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CLINICAL NUTRITION RESEARCH

Effects of 12-week Vegetarian Diet on the Nutritional Status, Stress Status and Bowel Habits in Middle School Students and Teachers

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This study investigated the effect of switching normal diet to vegetarian diet rich in vegetables and fruits for school foodservice and home meal on the nutritional status, bowel habit improvement and stress reduction of teachers and adolescents. A total of 40 research subjects (26 students, 14 teachers) from one middle school voluntarily participated in the research. Questionnaire surveys and blood analysis were conducted before and after a 12-week vegetarian diet period. The participants were asked on their dietary habit, bowel habit and stress measurement. After 12 weeks, reduction of BMI (kg/m^2) in the students ($p < 0.05$) and reduction of TC (mg/dL) in both teachers and students ($p < 0.05$) were observed. Also reduction of LDL-C (mg/dL) was observed in the teachers ($p < 0.05$) whereas serum calcium and Vitamin B_{12} was increased in the students and teachers ($p < 0.005$). The teacher's stress level was reduced ($p < 0.05$) after the 12-week vegetarian diet. As for the changes in bowel habit, the number of the students and teachers classified as experiencing functional constipation was decreased respectively from 10 to 7, from 7 to 5. Based on the result, it is considered that the vegetarian diet rich in fruits and vegetables improved general health status of study subjects suggesting that such a dietary habit would substantially contribute to improving nutritional status and bowel habit.

Key Words: Vegetarian diet, School food service, Nutritional status, Stress, Bowel habits

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Introduction

Dietary behaviors of Korean people in this society are heavily influenced by affluent dietary life style due to a rapid growth of economy and an introduction of western food culture. Major growth in the meat consumption and the increase in the frequencies of dining out has influenced the dietary behaviours of Korean adolescents as well as adults [1-3]. According to the results of National Health and Nutrition Examination for the daily intake trends of each food group, the daily mean intake of animal food was 261 g in 2001 but it rapidly increased to 304.4 g in 2010. As of 2013, it was 323.8 g and

presented an increasing trend each year. In contrast, the daily mean intake of vegetables and fruits has decreased [4].

Such dietary behaviours have great affects on the prevalence of non-communicable diseases. With the increase of meat intake, the prevalence of dyslipidemia or cancer has increased steadily. In case of hypertriglyceridemia, the prevalence increased from 10.2% for 1998 to 16.6% for 2010 by about 6.4%, and hypercholesterolemia also increased from 10% for 1998 to 13.5% for 2010 [4,5]. It was reported that the weekly mean intake of meat ≥ 500 g increased the risk for cancer including colon cancer [6].

It has been reported that that vegetables and fruits consumption strengthen the resistance to diseases as they contain a variety of minerals and vitamins including iron and improve bowel movement due to rich content of fibers. In addition, the anti-oxidation effects produced by a large amount of vitamins protect the cells from the oxidation-induced damages and greatly influence for prevention and treatment of various chronic diseases including obesity, diabetes, constipation, and cancer [2,3,7]. The consumption of fruits in adult population (19-29 yrs) was 152.8 g and 167.5 g in those aged from 30 to 49 years old, which was far less than the daily recommendation by WHO [8]. Especially, the intake of fruits of adolescents aged from 12 to 18 years old was very low as 137 g, and so was the intake of vegetables [4]. In comparison to those who mainly had meat-dominated diet, the vegetarians showed a higher intake rate of anti-oxidation nutrients and fibers with a lower intake of saturated fatty acid, sodium, and cholesterol and had reduced number of risk factors for cardiovascular diseases [9]. Dietary habits formed in adolescence are not corrected easily therefore, it is important to establish adequate dietary habits of adolescents in order to prevent chronic diseases in adulthood [2,10]

Adolescence is a transitional period from childhood to adulthood and during this period, the demands of various nutrients rapidly increase for physical, mental and physiological development. Because of such rapidly increasing demands, during that period, the adolescents need proper dietary behaviours and balanced intake of nutrients. Most adolescents have dietary behaviors favorable toward the processed meat product and protein intake rather than vegetables and fruits, and they show prominent reduction in consumption of plant food [3,7]

School foodservices are being implemented in Korea for the purpose to maintain and promote the health of students under growth period. For this purpose, the schools provide meals with excellent nutrition so as to establish a framework for constructing proper dietary behaviors and to foster the sense of community including spirits of cooperation and community service [10]. Notwithstanding the meals are being provided with balanced menu in the most of school meal program, in many cases, distributed meals to students are being wasted because the meals are not palatable to students' taste and this is likely to lead to inadequate nutrition intake. The rate of wasting food is the highest in the vegetables because of the low preference of vegetables in adolescence [11]. Therefore particularly, in the school meal program of junior high schools and senior high schools, dietitians tend to change the menu with more processed meat product to reduce food waste.

In this study, we investigated the effects of 12 week transient change to vegetables-focused diet of school fooldservice meals and at home on the anthropometric measurements, blood test, changes in bowel movement, and the level of stress in middle school students and teachers.

Materials and Methods

Subjects and period of study

The study was implemented in Buksung Junior High School located in Buk-gu of Gwangju-si. A total of 26 students (12 males, 14 females) at the age of 14-16 years and 14 teachers (3 males, 11 females) who had submitted voluntary consents were participated in the study. The study was conducted during the period over 12 weeks from April to July, 2013.

The survey on general information such as age, gender and dietary behaviours was conducted by using modified dietary behaviours assessment tool based on the Korean Healthy Eating Index (KHEI) presented at the website of the Korean Dietetic Association (KDA).

Vegetarian diet

The vegetable meals in this study were specially prepared by the school dietitian and were provided to the students and teachers who participated in the study (Table 1).

A simple training session was provided on the vegetables-related nutrition before the start of the study, and additional education sessions were conducted to maintain vegetable-focused diet habits at home during other meals and weekends outside of the school. While maintaining the usual diet, supply of vegetable-focused foods were increased and consumption of the processed food was restraint to maximize the effectiveness of vegetarian diet.

Table 1. Vegetarian menu switched from the general menu

	School meal	
	General menu	**Vegetarian menu**
Soups and stews	Spicy sausage stew	Fermented soybean paste stew
	Pork rib soup	Potato and perilla seed soup
	Boiled dumpling soup	Boiled vegetarian dumpling soup
	Tuna stew	Kimchi stew
	Loach soup	Noodle soup with perilla seed
	Rice porridge with chicken	Sweet pumpkin porridge
Side dishes	Chicken breast and bean curd salad	Paprica and bean curd salad
	Fish cutlet	Vegetarian ham cutlet
	Braised chicken	Steamed vegetable dumplings
	Fried chicken with sweet and spicy sauce	Vegetarian bulgogi
	Soy sauce braised quail eggs and mushrooms	Braised sweet pumpkin and chestnuts
	Spicy grilled chicken and perilla leaf	Pureed soybean curd and chive pancake
	Seafood and chive pancake	Korean style vegetarian meatball
	Duck bulgogi	Mushroom and bean bulgogi
	Korean rice and crab meatball	Brown rice meatball
	Pork cutlet	Vegetable roll
	Tortilla chicken roll	Tortilla vegetable roll

The selected diet of vegetarian meal was prepared by the school dietitian which was composed of the mean calorie of ~745.15 kcal, protein (16.09 g) and calcium (252.90-311.47 mg) for each meal. The vegetable diet were provided for 12 weeks. From the original school menu planned for each week, meat and meat products were substituted by vegetables 25.3%, fruits 19.5%, nuts and seeds 14.9%, beans/tofu 12.6%, mushrooms 10.3%, mixed grains 10.3%, and potatoes 6.9%.

AnAntrhopometric measurements

The anthropometric data of the study participants were collected at the school nurses office. Height and weight were measured and body mass index (BMI, BMI = weight [kg]/height [m²])was calculated.

BiBiochemical measurements

After 12 hours fasting, all the participants had their blood collected at a nearby community health center. Blood level of total cholesterol (TC), triglyceride (TG), HDL-cholesterol (HDL-C), non-HDL-cholesterol (non-HDL-C), blood hemoglobin (Hb), hematocrit (Hct), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglo-

bin concentration (MCHC), red blood cell (RBC), white blood cell (WBC), platelet (PLT), vitamin B_{12} were analyzed. Vitamin B_{12} was measured to monitor the possibility of anemia due to the deprivation of animal foods. As an useful predictor of cardiovascular disease and at the same time widely used inflammatory marker, high sensitivity C reactive protein (Hs-CRP) was analyzed. Minerals including Ca, Mg, Zn and Fe were also analyzed.

Questionnaire

The questionnaires were collected before and after the vegetarian diet intervention which include questions about bowel health and stress level.

1) Bowel Health Questionnaire

Bowel health was asked by the Rome III diagnostic criteria used for diagnosis of functional constipation and irritable bowel syndrome in order to evaluate the status of recent bowel movements of the subjects [12]. According to the Rome III diagnostic criteria, when 2 or more of 6 criteria is fullfilled for the last 3 months the patient can be diagnosed as functional constipation. The diagnostic criteria includes the frequency of

straining during defecations, hardness of stools, sensation of incomplete evacuation, compressing during defecations and frequency of stool.

On the other hand, irritable bowel syndrome (IRB) is defined by having recurrent abdominal pain or discomfort for at least 3 days per month for the past 3 months associated with two or more of the following criteria. 1) Improvement with defecation, 2) onset associated with a change in frequency of stool, 3) onset associated with a change in form of stool. All the questionnaires were filled by self-reporting of the study subjects before and after the study.

2) Stress Measurement

Measuring stress with questionnaires was conducted with different questionnaires for the student and teachers. The questionnaire used for the students were based on the questionnaire developed and validated by Lee [13]. The questions were consisted of 24 items for 5 domains; academic stress, friendship, relationship with teacher, relationship with family and their own body perception. Each item of those domains was scored by using the 5-point Likert scale (not at all stressed: 1, not really stressed: 2, more or less stressed: 3, slightly stressed: 4, extremely stressed: 5). The range of total stress scores is from 24 to 120 points, and the higher the score is, the stress level is high.

Stress questionnaires for the adults was conducted by using the Perceived Stress Questionnaire which was developed by Cohen et al. [14]. This questionnaire is most widely used questionnaire suitable for measuring stress in ordinary daily life and is consisted of 14 question items. The questionnaire emphasizes subjective perception on stress and the items are known to be easily understandable.

Each item of the questionnaire was scored by using the Likert scale (Nearly none: 1, rarely: 2, occasionally: 3, quite frequently: 4). The range of total stress scores is from 0 to 54 points. When total stress scores are broken into categorization,

the score $\leq$ 14 points is low level of stress, the score ranged 15-23 points is moderate level of stress, the score ranged 24-32 points is high level of stress, and the score $\geq$ 33 is very high level of stress.

Statistical analyses

All descriptive analyses were calculated for continuous variables using SPSS statistical software (Version 21, SPSS Inc., Chicago, IL, USA). The comparison between before and after the experiments in both adolescents and adults were performed via paired t-test analysis. Dietary habits were compared using chi-square test. All statistical significance was attained when a p-value is less than 0.05.

Results

General characteristics and physical measurements

The results of physical measurements of the subjects participated in this study are shown in Table 2.

For the students the mean weight increased by 0.08 kg, the mean height increased by 1.44 cm in proportion to the weight (p < 0.001), so as BMI was reduced by 0.38 (p < 0.01) after 12 weeks of intervention with vegetable meals. On the contrary, for the teachers, the mean weight decreased by 0.43 kg resulted in reduction of BMI by 0.21, however, statistical significance was not achieved.

When analyzed the dietary behaviors, the percentage of students who have regular three times of meals per day was increased by 15.3% from 46.2% at pre-intervention to 61.5% at post-intervention (Table 3).

Results of biochemical analysis

The analyses of complete blood cell count (CBC) conducted in both students and adults showed that Hb (g/dL), Hct (%), MCV (fl), MCH (pg), MCHC (%), and RBC (10^6/μL) were significantly reduced but still remained within the normal level in

Table 2. Comparison of anthropometric measurement between 0 week and 12 week of vegetarian diet in students and teachers

	Students (n = 26)[*]		p-value[+]	Teachers (n = 14)[*]		p-value[+]
	0wk	12wk		0wk	12wk	
Height, cm	160.30 ± 8.67[+]	161.74 ± 8.56	0.000[§]	161.15 ± 7.08	161.15 ± 7.08	–
Weight, kg	56.09 ± 12.41	56.17 ± 12.49	0.816	57.51 ± 9.00	57.08 ± 9.25	0.164
BMI[‖], kg/m²	21.69 ± 3.63	21.31 ± 3.36	0.007[¶]	22.07 ± 2.57	21.86 ± 2.67	0.074

[*]n: Students (12 males, 14 females), Teachers (3 males, 11 females); [+]Significance as determined by paired t-test; [+]Mean ± S.D.; [§]p < 0.001; [‖]Body mass index = Body weight (kg)/Height (m²); [¶]p < 0.01.

Table 3. Dietary habits of the participants

	Students (n = 26)				χ²-value	Teachers (n = 14)				value*
	0 wk		12 wk			0 wk		12 wk		
	n	%	n	%		n	%	n	%	
Number of meal					0.241					0.125
3 times/d	12	46.2	16	61.5		10	71.4	8	57.1	
2 times/d	9	34.6	8	30.8		4	28.6	5	35.7	
1 time/d	0	0.0	1	3.8		0	0.0	0	0.0	
More than 3 times	2	7.7	0	0.0		0	0.0	1	7.1	
Irregular	3	11.5	1	3.8		0	0.0	0	0.0	
Number of skipped breakfast per week					0.199					0.083
Always	13	50.0	13	50.0		8	57.1	8	57.1	
Frequently	6	23.1	9	34.6		3	21.4	3	21.4	
None	7	26.9	4	15.4		3	21.4	3	21.4	
Types of food at breakfast					0.285					0.090
Rice and side dishes	24	92.3	22	84.6		10	71.4	9	64.3	
Bread	2	7.7	6	23.1		2	14.3	1	7.1	
Milk	2	7.7	4	15.4		2	14.3	1	7.1	
Fruits	1	3.8	2	7.7		5	35.7	4	28.6	
Cereal	1	3.8	3	11.5		1	7.1	2	14.3	
Others	1	3.8	-	-		-	-	-	-	
Reason for skipping a meal					0.301					0.050
No appetite	11	42.3	14	53.8		3	21.4	5	35.7	
No time	12	46.2	6	23.1		2	21.4	5	35.7	
Difficult to digest	0	0.0	4	15.4		1	7.1	1	7.1	
Habit	4	15.4	2	7.7		2	14.3	2	14.3	
Not tasty	3	11.5	2	7.7		1	7.1	0	0.0	
The meal not ready	2	7.7	4	15.4		2	14.3	2	14.3	
Frequency of overeating					0.199					0.199
0–1 time/wk	13	50.0	13	50.0		6	42.9	4	28.6	
2–3 times/wk	9	34.6	11	42.3		7	50.0	9	64.3	
4 times and above/wk	4	15.4	2	7.7		1	7.1	1	7.1	
Types of snack					0.220					0.396
Bread	4	15.4	10	38.5		5	35.7	4	28.6	
Biscuit	9	34.6	7	26.9		5	35.7	3	21.4	
Street food	1	3.8	0	0.0		0	0.0	2	14.3	
Fast food	5	19.2	3	11.5		1	7.1	2	14.3	
Others	7	26.9	6	23.1		3	21.4	3	21.4	
Selective eating					0.157					0.157
Yes	18	69.2	17	65.4		11	78.6	12	85.7	
No	8	30.8	9	34.6		3	21.4	2	14.3	

Table 3. Continued

	Students (n = 26)				χ^2-value	Teachers (n = 14)				value[*]
	0 wk		12 wk			0 wk		12 wk		
	n	%	n	%		n	%	n	%	
Foods of dislikes					0.265					0.396
Seaweeds	3	11.5	1	3.8		–	–	–	–	
Legumes	3	11.5	3	11.5		2	14.3	1	7.1	
Fishes, shellfish	3	11.5	5	19.2				1	7.1	
Vegetables	12	46.2	11	42.3		2	14.3	2	14.3	
Others	–	–	–	–		1	7.1	–	–	
Night eating					0.157					–
Yes	10	38.5	8	30.8		7	50.0	4	28.6	
No	16	61.5	18	69.2		7	50.0	10	71.4	

[*]Significance as determined by χ^2-value with p-value, p-value less than 0.05.

Table 4. Comparison of blood profiles between 0 week and 12 week of vegetarian diet in students and teachers (lipid, complete blood cell count)

	Students (n = 26)		p-value	Teachers (n = 14)		p-value[*]
	0 wk	12 wk		0 wk	12 wk	
Blood Lipid, mg/dL						
Total cholesterol	165.9 ± 20.2[†]	154.3 ± 20.4	0.007[§]	196.5 ± 34.8	180.3 ± 28.8	0.008[§]
LDL-cholesterol	101.8 ± 15.6	94.2 ± 20.9	0.065	123.6 ± 28.1	113.2 ± 27.6	0.039[‡]
HDL-cholesterol	52.23 ± 11.3	48.3 ± 10.2	0.000[‖]	56.0 ± 9.6	52.5 ± 8.6	0.003[§]
Non HDL-cholesterol	113.7 ± 17.4	106.0 ± 22.1	0.056	140.5 ± 36.7	127.8 ± 32.5	0.029[‡]
Triglyceride	59.2 ± 24.8	59.4 ± 24.8	0.965	84.7 ± 69.8	73.4 ± 44.3	0.303
Complete blood cell count						
Hemoglobin, mg/dL	13.3 ± 1.3	12.4 ± 1.1	0.000[‖]	13.7 ± 1.8	12.7 ± 2.0	0.000[‖]
Hematocrit, %	39.1 ± 3.1	38.0 ± 2.9	0.001[‖]	40.2 ± 5.2	38.5 ± 5.6	0.004[§]
MCV, fl	85.5 ± 5.3	84.6 ± 4.7	0.002[§]	90.7 ± 5.4	89.7 ± 5.7	0.004[§]
MCH, pg	29.4 ± 2.3	27.7 ± 1.8	0.000[‖]	30.7 ± 2.0	29.4 ± 1.8	0.000[‖]
MCHC, %	33.9 ± 1.0	32.7 ± 0.6	0.000[‖]	33.9 ± 0.4	32.8 ± 0.5	0.000[‖]
RBC Count, 10^6/μL	4.6 ± 0.4	4.5 ± 0.4	0.004[§]	4.5 ± 0.7	4.3 ± 0.7	0.019[‡]
WBC Count, 10^6/μL	5.6 ± 1.2	5.5 ± 1.4	0.874	5.1 ± 1.4	5.1 ± 1.1	0.945
Platelet Count, 10^6/μL	286.4 ± 47.0	288.8 ± 51.8	0.803	258.2 ± 62.5	264.6 ± 82.4	0.534
Segment, %	54.0 ± 7.9	53.0 ± 10.8	0.658	56.9 ± 6.4	56.9 ± 7.3	0.992
Lymphocyte, %	35.1 ± 7.5	36.0 ± 10.3	0.640	33.3 ± 7.0	34.0 ± 7.6	0.596
Monocyte, %	7.6 ± 1.6	7.2 ± 1.4	0.197	6.6 ± 1.2	6.1 ± 1.2	0.395
Eosinophil, %	2.6 ± 1.7	3.1 ± 1.4	0.235	2.5 ± 1.0	2.3 ± 1.2	0.254
Baso, %	0.66 ± 0.15	0.67 ± 0.26	0.940	0.70 ± 0.2	0.56 ± 0.19	0.076

[*]Significantly different between 0wk and 12wk in Student and Teacher by paired t-test; [†]Mean ± S.D.; [‡]p < 0.05; [§]p<0.01; [‖]p < 0.001.

Table 5. Comparison of blood profiles in the subjects between 0 week and 12 week in student and teachers (Minerals)

	Reference value	Students (n = 26)		p-value	Teachers (n = 14)		p-value*
		0 wk	12 wk		0 wk	12 wk	
Ca, mg/dL	[8.6–10.2]	9.6 ± 0.3	9.9 ± 0.3	0.000[†]	9.4 ± 0.4	9.51 ± 0.26	0.142
Mg, mg/dL	[1.6–2.6]	2.21 ± 0.2	2.1 ± 0.1	0.001[†]	2.2 ± 0.2	2.13 ± 0.13	0.083
Zn, µg/dL	[81–121]	97.8 ± 13.8	92.8 ± 10.8	0.082	133.9 ± 43.9	83.9 ± 12.13	0.000[†]
Fe, µg/dL	[F:37-145 M:59-158]	106.5 ± 40.0	106.8 ± 33.8	0.096	124.1 ± 42.0	107.83 ± 29.26	0.110
B12, pg/mL	[160–970]	598.8 ± 197.0	729.0 ± 307.5	0.000[†]	654.5 ± 210.0	744.26 ± 253.02	0.019[‡]
HS-CRP[§], mg/dL	Low risk < 1.0 Intermediate risk 1.0–3.0 High risk > 3.0	0.47 ± 0.33	0.78 ± 1.60	0.343	0.6 ± 0.45	0.94 ± 1.102	0.251

hs-CRP: high sensitive c-reactive protein.
*Significance as determined by paired t-test; [†]p < 0.001; [‡]p < 0.05.

both groups. Regarding the lipid indices, TC (mg/dL) and HDL-C (mg/dL) were decreased in the students while in the adults, TC (mg/dL), HDL-C (mg/dL), LDL-C (mg/dL) and Non HDL-C (mg/dL) were significantly decreased.

On the other hand, in the teachers group, LDL-C and non-HDL-C were reduced by 10.4 mg/dL and 12.7 mg/dL, respectively (p < 0.01). Non-HDL-C is the amount obtained by deducting HDL-C from total cholesterol (Table 4).

In case of serum mineral contents, at 0 wk, there were no significant differences of Mg, Zn and Fe between the levels of students and teachers and were all within normal range. Yet, significant increase of serum Ca (p < 0.001) were observed in the students group.

Serum vitamin B_{12} was also increased from 598.81 mg/dL to 728.98 mg/dL in students (p < 0.001) and it also increased from 654.51 mg/dL) to 744.26 mg/dL (p < 0.01) in teachers (Table 5).

Bowel health and stress

In this study, although we were not able to analyze the amount of dietary fiber intake, symptomatic improvement of functional constipation and irritable bowel syndrome was confirmed based on the Rome III criteria questionnaires

12-week vegetable diet program brought the results that the number of students with tendency to functional constipation was reduced from 10 before intervention down to 7 after intervention. The number of adults were reduced from 7 to 5. The number of students with tendency to irritable bowel syndrome was 1 but the student did not show any tendency of irritable bowel syndrome after nutritional intervention (Figure 1,2).

The stress level of students was not significantly different

before and after the study. On the other hand, stress level of teachers was substantially reduced to 19.57 ± 9.68 points from 22.64 ± 10.73 points (Figure 3,4).

Discussion

This study was conducted by voluntary participation of the students and the teachers of Buksung Junior High School in Gwangju. The objective was to identify the positive effects of vegetarian diet on nutrition status, bowel conditions and improvement of stress level. Students' BMIs but not adult's were significantly reduced after the dietary interventions. It is suspected that the students had higher intake of vegetables and
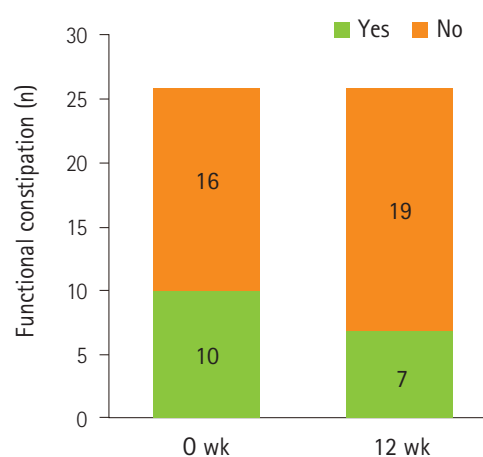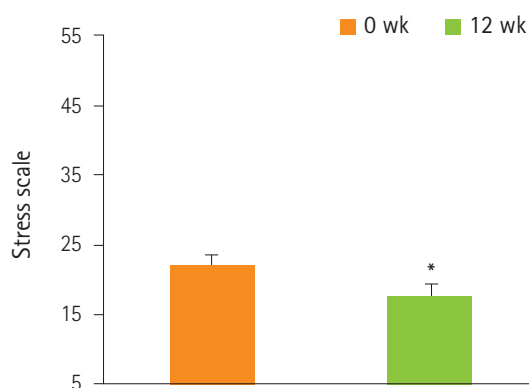

Figure 1. Changes in the number of participants with functional constipation in students.
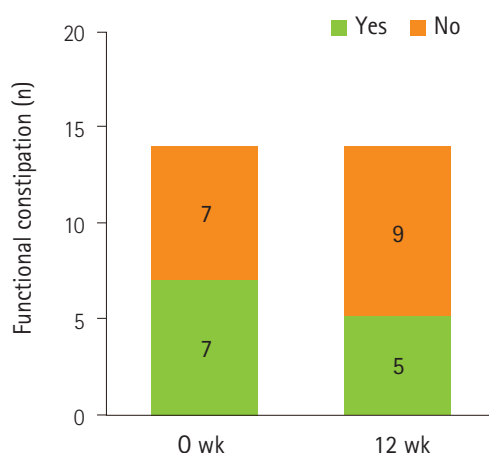
Figure 2. Changes in the number of participants with functional constipation in teachers.
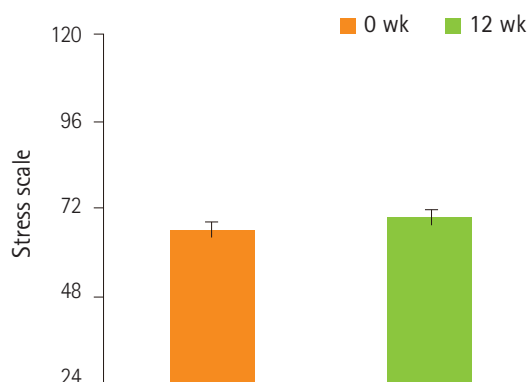
Figure 3. Changes of stress scale at 0 wk and 12 wk in students. Significance as determined by paired t-test. There is no significant differences in stress scales.

Figure 4. Changes of stress scale at 0 wk and 12 wk in teachers. Significance as determined by paired t-test. *p < 0.05.

lesser intake of fat in vegetarian diet compared to those in the ordinary meals. They also felt satiety from large amounts of fibers and water intakes, which could have effects on the decrease of snack intake and BMI reduction.

Rich intake of fibers leads to the reductions of weight and BMI, which can be considered as health benefits to maintain the normal weight while avoiding overweight and obesity. Dietary changes to incorporate large amount of vegetables, fruits and bean products had shown to be associated with high score of healthy dietary behaviour, which is higly correlated with lowering CVD related risk factors [5,15].

Reduction of TC can be seen as a positive outcome of vegetable intake for a certain period which reduced the intake of cholesterol and saturated fatty acids. In this study, TC was significantly decreased in both students and the teachers although the values remained within the reference level (p < 0.001). In case of the students, all of indices was within the normal range at pre and post intervention, but in the teachers the level lied on the marginal level of 196.6 mg/dL before vegetable meal intervention and total cholesterol was significantly lowered by 16.17 mg/dL after such intervention which suggest reduced risk of cardiovascular diseases. Since LDL-C is classified as the cardiovascular risk factor, the decreased values of LDL-C and Non-HDL-C after intervention can be seen as a very positive change as they further reduce the risks of cardiovascular events [16].

According to a previous study on Ca and Fe nutritional status of vegetarians, it was reported that the blood Ca concentration and the urine Ca concentration of vegetarians who have high level of dietary fiber intake were lower than non-vegetarians [17], but in this study, the blood Ca concentration increased significantly during the study period (p < 0.001). This is considered as the mixed grains, seaweeds, beans and nuts included in the diet menu had raised the blood Ca concentration and Ca left over from excessive intake have been likely excreted in the urine.

Vitamin B_{12} is a nutrient being supplemented by animal food mainly seen as the most serious issue of vegetarian diet for long-term vegetarians [18]. In this study, however, blood concentratin of vitamin B_{12} was rather increased and did not seem to have vitamin B_{12} deficiency. Such an increase in vitamin B_{12} level can be explained by the fact that it is contained for large quantity in brown rice, bean sprouts, broccoli, asparagus and mushrooms in addition to the study results that vitamin B_{12} is generated by specific lactic acid bacteria in kimchi. When the vegetable diet menu was examined in this study, supply

frequency of grains and mushrooms in addition to fruits and vegetables was high, indicating an increased intake of vitamin B_{12} in the subjects. Especially, it is known that vitamin B_{12} is abundant in laver sheet which is a frequently consumed food by vegetarians. By providing the vegeterian diet in this study we successfully showed that carefully planned vegeterian diet can complement the potential vitamin deficiency stated by Watanabe et al. [19].

Constipation, one of the major health complaints in students, was used as one health variable for this study. During the study period, restraining the intake of food containing simple sugar and a large amount of fat and fast food, and encouraging the intake of fresh vegetables and fruits that contained a large amount of cellulose seemed to have a positive impact to the internal environment of intestines, so it is considered that such diet had induced symptomatic improvement of constipation

According to a previous study on 8-week brown rice and vegetable-focused school meal program conducted in the high school students, the vegetable-focused school meal relieved the stress and had a positive effect inside the body [2] However, in the results of this study, the stress of the students was not significantly improved. Such result can be seen as the outcome from the fact that the students in the middle school were starting to prepare for the final exam. Also, they are in the developmental period likely to have more radical changes in physical, psychological, and social aspects but as they were relatively lacking the stress-coping skills [20]. On the other hand, stress level of the teachers was substantially reduced to 19.57 $\pm$ 9.68 points from 22.64 $\pm$ 10.73. These results are in accordance with a previous report which has shown that stress index has been improved approximately 44.6% in a subject who ate vegetables and fruits-focused meals in a weight loss diet program for adult women, indicating a positive impact of improved dietary habits on stress [21]. Therefore, the decrease of stress index in the teachers as shown in this study is seen as a positive change in physical and mental health by vegetarian diet.

The results of this study confirmed that providing vegetables-focused meal in school improved nutrition status, bowel conditions in students and teachers and reduced the stress levels in teachers. In addition, the study has shown that vegetable meal can be an effective method, if possibly being incorporated into the school system, to form desirable dietary habits of young people who need a balanced supply of nutrition and to improve dietary habits of the adults who need

preventive methods against chronic diseases and health care.

Conclusion

This study was designed in order to identify the transient effects of vegetarian diet provided at school foodservice followed by intake of vegetables and fruits-focused meal at home on dietary habits, anthropometrics, bowel conditions, stress and nutritional status in adolescents and adults. Students have shown significant reduction of BMI with improvement of bowel movement. Blood lipid profile was also improved significantly in both students and teachers. The level of vitamin B_{12} in the body was increased significantly in both students and teachers. Altogether, the vegetable diet program implemented over 12 weeks has reduced unnecessary intake of fat, which led to the increase of vegetables and fruits intake, resulting in positive outcomes for the nutrition status of the body. In addition, it is considered that the vegetable meals not only induced changes through meal provision but also had effects on formation of correct dietary habits. Given these findings, the authors suggest that vegetarian menu could be one of the alternative in school foodservice without posing any harm, but rather providing health benefit in both students and teachers.

Conflict of interest

All authors declare no conflict of interest.

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