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Development of dietary pattern evaluation tool for adults and correlation with Dietary Quality Index

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BACKGROUND/OBJECTIVES: As the prevalence of chronic diseases has risen, the need for straightforward diagnostic tools for monitoring nutrition status to improve nutrition counseling and disease prevention has likewise increased. This study developed an easily usable dietary behavior pattern diagnosis checklist and investigated its correlation with dietary quality index.
SUBJECTS/METHODS: A draft dietary pattern evaluation tool was generated by analyzing previous studies. The draft questionnaire comprised 61 questions for assessing dietary habits. A survey was administered to 320 adults (19 to 64 years old) using the dietary pattern evaluation tool and 24-hour-recall method between March and May of 2014 in Jeonbuk province and the metropolitan area. Principal component analysis with varimax rotation was performed to identify dietary behavior patterns. Nutritional analysis was conducted using CAN-Pro 4.0, and the Diet Quality Index-International (DQI-I) was calculated to assess dietary quality. The correlation between dietary pattern scores and DQI-I scores was also analyzed.
RESULTS: The factor analysis resulted in a total of 34 questions mapped to four main dietary behavior patterns: "high fat and calorie" pattern (12 questions), "overeating/binge" pattern (nine questions), "dietary impulse" pattern (eight questions), and "unbalanced food intake" pattern (five questions). The four dietary behavior patterns were negatively correlated with DQI-I adequacy and total scores ($P < 0.01$).
CONCLUSIONS: The dietary pattern evaluation tool developed in this study can be used to diagnose a client's dietary behavior problems and is available as a nutrition counseling tool in the field.

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INTRODUCTION

Modern diets have changing recently with improving economic and socio-cultural conditions [1]. In many cases, altered eating habits have caused nutritional imbalance, which has significantly increased the prevalence of chronic diseases such as obesity, hyperlipidemia, and hypertension [2]. According to the Korea National Health and Nutrition Examination Survey (KNHANES), more than 35% of men and more than 25% of women suffered from obesity between 2008 and 2012. The prevalence of hypertension during this period was more than 28% and 22% in men and women, respectively. The prevalence of hypercholesterolemia in men increased from approximately 3.0% in 2008 to 12.2% in 2012, whereas that in women increased from 5% in 2008 to a record rate of 16.4% in 2012 [3]. As these chronic diseases are closely related with dietary habits, prevention and management of these diseases through nutritional evaluation is becoming increasingly important [4,5].

The currently available tools for nutritional evaluation through a simple survey include simple questionnaires to diagnose the risk of nutritional deficiency among the elderly [6], simple evaluation sheets to evaluate overweight status and dietary life patterns in adults [7], simple evaluation sheets to screen overweight individuals [8], and dietary assessment sheets to assess nutritional risks [5]. Previously developed evaluation tools composed of items evaluating the overall quality of dietary habits are limited since they do not assess any detailed characteristics of an individual's dietary behavior.

For proper nutritional evaluation, dietary quality is as important as nutrient intake [9]. Tools for evaluating dietary quality based on nutrient intake include the Nutrient Adequacy Ratio (NAR) and Mean Adequacy Ratio (MAR) [10], which are frequently used in Korean studies. Tools for evaluating dietary quality based on food or food group intake include the Dietary Variety Score (DVS) [11] and Dietary Diversity Score (DDS) [12], whereas the Healthy Eating Index (HEI) [13] and the Diet Quality Index (DQI) [14] consider both the nutrient and food intakes. Tools based on dietary intake are currently used mostly in hospitals and

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health centers to evaluate dietary quality [5]. Assessment of food intake based on the 24-hour dietary recall method is limited since it can make a client feel cumbersome and is not considered to be representative of a habitual diet. Therefore, there is a need for standardized nutritional evaluation tools that are easy to use.

In this study, we aimed to develop a diagnostic tool to monitor dietary behaviors by considering an individual's dietary behaviors that can be easily utilized in nutritional counseling practice. In addition, we validated the tool by comparison with DQI-I, which is used as an evaluation tool for dietary quality.

SUBJECTS AND METHODS

Development of questionnaire to evaluate dietary behavior patterns

A draft evaluation questionnaire to monitor dietary behavior patterns was prepared based on examination of existing nutritional consultation programs and related studies within and outside of Korea [15-22]. The time schedule, target population, and content of programs such as "Health-IN" of the National Health Insurance Service (NHIS) [23], "Diet Net" of the Korean Society of Community Nutrition (KSCN) [24], "Diet-related Health Risk Appraisal" of the Korea Health Industry Development Institute (KHIDI) [25], and Your Disease Risk [26] were examined. Based on this investigation, general details and questions about dietary habits and behavior as well as physical activities of adults were selected for a draft questionnaire consisting of 79 total questions addressing general information (seven questions), dietary habits and behavior (59 questions), frequency of food intake (seven questions), physical activity (five questions), and one question about willingness to change dietary habits. The draft questions were modified and added after receiving advice from three dietitians and three professors of food and nutrition, resulting in a final questionnaire consisting of 80 total questions addressing general details (six questions), dietary habits and behavior (61 questions), frequency of food intake (seven questions), physical activity (five questions), and one question about intention to change dietary habits. Dietary habits and behaviors were scored on a 1-5 scale (1: not at all; 2: no; 3: average; 4: yes; 5: very much so). In the case of positive questions, score was given after reverse coding.

Subject selection and dietary survey

The study protocol was approved by the Institutional Review Board (IRB) of Wonkwang University (WKIRB-201403-SB-008). All subjects gave written informed consent, and a survey of 320 adults between 19 and 64 years of age was conducted in eight cities and provinces in Korea from March to May, 2014. Subjects answered the developed dietary behavior pattern questionnaire and the 24-hour dietary recall.

Factor analysis of dietary behaviors questionnaire

Factor analysis was conducted on data obtained from the 61 dietary habits and behavior questions to identify differences in dietary behavior patterns. Principle component analysis was used for factor extraction, and the varimax method was used for factor rotation. Questions with a factor loading higher than 0.4 and with communalities higher than 0.35 were selected and categorized based on patterns. However, questions with communalities of 0.35 or lower and showing correlation with questions for each dietary behavior pattern were incorporated under semantically similar queries.

Dietary intake assessment and Diet Quality Index-International (DQI-I) evaluation

The 24-hour dietary recall method was used to assess the nutrient intake status of subjects. For nutrient analysis of the surveyed dietary intake, Can-pro version 4.0 (Computer Aided Nutritional Analysis Program for Professionals 4.0; Korean Nutrition Society) was used.

Based on the results of the 24-hour dietary recall data, DQI-I was calculated to evaluate dietary quality as described previously [9]. DQI-I consists of weighted scores (maximum score 100 points) and focuses on four major dietary aspects: variety (20 points), adequacy (40 points), moderation (30 points), and overall balance (10 points).

Statistical analysis

All statistical analyses were performed using SPSS version 21.0 (IBM, Armonk, NY, USA), and the data are expressed as the mean ± SD.

Factor analysis was conducted to identify dietary behavior patterns from the dietary habit and behavior questions. Four patterns were identified. To validate the pattern questionnaire, ANOVA was conducted using quartile stratification of the subject's dietary pattern total scores with DQI-I scores, and tendencies among groups were analyzed through *P* for trend values. Pearson's correlation was used to examine the correlation between dietary behavior pattern scores and DQI-I scores. A *P*-value < 0.05 was considered significant.

RESULTS

General characteristics and dietary intakes of subjects

The general characteristics of the study subjects are shown in Table 1. In total, 116 men with an average age of 48.41 years and a BMI of 24.45 kg/m^2 as well as 204 women with an average age of 39.30 years and a BMI of 22.34 kg/m^2 participated in this study.

The results of the nutrient intake analysis are shown in Table 2. Caloric intakes were 1,998.95 kcal for men and 1,695.78 kcal for women, indicating a significant difference ($P < 0.001$). Dietary fiber intakes were 23.52 g/day for men and 20.28 g/day for women ($P < 0.01$) while sodium intakes were 5,281.98 mg/day for men and 3,930.39 mg/day for women ($P < 0.001$).

Table 1. Characteristics of the study participants

Variables	Sex		Total (n = 320)
	Men (n = 116)	Women (n = 204)	
Age (yrs)	48.41 ± 11.45[2)]	39.30 ± 13.56	42.60 ± 13.55
Height (cm)	171.60 ± 5.57	160.02 ± 5.12	164.22 ± 7.68
Weight (kg)	72.12 ± 8.12	57.16 ± 8.08	62.58 ± 10.82
BMI[1)] (kg/m^2)	24.45 ± 2.08	22.34 ± 3.10	23.10 ± 2.95

[1)] BMI: Body mass index
[2)] Mean ± SD

Table 2. Dietary intakes of the subjects

	Sex		Total subjects (n = 320)	*P*-value
	Men (n = 116)	Women (n = 204)		
Energy (kcal)	1,998.95 ± 696.80[1)]	1,695.78 ± 525.07	1,805.68 ± 609.74	< 0.001
Carbohydrate (g)	280.80 ± 84.23	255.72 ± 75.04	264.81 ± 79.29	0.006
Fat (g)	48.66 ± 28.27	45.61 ± 24.34	46.71 ± 25.83	0.310
Protein (g)	80.37 ± 32.50	64.64 ± 23.18	70.34 ± 27.93	< 0.001
Fiber (g)	23.52 ± 9.55	20.28 ± 8.42	21.45 ± 8.97	0.002
Vitamin A (μgRE)	994.97 ± 747.62	901.16 ± 679.54	935.17 ± 705.26	0.253
Vitamin B_1 (mg)	1.41 ± 0.68	1.24 ± 0.63	1.30 ± 0.65	0.020
Vitamin B_2 (mg)	1.29 ± 0.56	1.16 ± 0.53	1.21 ± 0.54	0.055
Niacin (mg)	17.66 ± 7.37	15.05 ± 9.41	16.00 ± 8.80	0.011
Vitamin B_6 (mg)	1.81 ± 0.66	1.47 ± 0.52	1.59 ± 0.60	< 0.001
Vitamin B_{12} (μg)	10.42 ± 7.73	8.02 ± 8.44	8.90 ± 8.26	0.012
Folate (μg)	619.40 ± 287.97	513.43 ± 229.86	551.84 ± 257.14	< 0.001
Vitamin C (mg)	116.13 ± 96.66	111.46 ± 79.52	113.15 ± 86.01	0.641
Vitamin D (μg)	6.62 ± 7.18	3.98 ± 5.06	4.93 ± 6.04	< 0.001
Vitamin E (mg)	16.01 ± 8.73	15.15 ± 7.10	15.46 ± 7.73	0.339
Vitamin K (μg)	289.78 ± 262.83	216.94 ± 172.93	243.35 ± 212.56	0.003
Calcium (mg)	565.27 ± 254.50	511.56 ± 232.44	531.03 ± 241.66	0.056
Phosphorus (mg)	1,166.81 ± 401.04	983.06 ± 325.53	1,049.67 ± 365.02	< 0.001
Sodium (mg)	5,281.98 ± 1,906.36	3,930.39 ± 1,694.38	4,420.34 ± 1,886.94	< 0.001
Potassium (mg)	3,123.35 ± 1,138.37	2,686.22 ± 1,137.79	2,844.68 ± 1,155.54	0.001
Magnesium (mg)	87.51 ± 56.55	80.99 ± 49.82	83.35 ± 52.37	0.286
Iron (mg)	17.22 ± 8.30	14.52 ± 7.73	15.50 ± 8.03	0.004
Zinc (mg)	11.10 ± 3.71	9.36 ± 3.10	9.99 ± 3.43	< 0.001
Copper (mg)	1.26 ± 0.50	1.09 ± 0.44	1.15 ± 0.47	0.001
Iodine (μg)	431.42 ± 785.59	262.85 ± 654.49	323.96 ± 708.28	0.041
Selenium (μg)	105.28 ± 46.91	89.00 ± 36.25	94.90 ± 41.12	0.001

[1)] Mean ± SD

Table 3. Factor loading matrix of the four major dietary behavior patterns

Question	Dietary behavior pattern type				Communalities
	Overeating / Binge	High fat / High calorie	Unbalanced food intake	Dietary impulse	
Do you continue to eat even after you feel like stopping?	0.756				0.669
Do you overeat frequently?	0.732				0.618
Do you eat more food than you had planned to?	0.675				0.498
Do you feel depressed or regret after overeating?	0.604				0.558
Do you feel that you do not have a good dietary behavior as compared to other people?	0.579				0.406
Do you overeat when you eat out (except staff cafeteria)?	0.566				0.400
Do you sometimes eat food although you are not hungry?	0.559				0.534
Have you ever failed in trying to lose weight?	0.551				0.506
Can you stop have a meal when you are full?	0.537				0.371
Do you often eat instant noodles such as ramen?		0.656			0.493
Do you often eat meat products such as ham or sausage?		0.601			0.449
Do you eat bread, pizza, and chicken instead of your regular meal at dinner?		0.583			0.481
Do you eat fast food more than twice a week?		0.581			0.425
Do you usually eat out (except staff restaurant) about twice a week?		0.571			0.358
Do you like greasy food?		0.428			0.489
Do you often eat greasy food such as fried food, stir-fry, or salad dressing?		0.539			0.453
How often do you eat snacks instead of a regular meal?		0.526			0.496
Do you eat fried of stir-fry dishes at least once in two days?		0.507			0.358
Do you eat foods containing sugar (cracker, candy, chocolates, cakes, ice cream) every day?		0.503			0.358
Do you drink soft drinks, vitamin drinks, or fruit juice instead of water when you feel thirsty?		0.501			0.413
Do you like meat?		0.452			0.411

Table 3. continued

Question	Dietary behavior pattern type				Communalities
	Overeating / Binge	High fat / High calorie	Unbalanced food intake	Dietary impulse	
Do you eat vegetables in each meal (except Kimchi)?			0.669		0.485
Are you eating beans (rice with bean, bean paste stew, or stewed bean in soy sauce) or tofu once a day?			0.562		0.378
Are you having fruits or fruit juice every day?			0.552		0.333
Are you eating at least one of the following foods: meat, fish, egg, bean, and tofu when you have a meal?			0.541		0.311
Do you prefer to eat multi-grain rice over white rice?			0.515		0.324
Do you eat food when you feel depressed or unhappy?				0.699	0.580
Do you eat food when you feel inferior or dissatisfied?				0.697	0.556
Do you eat food on impulse?	0.616				0.573
Do you eat food when you feel anxiety or stress ?				0.608	0.437
Do you feel that you should eat delicious food when you get stressed?				0.539	0.484
Do you eat food when you are angry?				0.531	0.533
Do you feel that you can recover yourself through eating sugary foods?				0.477	0.352
Do you eat food when you feed bored?				0.426	0.352

Kaiser-Meyer-Olkin (KMO): 0.862
Factor rotation method: varimax
Principle component analysis

Table 4. Dietary behavior pattern scores by sex

Dietary behavior pattern type	Sex		All subjects (n = 320)	*P*-value
	Men (n = 116)	Women (n = 204)		
Overeating / Binge[2)]	22.04 ± 5.55[1)]	24.91 ± 6.17	23.87 ± 6.10	< 0.001
High fat / High calorie[3)]	28.78 ± 6.64	29.71 ± 7.67	29.38 ± 7.32	0.277
Unbalanced food intake[4)]	15.16 ± 3.04	14.21 ± 3.25	14.55 ± 3.20	0.011
Dietary impulse[5)]	15.39 ± 3.95	18.44 ± 5.31	17.33 ± 5.07	< 0.001

[1)] Mean ± SD
[2)] Overeating/Binge score range: 9-45
[3)] High fat /High calorie total score range: 12-60
[4)] Unbalanced food intake score range: 5-25
[5)] Dietary impulse score range: 8-40
The higher score is undesirable dietary habits and behavior.

Development of dietary pattern evaluation tool

Table 3 presents the results of the final factor analysis of the data obtained from the 61 questions regarding dietary habits and behavior in the dietary pattern evaluation questionnaire. The 61 dietary habit and behavior questions were narrowed down to 34 questions that allowed assessment of four dietary behavior patterns. The dietary behavior patterns were named based on the features addressed by the corresponding questions as follows: "high fat/high calorie" pattern (12 questions), "overeating/binge" pattern (nine questions), "dietary impulse" pattern (eight questions), and "unbalanced food intake" pattern (five questions). Final questionnaire was composed of 43 total questions on dietary habit and behavior (34 questions), general information (six questions), physical activity (two questions), and one question addressing intention to change dietary habits. A higher dietary pattern score indicates undesirable dietary habits and behavior.

Dietary behavior pattern scores

The individual dietary behavior pattern scores of the study subjects are shown in Table 4. The scores for each dietary behavior pattern type ("overeating/binge", "high fat/high calorie", "unbalance food intake", and "dietary impulse") ranged from 9-45, 12-60, 5-25, and 8-40, respectively. Women displayed higher scores for the "overeating/binge" pattern with 24.91 points compared to men with 22.04 points ($P < 0.001$). For the "dietary impulse" pattern, women scored 18.44 points and men scored 15.39 points ($P < 0.001$), indicating that feelings influenced eating patterns more in women than in men. In contrast, men had higher scores for the "unbalanced food intake" pattern (15.16 points) than women (14.21 points; $P < 0.05$). A higher dietary pattern score means undesirable dietary habits and behavior.

DQI-I scores

The DQI-I scores of the study participants are shown in Table 5. Women scored 15.76 points for variety, which was higher than the score for men (15.58 points). Men showed significantly higher scores for dietary adequacy than women, with men and women participants scoring 29.44 and 27.18 points, respectively ($P < 0.01$). With respect to adequacy, men had significantly higher scores than women for intakes of vegetables, iron, cereal, and dietary fiber ($P < 0.01$), whereas women scored higher than men for fruit intake ($P < 0.05$). For the component dietary

Table 5. DQI-I scores by sex

Variables	Sex		Total subjects (n = 320)	*P*-value
	Men (n = 116)	Women (n = 204)		
Variety	15.58 ± 2.66[1)]	15.76 ± 2.98	15.69 ± 2.87	0.586
Overall food group variety (15)	11.04 ± 2.22	11.37 ± 2.38	11.25 ± 2.33	0.231
Within-group variety for protein source (5)	4.53 ± 1.03	4.39 ± 1.08	4.44 ± 1.06	0.251
Adequacy	29.44 ± 5.51	27.18 ± 6.50	28.00 ± 6.24	0.002
Vegetable group (5)	3.53 ± 1.45	2.63 ± 1.40	2.96 ± 1.48	< 0.001
Fruits group (5)	1.63 ± 2.17	2.27 ± 2.20	2.04 ± 2.21	0.012
Cereal group (5)	3.64 ± 1.28	3.10 ± 1.44	3.30 ± 1.41	0.001
Fiber (5)	4.17 ± 1.06	3.75 ± 1.30	3.90 ± 1.23	0.002
Protein (5)	4.97 ± 0.26	4.94 ± 0.34	4.95 ± 0.31	0.504
Iron (5)	4.84 ± 0.60	3.97 ± 1.28	4.29 ± 1.16	< 0.001
Calcium (5)	3.07 ± 1.24	3.01 ± 1.31	3.03 ± 1.28	0.692
Vitamin C (5)	3.59 ± 1.35	3.50 ± 1.51	3.53 ± 1.45	0.611
Moderation	18.08 ± 6.08	19.16 ± 5.59	18.77 ± 5.79	0.107
Total fat (6)	4.09 ± 2.07	3.34 ± 2.15	3.61 ± 2.15	0.003
Saturated fat (6)	4.78 ± 2.27	5.49 ± 1.41	5.23 ± 1.80	0.003
Cholesterol (6)	3.31 ± 2.78	4.03 ± 2.61	3.77 ± 2.69	0.021
Sodium (6)	0.52 ± 1.44	1.75 ± 2.30	1.30 ± 2.12	< 0.001
Empty calorie foods (6)	5.38 ± 1.61	4.56 ± 2.26	4.86 ± 2.08	< 0.001
Overall balance	2.48 ± 2.63	2.49 ± 2.38	2.49 ± 2.47	0.979
Macronutrient ratio (carbohydrate : protein : fat) (6)	1.41 ± 1.88	1.39 ± 1.85	1.40 ± 1.86	0.920
Fatty acid ratio (PUFA : MUFA : SFA) (4)	1.07 ± 1.55	1.10 ± 1.54	1.09 ± 1.54	0.871
Total DQI-I Score (100)	65.58 ± 9.63	64.59 ± 10.21	64.95 ± 10.00	0.396

[1)] Mean ± SD

Table 6. Comparison of dietary behavior pattern score quartiles and DQI-I scores

	Q1 (n = 84)	Q2 (n = 78)	Q3 (n = 81)	Q4 (n = 77)	Total (n = 320)	*P* for trend
Median	68.00 (46.00-74.00)	80.00 (75.00-84.00)	90.00 (85.00-96.00)	104.00 (97.00-143.00)	84.00 (46.00-143.00)	
Variety (20)	15.80 ± 2.78[1)]	15.95 ± 3.02	15.73 ± 2.79	15.29 ± 2.90	15.69 ± 2.87	0.232
Adequacy (40)	30.35 ± 5.06	28.73 ± 5.96	28.53 ± 5.70	24.13 ± 6.58	28.00 ± 6.24	< 0.001
Moderation (30)	19.46 ± 5.79	18.38 ± 5.75	18.26 ± 5.98	18.94 ± 5.64	18.77 ± 5.79	0.524
Balance (10)	2.69 ± 2.72	2.62 ± 2.48	2.57 ± 2.39	2.05 ± 2.25	2.49 ± 2.47	0.117
Total (100)	68.55 ± 8.51	65.46 ± 9.12	64.48 ± 10.62	60.90 ± 10.34	64.95 ± 10.00	< 0.001

[1)] Mean ± SD

Table 7. Pearson's correlations between dietary behavior pattern scores and DQI-I scores.

	Dietary behavior pattern type				
	Overeating / Binge	High fat / High calorie	Unbalanced food intake	Dietary impulse	Total
Variety (20)	-0.069	0.031	-0.206**	-0.054	-0.069
Adequacy (40)	-0.252**	-0.349**	-0.227**	-0.222**	-0.367**
Moderation (30)	0.044	-0.123*	0.020	0.003	-0.034
Overall balance (10)	-0.032	-0.061	-0.097	-0.004	-0.060
Total DQI-I score (100)	-0.159**	-0.295**	-0.213**	-0.153**	-0.283**

* $P < 0.05$, ** $P < 0.01$

moderation, men and women scored 18.08 and 19.16 points, respectively. For overall balance, men and women scored 2.48 and 2.49 points, respectively. The total DQI-I scores for men and women were 65.58 and 64.59 points, respectively.

Comparison of dietary behavior pattern scores with DQI-I scores

DQI-I scores according to dietary behavior pattern scores of subjects are shown in Table 6. Quartile values of dietary pattern scores tended to increase as values of DQI-I scores decreased; first, second, third, and fourth quartiles of total DQI-I scores were 68.55, 65.46, 64.48, and 60.90, respectively (*P* for trend < 0.001). A higher dietary behavior pattern score was associated with lower adequacy scores (*P* for trend < 0.001).

Correlation analysis of dietary behavior pattern scores and DQI-I

The results of correlation analysis between dietary behavior patterns and DQI-I scores are shown in Table 7. The "high fat/high calorie" pattern showed a negative correlation with moderation ($r = -0.123$, $P < 0.05$). The "unbalanced food intake" pattern was negatively correlated with the variety DQI-I component ($r = -0.206$, $P < 0.01$). All four dietary behavior patterns showed a negative correlation with adequacy and total DQI-I score ($P < 0.01$). Finally, the total dietary pattern score and DQI-I total score showed a negative correlation ($r = -0.283$, $P < 0.01$).

DISCUSSION

As the prevalence of diseases associated with poor dietary habits increases, healthcare administered through nutritional counseling based on evaluation of eating habits has become more important. Dietary quality exerts immense effects on health in the form of food intake, but methods for evaluating dietary quality based on dietary intake are time-consuming and cumbersome. Therefore, it is necessary to develop an easy-to-use nutritional evaluation tool. In this study, we aimed to develop a convenient dietary diagnosis tool by creating a draft dietary pattern evaluation tool and conducting a survey on 320 adults using the draft questionnaire and the 24-hour dietary recall method. Based on the survey results, the dietary assessment tool was refined and assessed the relation with DQI-I, which was used for dietary quality evaluation in the nutrition education field.

A survey consisting of 34 total questions on dietary habits and behavior selected by factor analysis was conducted using the draft dietary pattern evaluation tool. The questions were classified into "high fat/high calorie," "overeating/binge," "dietary impulse," and "unbalanced food intake" dietary behavior patterns based on the factor analysis. Previously developed analysis tools include simplified questionnaire sheets to evaluate dietary patterns associated with overweight status in adults [7] and young adults [8], and they are composed of 10 questions scored on a scale of 0 to 14 points, in which a score of 7 or higher is regarded as a dietary pattern associated with risk of being overweight. A dietary pattern assessment index was developed to identify nutritional risk groups among adults consisting of 10 questions with a maximum total index score of 50 points, with an index of 30 points reflecting the dietary pattern score of normal adults [5]. These dietary pattern evaluation tools were designed with a small number of questions for convenience of the subjects. However, as dietary behavior patterns are related with diverse factors, these simplified questionnaires did not obtain an accurate dietary behavior index for predicting risk of being overweight due to limited data [7,8]. The questions related to dietary habits and behavior in the tool developed in this study are similar to those in existing evaluation tools in the sense that subjects can answer them conveniently. However, we included 34 questions, which is more than that in existing tools. Another difference between our tool and existing tools developed in Korea is that the evaluation is based on scores calculated for each dietary pattern separately, and not only dietary habit-related questions but also dietary behavior-related questions are included in our tool.

The dietary behavior pattern scores were calculated for all subjects using the final version of the dietary pattern evaluation tool. There was no significant difference between the "high fat/high calorie" pattern scores between women and men. This result does not seem to be consistent with previously reported results from a study on college students in which the calorie intake composition ratio (% kcal) was calculated according to gender, indicating that women tend to have a higher fat intake ratio than men [27].

In previous studies on adults in the Korean region of Ulsan [28] and in department store staff [29], the proportion (%) of women who selected overeating as a dietary problem was higher than that of men, indicating that women have a higher tendency of self-perception of overeating than men. This is in agreement with the results of this study, as women had a significantly higher "overeating/binge" pattern score than men.

In the "dietary impulse" pattern, women also scored higher than men, which indicates a stronger influence for emotional feelings in dietary patterns of women compared to men. In previous studies on the influence of stress on eating patterns, similar results were obtained [30-32]. In a study by Cho & Song [30]. in college students, a significant difference was detected between men and women regarding food intake under stress; 31.2% of men and 53.5% of women reportedly consumed more food than usual in this circumstance. In studies by Sung & Chang [32] and Oliver & Wardle [33], more women than men indicated that they ate more when stressed.

In a previous study on female college students, students under stress preferred foods with high fat content and showed a tendency to eat faster as well as overeat [34]. In the current study as well, women with a high score for the "dietary impulse" pattern had a higher score in the "overeating/binge" pattern than men.

The DQI-I was composed of four main categories: variety (overall food group variety, protein sources), adequacy (vegetable, fruits, grain, fiber, protein, iron, calcium, vitamin C), moderation (fat, saturated fat, cholesterol, sodium, empty calories food), and overall balance (macronutrient ratio, fatty acid composition) [35]. DQI-I provides a practical tool for dietary assessment of dietary quality in terms of food intake, as well as problems in eating habits [14]. This collectively suggests a direct relationship between a higher DQI-I score and more desirable nutrition state.

The DQI-I analysis showed that women scored higher for dietary variety. This is in accordance with the results from a study that performed DQI-I analysis in patients with metabolic syndrome [9]. Men scored significantly higher for DQI-I adequacy than women. However, women had significantly higher scores than men for fruit intake within the DQI-I adequacy component. Similarly, in a previous study in metabolic syndrome patients, women scored higher than men in terms of fruit intake [9]. With regard to the moderation component of DQI-I, women had a higher score than men, which was again consistent with the results from the study on metabolic syndrome patients [9]. Further, the total fat intake score within the DQI-I moderation aspect was lower in women than in men, indicating higher intake of fat in women.

Both men and women had a mean total DQI-I score of 60

points or more. Compared to the results of a previous study using the same index [9], men scored higher and women scored lower in this study [27,14]. However, as in the previous study, scores of 60 points or more were recorded, which means that the dietary quality of the subjects in this study can be regarded normal.

The dietary behavior pattern scores developed in this study were compared with the DQI-I scores, which were calculated by using the 24-hour-recall method. In comparing the similarity of each item between the dietary behavior pattern questionnaire and DQI-I, parts of the detailed items from DQI-I's adequacy/moderation were similar to those included in the items of high fat/high calorie types and the unbalanced food intake types from the dietary behavior pattern scores. Among the items from DQI-I's adequacy, the fruits group and dietary behavior pattern scores were similar to the "Are you having fruits or fruit juice every day?" category under unbalanced food intake types. Among the items from DQI-I's moderation, "total fat" was similar to the fat intake-related items from the dietary behavior pattern scores included under the high fat/high calorie types, such as "Do you like greasy food?", "Do you often eat instant noodles such as ramen?", "Do you eat bread, pizza, and chicken instead of your regular meal at dinner?", and "Do you eat fast food more than twice a week?". The questions of the developed tools showed similarity between each DQI-I item to assess dietary quality. The total DQI-I scores were significantly correlated with the scores of each dietary pattern. However, since the present developed tools included questions regarding dietary habits and behavior, there was no significant relation between each variable of the DQI-I based on analysis of nutrient intakes, except the "adequacy" variable.

There was an inverse relationship between DQI-I and the dietary behavior pattern scores; higher total dietary behavior pattern score was associated with lower DQI-I adequacy and total scores. Especially, the indices of the "high fat/high calorie" dietary behavior pattern had a significantly negative correlation with DQI-I moderation. Further, there was a negative association between DQI-I overall balance and the dietary behavior pattern of "unbalanced food intake". The dietary pattern behavior evaluation tool considered nutrition state by DQI-I. The dietary pattern evaluation tool developed in this study showed high correlation with the dietary quality assessment tool, which reflects intake of nutrients. Therefore, this tool can be used for dietary assessment in the nutrition education field.

This study has several limitations. The assessment tool is limited to four dietary behavior patterns. Therefore, an analysis with more questions, e.g. on sodium intake and addressing habits such as skipping meals, will be able to cover a broader scope of dietary problems. This study investigated height and weight by using a self-administered questionnaire, which means the measurements lack reliability. Thus, the indices developed in this study were not analyzed for their relationship with obesity. In this study, we instead analyzed the correlation between the dietary pattern evaluation tool and the DQI-I by using 24-hour-recall data. Evaluation of dietary quality through one day analysis is limited to general eating habits only. Further validation of the present tool through comparison between dietary intake methods for determining usual dietary quality is required.

In summary, the dietary pattern behavior evaluation tool developed in this study can easily distinguish dietary patterns in adults based on evaluation of data obtained from simple questions that can be conveniently answered by clients. This allows nutritionists to counsel clients and help them understand their dietary problems.

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