]. Japanese-Americans who retain a more traditional Japanese diet show reduced prevalence of diabetes in Hawaii [36]. Judging from the hematological data, our subjects were in fair condition. Interestingly, no changes in total cholesterol, triglycerides, or LDL-cholesterol but increased levels of HDL-cholesterol and the HDL/LDL ratio were found in our subjects, which was contrary to findings from immigrants to Western countries [37,38]. Further studies are needed to investigate why increased levels of HDL-cholesterol have occurred in our subjects despite decreased protein intake and no changes in fat intake. In addition, blood hs-CRP levels decreased from baseline to follow-up. hs-CRP, a biomarker of subclinical inflammation, is produced by the liver in response to various inflammatory conditions and is a predictor of cardiovascular disease risk [39-41]. These results can be explained by changes in milk and dairy food consumption, which were observed clearly in our study. The reduced fiber intake, partly due to decreased consumption of fruit and vegetable, may be attributable to increased blood glucose levels in our study subjects, as shown in other South Asian immigrant studies in Europe [42].

Several studies have found a negative association between the intake of milk or dairy products, rich sources of calcium, and risk factors for cardiovascular diseases including lipid metabolism [43,44] and blood hs-CRP levels [45,46]. Several mechanisms have been proposed for how calcium benefits lipid profiles. Calcium can be bound to fatty acids and bile acids in the gut by bile salt hydrolase; thus, interfering with lipid absorption [47,48]. In addition to these intestinal effects, an HDL-cholesterol-increasing effect of calcium via a reduction in plasma cholesteryl ester transport protein (CETP) has also been suggested [49]. Enhancing calcium intake via milk consumption could increase serum HDL-cholesterol by decreasing CETP activity. Dietary calcium may also suppress circulating 1-alpha, 25-dihydroxycholecalciferol, which inhibits inflammatory stress [45,46].

This study had some limitations. First, the cohort observation period in Korea may not have been long enough to have produced changes in dietary patterns, and it may have been too early to draw conclusions about the effects of immigration on health status. Second, a 1-day 24-hour recall may be insufficient to assess usual daily intake due to large intra-individual variability in food and nutrient intake, but trained dietitians using standard protocols were employed to minimize bias and to aid the subjects when reflecting on their daily diet. Third, some communication problems were encountered, particularly with subjects who had lived for a relatively short time in Korea and had a low level of education, although Vietnamese translators fluent in both Korean and Vietnamese assisted whenever needed.

Although this study had some limitations, it was the first to investigate changes in daily food and nutrient intakes and blood profiles between baseline and follow-up among Vietnamese female marriage immigrants living in Korea. Moreover, the results may be helpful for developing nutritional programs in Vietnamese female marriage immigrants in Korea and could be a basis for further studies on international marriage immigrants.

In conclusion, overall dietary intake decreased in Vietnamese female marriage immigrants during the follow-up period. A long-term follow-up study is needed to assess the association between changes in consumption of milk and dairy products and biochemical indicators including blood hs-CRP levels in Vietnamese female marriage immigrants.

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