

Individualized diabetes nutrition education improves compliance with diet prescription*

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Abstract

This study was designed to evaluate the effect of individualized diabetes nutrition education. The nutrition education program was open to all type 2 diabetes patients visiting the clinic center and finally 67 patients agreed to join the program. To compare with 67 education group subjects, 34 subjects were selected by medical record review. The education program consisted of one class session for 1-2 hours long in a small group of 4-5 patients. A meal planning using the food exchange system was provided according to the diet prescription and food habits of each subject. Measurements of clinical outcomes and dietary intakes were performed at baseline and 3 months after the education session. After 3 months, subjects in education group showed improvement in dietary behavior and food exchange knowledge. In education group, intakes of protein, calcium, phosphorus, vitamin B₂, and folate per 1,000 kcal/day were significantly increased and cholesterol intake was significantly decreased. They also showed significant reductions in body weight, body mass index (BMI), and fasting blood concentrations of glucose (FBS), HbA1c, total cholesterol, and triglyceride. However, no such improvements were observed in control group. To evaluate telephone consultation effect, after the nutrition education session, 34 subjects of the 67 education group received telephone follow-up consultation once a month for 3 months. The others (33 subjects) had no further contact after the nutrition education session. Subjects in the telephone follow-up group showed a decrease in BMI, FBS, and HbA1c. Moreover, the subjects who did not receive telephone follow-up also showed significant decreases in BMI and FBS. These results indicated that our individually planned education program for one session was effective in rectifying dietary behavior problems and improving food exchange knowledge, and quality of diet, leading to an improvement in the clinical outcomes. In conclusion, our individualized nutrition education was effective in adherence to diet recommendation and in improving glycemic control and lipid concentrations, while follow-up by telephone helped to encourage the adherence to diet prescription.

Key Words: Nutrition education, type 2 diabetes, diet behavior, nutritional knowledge, telephone consultation

Introduction

The prevalence of type 2 diabetes mellitus (DM) has drastically increased in recent years in Korea. Type 2 diabetes is accompanied by complications such as dyslipidemia, hypertension and obesity (Gray *et al.*, 1998; Hopkins *et al.*, 1996). These complications can be prevented if glycemic control is maintained within a normal range (Genuth *et al.*, 2003; Ko *et al.*, 2007).

Dietary management is considered the cornerstone of glycemic control in DM patients (Lindstorm *et al.*, 2003). Patient education including nutrition education is now accepted as an essential component of diabetic management (Jiang *et al.*, 1999). Numerous studies with DM patients have shown the association of nutrition education with improving dietary behavior (Albarran *et al.*, 2006; Norris *et al.*, 2001), nutritional knowledge (Bruce *et al.*, 2002; Lim *et al.*, 2001) and improving clinical outcomes

such as lower blood glucose and HbA1c levels (Christensen *et al.*, 2000; Delahanty & Halford, 1993; Johnson & Valera, 2001; Miller *et al.*, 2002) and lipid concentrations (Lee, 2007; Norris *et al.*, 2001).

Since the diabetes educational program began in Korea in the 1970s, there were over 170 hospitals providing diabetes educational program nationwide in 2005 (Park & Ahn, 2007). Most of these programs consisted of one class session focusing on principles of diet therapy and were delivered in a group setting (Lim *et al.*, 2001). Thus patients have found it difficult to understand and follow dietary advice at home. For most patients, they do not have channels to communicate with dietitians. Nutrition intervention through telephone consultation is a strategy for extending diabetes management into the patient's home (Kim & Oh, 2003). But few studies have identified and documented individualized nutrition education and telephone interviews for

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DM patients in Korea. Woo *et al.* (2005) reported that individualized dietary consultation using a diabetic buffet system was effective for helping patient to understand their diet prescriptions and controlling body weight and blood sugar level. Hayes *et al.* (2001) and Maljanian *et al.* (2005) have demonstrated the effectiveness of telephone consultations in diabetes management. Therefore, various approaches of nutrition education including telephone consultation are urgently needed to achieve more effective management of diabetes.

In this study, we aimed to examine the effect of individualized nutrition education for type 2 DM patients by evaluating changes in dietary behavior, nutritional knowledge, nutrient intakes and the effect of nutrition education followed by telephone consultation once a month for the following 3 months.

Subjects and Methods

Subjects

To recruit the subjects, an announcement on diabetic nutrition class was made at a DM clinic center in Seoul. The program was open to all type 2 DM patients who had gone through the baseline tests including FFQ at the clinic from September 2007 through April 2008, and 67 DM patients were voluntarily participated in the program. The control group composed of patients who visited the same clinic at the same period but did not join the program and 34 subjects were selected by medical record review. Patients were aged 33-81 years old and had no identifiable language barrier or known mental disability.

After the nutrition education session, 67 subjects in the education group were divided into the telephone follow-up group (34 subjects) and no telephone consultation group (33 subjects). The telephone follow-up group subjects were completed the intensive telephone follow up and no telephone consultation group subjects had any further contact for 3 months. This study was approved by the institutional review board (IRB) of Yonsei University Medical Center and written informed consent was obtained from all subjects.

Measurements

Diet survey and clinical measurements were made before enrolling the nutrition program and all the measurements were repeated at the end of study period for all subjects including control group.

General characteristics and dietary behaviors and nutrient intakes

An interview using a questionnaire was performed to get general characteristics and health behavior data. Dietary behavior and food exchange knowledge were assessed by the questionnaire developed for this study.

The dietary behavior questionnaire was developed based on questionnaire by Dunn *et al.* (1990), Fitzgerald *et al.* (1998), Kim and Seung (1985), Lee *et al.* (1985) and Lim *et al.* (2001).

The questionnaire was composed of 6 questions of diet adequacy, compliance with diet prescription using food exchange units, meals regularity, and food variety, frequency of salty food, and high fat / high cholesterol food use.

It was preliminarily tested before using and subjects were asked to answer 'often and always' (5 points), 'seldom and sometimes' (3 points), or 'never' (1 point) to get dietary behavior score.

To assess food exchange knowledge, subjects were asked to match 12 food items (① Rice, ② Laver, ③ Oil ④ Soy milk ⑤ Bean ⑥ Orange juice ⑦ Kim-chi ⑧ Acorn starch jelly ⑨ Yogurt ⑩ Apple ⑪ Peanuts ⑫ Beef) to food exchange groups. For a correct answer, 1 point was assigned and the possible total score was 12 points.

Nutrient intakes were measured by trained nutrition graduate students using 114-item FFQ previously validated (Oh *et al.*, 2007). Dietary intakes data were analyzed by using Can-pro 2.0 software (The Korean Nutrition Society, Korea).

Anthropometric and serological variables

The standing height was measured using a stadiometer. Body weight, body fat mass (kg), % body fat and waist hip ratio (WHR) were measured with an In-body 4.0 (Biospace Co., LTD., Seoul, Korea) and BMI (body mass index, kg/m²) was calculated. Blood samples were collected after a 12-h overnight fast. FBS, total cholesterol, triglyceride, and HDL-cholesterol were measured by using an auto analyzer (COBAS MIRA, Roche, Switzerland). LDL-cholesterol was calculated as described by Friedewald *et al.* (1972)

$$[\text{LDL-cholesterol} = \text{Total cholesterol} - \text{HDL cholesterol} - (\text{Triglyceride}/5)]$$

Hemoglobin A1c was measured by HLC-723 G7 (Toche, Japan). Systolic and diastolic blood pressures were measured in the sitting position after 10-minute rest by using an automatic pressure calculator (Biospace co, Seoul Korea).

Contents and procedure of nutrition education

Diet planning

- Energy requirement was prescribed by physicians for each subject based on the subject's height, weight, and activity level according to the guidelines of Korean diabetes association (KDA).
- Energy distribution was set in accordance with Korean Dietetic Association recommendation (protein 15-20%, fat 20-25%, carbohydrate 55-60%).
- Individualized diet planning using food exchange system was given considering food preference and dietary behavior shown in the results of FFQ and dietary behavior questionnaire. Also, diabetic complications were taken into account, if any.

Curriculum of nutrition education

The curriculum of nutrition education was structured to provide an understanding of meal planning and dietary recommendation (Fig. 1). The purpose of this program was to encourage and support self-management leading to long-term adherence to diet recommendation. Food model was used to help subjects understand the food exchange system.

Procedures of nutrition education

The nutrition education program consisted of one session for 1 to 2 hours long according to individualized diet prescription and was performed in a small group of 4-5 patients. The control group subjects were given written results of the FFQ after baseline examination and had no further contact for following 3 months.

After the education session, the 34 telephone follow-up group subjects received intensive consultation for 3 months. The telephone consultation focused on checking their adherence to diet recommendation leading to long-term dietary behavior maintenance. No telephone consultation group subjects had any further contact after the nutrition education session.

Statistical analysis

Statistical analyses were conducted using SPSS program (version 12.0). All data were expressed as mean and standard error (continuous variables) or number and percentage (categorical variables). Chi-square test was performed to determine differences in frequencies of categorized variables including use of medication

between two groups. Comparison analysis between baseline and after 3 months was done by paired t-test. Data within each group were analyzed by repeated measures analysis of variance to establish significant differences in treatment. In all statistical tests, *p* values of less than 0.05 were considered significant.

Results

General characteristics and health behavior of the subjects at baseline

As shown in Table 1, mean age and DM duration were 59.0 y and 7.1 y for education group and 58.0 y and 8.6 y for control

Table 1. Baseline characteristics of the subjects in the intervention study

Variables	Education group (n=67)	Control group (n=34)
Sex (Male, %)	44.1	49.3
Age (y)	59.0 ± 1.3 ¹⁾	58.0 ± 1.0
Duration of DM (y)	7.1 ± 0.7	8.6 ± 1.4
Family history of DM (%)	68.7	65.6
Previous education on DM diet (%)	38.1	38.2
Cigarette smoking (%)	9.5	17.6
Alcohol drinking (%)	39.7	38.2
Anthropometric variables		
Height (cm)	161.1 ± 0.7	161.6 ± 1.1
Weight (kg)	63.5 ± 1.6	64.6 ± 2.0
BMI (kg/m ²)	24.4 ± 0.4	24.8 ± 0.6
WHR	0.90 ± 0.01	0.91 ± 0.01
Serological variables		
FBS (mg/dl)	159.6 ± 6.1	168.1 ± 11.4
HbA1c (%)	8.0 ± 0.2	8.5 ± 0.3
Triglyceride (mg/dl)	135.8 ± 10.4	119.6 ± 10.8
Total cholesterol (mg/dl)	190.2 ± 4.4	200.7 ± 8.1
HDL-cholesterol (mg/dl)	49.5 ± 2.1 /	46.6 ± 1.6 /
(mg/dl, Male/Female)	50.5 ± 1.6	51.9 ± 1.9
LDL-cholesterol (mg/dl)	110.6 ± 4.3	127.4 ± 7.3
Blood pressure		
SBP (mmHg)	136.7 ± 2.5	140.8 ± 2.8
DBP (mmHg)	84.5 ± 1.5	82.7 ± 1.7
Dietary intakes (per 1,000 kcal)		
Energy (kcal)	1981.2 ± 106.5	1991.3 ± 114.3
Carbohydrate (g)	142.3 ± 2.6	146.0 ± 3.6
Protein (g)	42.3 ± 0.8	42.6 ± 1.0
Lipid (g)	27.0 ± 0.8	26.2 ± 1.2
Dietary behavior and nutritional knowledge score		
Dietary behavior score ²⁾	18.2 ± 0.8	18.8 ± 0.9
Knowledge score ³⁾	8.9 ± 0.3	7.9 ± 0.9

¹⁾ Mean ± SE

²⁾ Maximum score for each question was 5 points and total maximum score was 30 points.

³⁾ Maximum score for each question was 1 point and total maximum score was 12 points.

BMI = body mass index, WHR = Waist-to-hip ratio, SBP = systolic blood pressure, DBP = Diastolic blood pressure, FBS = fasting blood concentrations of glucose, HbA1c = Hemoglobin A1c

No significant differences were found all variables between education group and control group.

Curriculum	Contents
Understanding of meal planning	<ul style="list-style-type: none"> The importance of diet therapy and general principles of diabetic management was explained. The concept of nutritional elements, six food groups, food items for each food group, and food exchange units was explained. The ideal diabetes meal according to prescribed diet was planned.
Diet recommendation for special occasions and complications of diabetes	<ul style="list-style-type: none"> The guidance for eating out, holidays, and special occasions was given. Diet recommendation, signs, and symptoms for complications of diabetes were also made. If the subjects experienced hypoglycemia, proper strategy to raise blood glucose was explained. If the subjects had complications, diet recommendation was made accordingly such as sodium reduction for hypertension or low cholesterol for hypercholesterolemia.
Diet recommendations with educational leaflets	<ul style="list-style-type: none"> Educational leaflet including information about diabetes management was provided. Information about difference between simple and complex carbohydrate, difference between saturated and unsaturated fat, calories contained in beverages and alcohol was given. The importance of calcium intake and high fiber diet was explained.
Individualized advice to comply with dietary behavior	<ul style="list-style-type: none"> Individualized advice was given based on the result of FFQ and dietary behavior problem identified by questionnaire.
Question and discussion	<ul style="list-style-type: none"> At the end of nutrition education session, there was time for questions and discussion.

Fig. 1 Curriculum of nutrition education

Table 2. The change of dietary behavior and food exchange knowledge score after 3 months

	Education group (n=67)		Control group (n=34)		P
	Baseline	After 3 months	Baseline	After 3 months	
I have a meal adequately.	2.82 ± 0.26 ¹⁾	3.53 ± 0.24*	3.00 ± 0.25	3.48 ± 0.20*	0.820
I comply with food exchange units according to my prescription.	2.12 ± 0.19	2.82 ± 0.22*	1.97 ± 0.23	2.27 ± 0.24	0.154
I eat three meals regularly.	3.53 ± 0.24	3.41 ± 0.25	3.36 ± 0.27	3.48 ± 0.29	0.885
I eat a variety of foods.	3.59 ± 0.22	3.41 ± 0.25	3.91 ± 0.25	3.61 ± 0.24	0.603
I usually don't eat salty foods.	2.88 ± 0.24	3.24 ± 0.25	3.00 ± 0.26	3.12 ± 0.26	0.995
I don't eat fried- or high cholesterol foods.	3.24 ± 0.24	3.88 ± 0.19*	3.61 ± 0.25	3.91 ± 0.23	0.437
Total scores (30 points) ²⁾	18.2 ± 0.8	20.5 ± 0.9*	18.8 ± 0.9	19.9 ± 0.4	0.992
Knowledge test (12 points) ³⁾	8.9 ± 0.3	9.9 ± 0.3*	7.9 ± 0.9	7.8 ± 0.4	0.000

¹⁾ Mean ± SE²⁾ Maximum score for each question was 5 points and total maximum score was 30 points.³⁾ Maximum score for each question was 1 point and total maximum score was 12 points.Significantly different by paired t-test between baseline and after 3 months * $P < 0.05$, ** $P < 0.001$ By repeated measured ANOVA between baseline and after 3 months after adjusting for sex (time * education interaction, $P < 0.05$)**Table 3.** The change of anthropometric and serological variables and nutrient intakes

	Education group (n=67)		Control group (n=34)		P
	Baseline	After 3 months	Baseline	After 3 months	
Anthropometric variables					
Weight (kg)	63.5 ± 1.6 ¹⁾	61.9 ± 1.5**	64.6 ± 2.0	64.9 ± 1.9	0.389
BMI (kg/m ²)	24.4 ± 0.4	23.7 ± 0.4**	24.8 ± 0.6	24.9 ± 0.5	0.214
Body fat (%)	26.2 ± 1.2	25.1 ± 1.4	27.8 ± 1.2	27.8 ± 1.3	0.211
WHR	0.90 ± 0.01	0.89 ± 0.01*	0.91 ± 0.01	0.91 ± 0.01	0.219
Serological variables					
FBS (mg/dl)	159.6 ± 6.1 ¹⁾	136.0 ± 4.3**	168.1 ± 11.4	166.4 ± 7.4	0.068
HbA1c (%)	8.0 ± 0.2	7.3 ± 0.2**	8.5 ± 0.3	8.6 ± 0.3	0.004
Triglyceride (mg/dl)	135.8 ± 10.4	112.8 ± 6.4*	119.6 ± 10.8	129.8 ± 11.0	0.915
Total cholesterol (mg/dl)	190.2 ± 4.4	178.3 ± 3.7*	200.7 ± 8.1	201.4 ± 7.0	0.004
HDL-cholesterol (mg/dl)					
Male	49.5 ± 2.1	48.9 ± 2.2	46.6 ± 1.6	45.8 ± 2.0	0.400
Female	50.5 ± 1.6	54.0 ± 2.3	51.9 ± 1.9	51.0 ± 2.0	0.760
LDL-cholesterol (mg/dl)	110.6 ± 4.3	103.5 ± 3.6	127.4 ± 7.3	127.0 ± 5.7	0.001
Blood pressure					
SBP (mmHg)	136.7 ± 2.5	126.8 ± 1.8**	140.8 ± 2.8	133.2 ± 3.4*	0.083
DBP (mmHg)	84.5 ± 1.5	76.8 ± 1.7**	82.7 ± 1.7	81.8 ± 1.7	0.410
Dietary intakes (per 1,000 kcal)					
Energy (kcal)	1981.2 ± 106.5 ¹⁾	1829.1 ± 66.3	1991.3 ± 114.3	1989.6 ± 78.6	0.490
Carbohydrate (g)	142.3 ± 2.6	142.7 ± 2.7	146.0 ± 3.6	153.8 ± 3.3*	0.097
Protein (g)	42.3 ± 0.8	45.1 ± 1.1*	42.6 ± 0.9	40.8 ± 1.0	0.056
Lipid (g)	27.0 ± 0.8	26.8 ± 0.9	26.2 ± 1.2	23.5 ± 1.1*	0.102
Fiber (g)	4.67 ± 0.2	4.86 ± 0.2	4.6 ± 0.2	4.3 ± 0.2	0.152
Calcium (mg)	358.7 ± 15.2	419.3 ± 17.2**	384.1 ± 17.9	359.1 ± 16.7	0.431
Phosphorus (mg)	643.7 ± 14.1	709.6 ± 17.7**	656.1 ± 16.7	627.9 ± 14.3	0.098
Sodium (mg)	2841.1 ± 104.8	2933.8 ± 130.7	2912.8 ± 140.3	2546.5 ± 117.5*	0.301
Folate (µg)	183.2 ± 6.9	199.4 ± 7.3*	172.0 ± 8.1	173.6 ± 7.8	0.060
Cholesterol (mg)	177.3 ± 7.5	159.8 ± 7.2*	174.0 ± 12.3	150.2 ± 8.8	0.533
Vitamin A (µg RE)	553.6 ± 29.9	591.5 ± 43.1	497.1 ± 35.0	414.3 ± 33.0*	0.012
Vitamin B ₁ (mg)	0.66 ± 0.01	0.69 ± 0.02	0.67 ± 0.02	0.63 ± 0.01*	0.154
Vitamin B ₂ (mg)	0.69 ± 0.02	0.76 ± 0.03*	0.69 ± 0.03	0.63 ± 0.02*	0.066
Vitamin B ₆ (mg)	1.30 ± 0.04	1.35 ± 0.05	1.29 ± 0.04	1.18 ± 0.03*	0.075
Vitamin C (mg)	74.3 ± 3.9	74.5 ± 4.0	69.5 ± 3.8	65.0 ± 3.7	0.157
Vitamin E (mg)	8.5 ± 0.4	9.0 ± 0.4	7.7 ± 0.4	6.9 ± 0.4	0.008

¹⁾ Mean ± SESignificantly different by paired t-test between baseline and after 3 months * $P < 0.05$, ** $P < 0.001$ By repeated measured ANOVA between baseline and after 3 months after adjusting for sex (time * education interaction, $P < 0.05$)

group, respectively. About two thirds of patients had DM family history and one third had previous education on DM diet. There were no significant differences between education and control group in baseline characteristics such as sex, age, duration of DM, cigarette smoking and alcohol consumption.

Baseline mean BMIs for education and control groups were 24.4 kg/m² and 24.8 kg/m², respectively, which were in the overweight range. The mean WHR was 0.90 cm for education and 0.91 cm for control group which were higher than normal range. Baseline FBS levels for both groups were higher than the normal range and the level of lipid profile was in the normal range. There were no significant differences in mean height, weight, BMI, and blood levels of glucose and lipids. Systolic blood pressure for both groups were higher than the normal value, however, diastolic blood pressure was in the normal range.

Also, no significant differences were found in macronutrients and micronutrients intakes between two groups. Dietary behavior score and food exchange knowledge score were 18.2 and 8.68 for education group and 18.8 and 7.93 for control group, respectively, and the differences between two groups were not significant.

Effect of nutrition education program

Dietary behavior and food exchange knowledge score: Table 2 shows the changes of dietary behavior and food exchange knowledge after 3 months of intervention period. In education group, the scores for 3 questions on food adequacy, compliance with prescription, and low fat meal were significantly increased. The scores on food regularity, variety, and salty food intake did

Table 4. The changes of anthropometric variables and serological variables according to telephone follow-up

	Telephone follow-up group (n=34)		No telephone consultation group (n=33)		<i>P</i>
	Baseline	After 3 months ²⁾	Baseline	After 3 months	
Anthropometric variables					
Weight (kg)	63.7 ± 2.3 ¹⁾	62.9 ± 2.1	63.3 ± 2.2	60.7 ± 2.1*	0.665
BMI (kg/m ²)	23.7 ± 0.5	23.3 ± 0.4*	25.2 ± 0.7	24.1 ± 0.7*	0.144
Body fat (%)	26.0 ± 1.4	24.6 ± 1.7	27.5 ± 1.0	27.3 ± 1.6	0.482
WHR	0.90 ± 0.01	0.89 ± 0.01	0.92 ± 0.01	0.90 ± 0.01	0.349
Serological variables					
FBS (mg/dl)	156.0 ± 7.4	139.1 ± 7.2**	164.0 ± 10.2	132.3 ± 21.5*	0.946
HbA1c (%)	7.8 ± 0.3	7.4 ± 0.2	8.3 ± 2.0	7.1 ± 0.2*	0.893
Triglyceride (mg/dl)	127.5 ± 15.4	99.1 ± 7.6*	145.7 ± 13.8	129.3 ± 10.0	0.094
Total cholesterol (mg/dl)	191.3 ± 7.1	176.6 ± 5.9	188.8 ± 4.9	180.4 ± 4.1	0.920
HDL-cholesterol (mg/dl)					
Male	52.0 ± 3.0	50.1 ± 3.6	46.5 ± 3.0	47.5 ± 2.1	0.341
Female	50.6 ± 2.1	52.6 ± 3.0	50.5 ± 2.5	55.8 ± 3.6	0.668
LDL-cholesterol (mg/dl)	111.6 ± 5.9	105.5 ± 5.1	109.4 ± 6.4	101.1 ± 5.3	0.626
Blood pressure					
SBP (mmHg)	131.3 ± 3.0	125.3 ± 2.5*	141.5 ± 4.1	128.8 ± 2.4**	0.069
DBP (mmHg)	83.3 ± 1.8	77.1 ± 1.7*	86.1 ± 2.4	76.4 ± 3.2*	0.644
Dietary intakes (per 1,000 kcal)					
Energy (kcal)	1981.1 ± 132.2	1733.3 ± 75.8*	1981.2 ± 176.6	1951.3 ± 113.4	0.491
Carbohydrate (g)	145.7 ± 3.6	145.2 ± 3.2	138.1 ± 3.7	139.5 ± 4.6	0.148
Protein (g)	41.8 ± 1.0	45.1 ± 1.5	42.9 ± 1.2	45.1 ± 1.6	0.712
Lipid (g)	26.1 ± 1.0	25.8 ± 1.0	28.2 ± 1.2	28.0 ± 1.7	0.149
Fiber (g)	4.5 ± 0.2	5.0 ± 0.2	4.8 ± 0.3	4.8 ± 0.2	0.761
Calcium (mg)	343.0 ± 15.5	424.1 ± 24.3**	378.8 ± 19.1	413.3 ± 24.5	0.660
Phosphorus (mg)	629.3 ± 18.1	720.7 ± 25.8**	662.2 ± 22.0	695.3 ± 23.3	0.891
Sodium (mg)	2726.7 ± 132.8	2913.4 ± 183.3	2987.0 ± 166.6	2959.9 ± 187.3	0.430
Folate (μg)	174.2 ± 9.0	198.6 ± 10.3*	194.6 ± 10.5	200.3 ± 10.3	0.359
Cholesterol (mg)	172.0 ± 9.2	162.6 ± 10.7	184.1 ± 12.3	156.3 ± 9.3*	0.807
Vitamin A (μg RE)	524.8 ± 36.2	549.9 ± 39.7	590.3 ± 49.8	644.7 ± 83.9	0.173
Vitamin B ₁ (mg)	0.64 ± 0.02	0.68 ± 0.02	0.69 ± 0.02	0.70 ± 0.02	0.143
Vitamin B ₂ (mg)	0.65 ± 0.03	0.75 ± 0.04*	0.74 ± 0.04	0.77 ± 0.04	0.221
Vitamin B ₆ (mg)	1.25 ± 0.05	1.34 ± 0.06	1.36 ± 0.07	1.37 ± 0.05	0.311
Vitamin C (mg)	68.7 ± 4.3	71.5 ± 5.0	81.5 ± 6.7	78.4 ± 6.4	0.132
Vitamin E (mg)	7.9 ± 0.4	9.0 ± 0.6	9.1 ± 0.6	8.9 ± 0.6	0.445

¹⁾ Mean ± SE

²⁾ After 3 months data represented the result according to the telephone follow up consultation of the 67 education group subjects after education session. Significantly different by paired t-test between baseline and after 3 months * $P < 0.05$, ** $P < 0.001$

By repeated measured ANOVA between baseline and after 3 months after adjusting for sex (time * education interaction, $P < 0.05$)

not change. The total score of dietary behavior was significantly increased from 18.2 to 20.5 out of possible score of 30. On the other hand, in control group, only the score for meal adequacy was significantly increased and total scores did not change.

The food exchange knowledge score of education group was significantly increased from 8.68 to 9.91, however, no significant change was found in control group.

Repeated tests for treatment showed significant effects of nutrition education on increasing knowledge score (time \times education interaction, $P < 0.05$).

Anthropometric and serological variables: After 3 months of intervention period, subjects in education group showed significant decreases in the body weight, BMI and WHR compared to the baseline values. Significant reductions were also found in FBS, HbA1c, total cholesterol, and triglyceride. No changes in HDL and LDL cholesterol levels were observed during the same period. However, no significant changes of all anthropometric and blood variables were found in control group (Table 3). Repeated tests for treatment showed significant effects of nutrition education on lowering HbA1c and total cholesterol (time \times education interaction, $P < 0.05$).

Both systolic and diastolic blood pressures were significantly decreased in education group and reached the normal range, however, only SBP was significantly decreased in control group.

Nutrient intakes: In education group, the intakes of protein, calcium, vitamin B₂, and folate were significantly increased and cholesterol intake was significantly decreased. The intakes of energy, carbohydrate, lipid, and fiber did not change. On the contrary, in control group, the carbohydrate intake was significantly increased and the intakes of lipid, sodium, vitamin A, vitamin B₁, vitamin B₂, and vitamin B₆ were significantly decreased after 3 months.

Effect of telephone follow-up

To evaluate the effect of follow-up telephone consultation, the results of 34 participants were compared with those of 33 subjects in education group who did not join the telephone follow-up. In telephone follow-up group, BMI was significantly decreased from 23.7 kg/m² to 23.3 kg/m² and there were no significant changes in weight, body fat (%), and WHR. Also, significant decreases in FBS and triglyceride were found. No changes were observed in total cholesterol, HDL cholesterol, and LDL cholesterol. The subjects who did not receive telephone consultation also showed significant decrease in body weight, BMI, FBS and HbA1c. SBP and DBP were significantly decreased in both groups and reached a normal range after 3 months.

For nutrient intakes, in the subjects who did not receive telephone consultation, only cholesterol intake was significantly decreased and no significant changes were observed in other

nutrients. On the other hand, in telephone follow-up group, energy intake was significantly decreased and the intakes of calcium, phosphorus, vitamin B₂ and folate were significantly increased and the intakes of carbohydrate, lipid, fiber, and cholesterol did not change after 3 months. Repeated tests for treatment showed no significant effects of telephone follow-up consultation.

Discussion

Many studies have reported that patients who have participated in diabetes education program improved dietary behavior and nutritional knowledge, resulting in the positive changes in nutrients intake such as increase in vitamin intake and decrease in fat and cholesterol intake (Elshaw *et al.*, 1994; Lee, 2007; Woo *et al.*, 2005) as well as improvement in clinical outcomes such as lower blood levels of glucose and HbA1c (Christensen *et al.*, 2000; Delahanty & Halford 1993; Johnson & Valera, 2001), lower cholesterol and lower triglyceride concentrations (Franz *et al.*, 1995; Lee, 2007; Norris *et al.*, 2001; Shabbidar *et al.*, 2006).

In our study, subjects who joined nutrition education program showed an improvement in dietary behavior score and food exchange knowledge score. Also, nutrition intakes of education group were improved. Intakes of calcium, and vitamins were increased and cholesterol intake was decreased. These results were similar to the results from the study by Lee (2007) and Woo *et al.* (2005) in which intakes of vitamins and minerals in education group subjects were significantly increased to meet the prescription.

The education group subjects in our study also showed improvements of anthropometric variables and clinical outcome. Weight and BMI of education group were significantly decreased and these results were consistent with the study by Lemon *et al.* (2004). The improvement in glycemic control shown by reduction of FBS and HbA1c in this study was similar to that of the study by Christensen *et al.* (2000) in which medical nutrition therapy brought about mean reduction of HbA1c levels to $< 8\%$. Franz *et al.* (1995) and Shabbidar *et al.* (2006) have reported that the concentrations of serum cholesterol and triglyceride were decreased significantly and reached the normal range after medical nutrition therapy, which is consistent with our results of reduction in serum cholesterol level.

The repeated education session seems to be essential for diabetic diet consultation. However, it is often difficult for patients to attend classes regularly. Kim and Oh (2003) reported that telephone care programs were a viable strategy for bringing diabetes management into the patient's home, improving glycemic control and increasing compliance with diet recommendations. Maljanian *et al.* (2005) showed that an intensive telephone follow-up for 12 weeks as an additional component of diabetes management was effective in improving

glycemic control and adherence to dietary recommendations. In our study, to examine the effect of nutrition education session followed by telephone consultation, telephone interview was given once a month for the following 3 months. There were no significant differences in changes of BMI, glycemic control and lipid profiles whether or not the subjects received telephone consultation after individualized nutrition education. However, nutrient intakes of the subjects who received telephone consultation were improved and these results were similar to the study by Kim and Oh (2003). It seemed that one class session of our individualized nutrition education was effective in adherence to diet recommendation and in improving glycemic control and lipid concentrations while follow-up by telephone helped encourage adherence to diet prescription.

In summary, in our education group, dietary behavior and food exchange knowledge score were significantly increased. Also, intakes of protein, calcium and vitamins were significantly increased, while FBS, HbA1c, total cholesterol, and triglyceride significantly decreased. Even though diet education was performed only one time, it was effective in rectifying dietary behavior problems and, improving food exchange knowledge, and quality of diet, leading to an improvement in the clinical outcomes. This study proves that individualized diabetes education is effective for diabetes management. To assess that the effect of individualized nutrition education is continually maintained, constant monitoring for diabetes patients is necessary.

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