

Transitional Changes in Energy Intake, Skeletal Muscle Content and Nutritional Behavior in College Students During Course-Work Based Nutrition Education

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The purpose of this study was to investigate whether elective course work based nutrition education in university can change students' body composition and eating habits associated with obesity and its related health risk in first-year college students. A total of 38 students agreed and participated in the study. Participants received a series of lecture about obesity, weight management, and concepts of nutrition and food choices for 13 weeks. The students' BMI and body composition, including body fat and muscle contents, were measured. A 24-hour diet recall for two days was performed for food intake analysis, and the questionnaires for dietary behaviors were collected at the beginning and the end of the study. Paired t-test and χ^2 -test were used for statistical analysis. Data showed that most of the anthropometric parameters including body weight were not significantly changed at the end of the coursework. Interestingly, skeletal muscle contents in both obese (BMI \geq 23) and lean ($18.5 \leq$ BMI \leq 22.9) subjects were significantly increased. Total energy intake was decreased in total subjects after the study. Also, general nutrition behavior of the subjects including enough hydration and utilization of nutrition knowledge were significantly improved during the study period. The total number of responses to doing aerobic exercise was slightly increased after the study, but the average frequency of exercise in each individual was not changed. These results suggest that class-work based nutrition education on a regular basis could be a time and cost effective method for improving body composition and nutritional behavior in general college students.

Key Words: Skeletal muscle, Energy intake, Nutrition education

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Received Feb 27, 2013

Revised Mar 29, 2013

Accepted Mar 30, 2013

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Introduction

Obesity is defined as an over-accumulation of body fat and a risk factor for several metabolic diseases such as diabetes, hyperlipidemia and cancer [1]. Obesity also contains a psychological element as it can discourage an individual from engaging in many parts of social activities [2-4]. The World Health Organization (WHO), defines, obesity as a disease and classifies obesity as a more severe disorders than any other threats to the public health, including malnutrition or inflammatory diseases [1]. Various factors or combination of these have been proposed as a cause of obesity and these include: dysregulation of energy consumption and expenditure, inappropriate dietary habits, lack of exercise, psychological problems, genetic and dysregulation of the endocrine system [1,2,4,5].

Hence, many kinds of weight-management program such as exercise treatment, psychological therapy, medication and diet therapy have been developed to help obese individual to lose their weight and enhance their overall health conditions [6-10]. Although many kinds of weight-management programs including diet therapy were proved to be effective in reducing body weight of study subjects, these interventions mostly focused on actual weight loss but the importance of food conception or nutritional behavior for maintaining reduced body weight were largely ignored. Especially for short-term weight management program, a caution is always necessary to avoid side effects of weight loss like yo-yo effect or developing an eating disorder (e.g. anorexia nervosa, bulimia) [11] so establishing good nutrition habits which have long term effects on maintaining good overall health as well as appropriate body weight should be a primary focus in validating an efficacy of those weight-management programs.

Many college students experience changes in their life patterns and a weakening of dietary habits during their college years [12]. Numerous literatures reported that college students have inappropriate eating habits such as: skipping meals, choosing unhealthy food and high-energy intake with high fat and sodium but with low calcium and iron consumption [12]. The lifestyles of young adults including their dietary patterns established during college years, have significant influences on the health of their prospective family, and even themselves [13]. Additionally, an unhealthy diet and the body composition of college students may lead to unfavorable physiological consequences in their future [14,15]. Although some health promoting studies recruited college students as a program participants or provided an intervention to a specific group of students for weight management [2,7,9], only a limited number of studies exist in health promoting programs targeted for college students who have a broad range of social and family background. Therefore, class settings in college may serve as an appealing option to provide a channel to efficiently deliver health information in which to address nutritional and physical activity behaviors associated with obesity for college students. The purpose of this study was to investigate if nutrition education on a regular basis during elective course work in college setting can change obesity related nutritional behavior and body composition in general college students and also compare the response to 13 weeks of nutrition education between obese/overweight and normal weight college students.

Materials and Methods

Subjects

During the fall of 2011, a total of 54 healthy college students between the ages of 19 and 22 years who enrolled in a basic freshmen-level nutrition and weight management class at a university in the Gyeongbuk area participated in the study. Among them, 10 participants were excluded from the final analysis. Reasons of exclusions were illnesses affecting food intake during the data collection period, or incomplete or unreliable data. The study population consisted of undergraduate students from various majors. Participants were informed that the purpose of the study was to obtain data to develop a nutrition education intervention program for college students. Of those who participated in the study, only the results of the subjects who agreed to the purpose of the study and followed each step had their data collected. The initial measurements, including a dietary survey, were done at the beginning of the study (the first week of the class) and referred to as "pre" and "post" anthropometric measurement. Dietary assessments were done at 13 week after the initial measurements (fourteenth week of the class) and, as a result, a total of 38 subjects (21 males and 17 females) completed all procedures of this study and were subjected to statistical analysis.

Anthropometric measurement

The height and weight of the subjects, wearing light underclothes and no shoes, were measured in kilograms to the nearest ± 0.1 kg using an automatic scale (JENIX, Seoul, Korea) and the mean values of the measurements were calculated. For classification of the degree of obesity in study subjects body mass index (BMI) was calculated as body weight (kg) / [height (m)]². The percentage of body fat and the waist circumference were computed by bioelectric impedance analysis using the InBody 3.0 (Biospace, Seoul, Korea) as previously described [16]. The mean value was calculated after carrying out all measurements 2 times. After obtaining the BMI values, subjects were classified into two groups: lean group - $18.5 \leq \text{BMI} \leq 22.9$ (17 subjects) and obese group - at $23 \leq \text{BMI}$ (21 subjects). The gender distribution was not significantly different between each BMI group.

Dietary intake survey and dietary assessment

A dietary intake survey was carried out through the 24-hour recall method and the dietary intake records for two consecutive days were collected. They were told to avoid days

with special events or exam days for reporting dietary intake. Pictures or photos for food, measuring cups and tableware were used to illustrate proper portion sizes and to help experimental participants accurately recall the food they had eaten. The type of food, food ingredients and portion size during a regular day were analyzed for each meal: breakfast, lunch, dinner, and snacks. Dietary analyses including calculation of the intake of calcium, sodium, and iron were performed by using the CAN-Pro 3.0 program, developed by the Korean Nutrition Society.

Nutrition education and questionnaire

The class met once a week for 100 minutes per session over a 13-week period. Class lectures covered topics that addressed overall dietary quality, including: the importance of nutrition in maintaining normal body functions, the concept and assessment of obesity, diet strategies for reducing body weight, desirable nutritional behaviors for maintaining normal body weight, encouraging physical activity to gain muscle and improve energy metabolism; discouraging over-reliance on dietary supplements and the side effects of substantial weight loss. For the analysis of their nutrition behavior, a self-administered questionnaire was distributed to each participant. The questionnaire was composed of 20 items including 1. Skipping meals, 2. Skipping breakfast, 3. Having meals on time, 4. Not being picky about food during meal time 5. No binge eating, 6. Not hurrying in having a meal, 7. Chewing a food well before swallowing, 8. Focusing on eating during meals, 9. Being patient with your appetite, 10. Not eating late at night, 11. Drinking enough water every day, 12. The frequency of drinking alcoholic beverage, 13. Making a list before going to the grocery store, 14. Frequency of eating-out, 15. Not eating

salty foods, 16. Not eating instant food, 17. Having food with protein at least two meals every day, 18. Having fruits or vegetable at every meal, 19. Having dairy products at every meal, 20. Utilizing of nutrition knowledge in daily life. The responses of questionnaires were evaluated using a five point scale (1. Never performed: strongly disagree – 5. Performed nearly every day: strongly agree) and calculated the average score of responses in each item.

Statistical analysis

SAS program (version 9.2, SAS Institute, Cary, NC, USA) was used to calculate the average and standard deviation from all study results. A paired t-test was employed to determine the difference between pre- and post study and χ^2 -test was used to determine the difference of distribution between variables. All statistical significance was verified at the level of $p < 0.05$.

Results

General characteristics

The average height, weight, and BMI and skeletal muscle contents were 174.1 ± 1.4 cm, 73.1 ± 2.6 kg, 24.0 ± 0.7 kg/m², 31.7 ± 1.1 for male students and 162.2 ± 1.3 cm, 61.4 ± 2.7 kg, 23.2 ± 0.8 kg/m², 21.8 ± 0.8 for female students, 168.8 ± 2.6 cm, 67.9 ± 2.6 kg, 23.7 ± 0.8 kg/m², 27.2 ± 1.0 for total subjects respectively. The average height, weight, BMI and skeletal muscle content of men were significantly higher than those of women (Table 1). Interestingly, the body fat percent in female students (32.6 ± 1.5 %) is significantly higher than that of male students (21.3 ± 1.5 %).

Table 1. Anthropometric characteristics of the subjects

Variable	Male	Female	Total	P value*
Height, cm	$174.1 \pm 1.4^{\dagger}$	162.2 ± 1.3	168.8 ± 2.6	< 0.001
Weight, kg	72.4 ± 2.3	60.8 ± 2.7	67.9 ± 2.6	< 0.01
Body fat, %	21.3 ± 1.5	32.6 ± 1.5	26.5 ± 1.4	< 0.001
BMI, kg/m ^{2†}	24.0 ± 0.7	23.2 ± 0.8	23.7 ± 0.8	0.3728
Skeletal muscle, kg	31.7 ± 1.1	21.8 ± 0.8	27.2 ± 1.0	< 0.001
Waist, cm	83.4 ± 2.0	81.0 ± 2.3	82.3 ± 2.1	0.3876
Distribution BMI ≥ 23	12 [§]	9	21	0.0671
18.5 < BMI < 23	9	8	17	(0.7956)

*Significance of differences between pre and post of the study as determined by paired t-test; [†]Mean \pm standard error; [‡]Body mass index; [§]N (%); ^{||}Chi-square value for BMI distribution (Significance as determined by χ^2 -test).

Table 2. Changes in anthropometric measurement of the subjects

Variable		Pre	Post	P value*
Body weight, kg	Obese [†]	74.1 ± 2.3 [§]	75.0 ± 2.6	0.134
	Lean [‡]	58.7 ± 1.8	59.1 ± 1.9	0.363
	Total	67.2 ± 2.0	67.9 ± 2.1	0.075
Skeletal muscle, kg	Obese	29.0 ± 1.5	29.7 ± 1.5	< 0.05
	Lean	25.0 ± 1.4	25.3 ± 1.3	< 0.05
	Total	27.2 ± 1.0	27.7 ± 1.1	< 0.01
Body fat, %	Obese	21.6 ± 1.4	21.9 ± 1.6	0.211
	Lean	13.1 ± 0.9	13.2 ± 1.1	0.725
	Total	17.7 ± 1.1	18.0 ± 1.2	0.197
BMI, kg/m ²	Obese	25.3 ± 0.5	25.6 ± 0.6	0.197
	Lean	21.1 ± 0.4	21.3 ± 0.4	0.304
	Total	23.5 ± 0.5	23.7 ± 0.5	0.096
Waist, cm	Obese	86.8 ± 1.4	87.1 ± 1.7	0.512
	Lean	74.0 ± 1.0	74.2 ± 1.2	0.667
	Total	80.9 ± 1.4	81.3 ± 1.5	0.424
Hip circumference, cm	Obese	99.1 ± 1.0	99.7 ± 1.2	0.106
	Lean	91.5 ± 0.6	91.5 ± 0.7	0.859
	Total	95.6 ± 0.9	96.1 ± 1.0	0.129

*Significance of differences between pre and post of the study as determined by paired t-test; [†]Obese: 23 ≤ BMI; [‡]Lean: 18.5 ≤ BMI ≤ 22.9; [§]Mean ± standard error.

Changes in anthropometric measurement after class based nutrition education

Anthropometric changes at the beginning of (pre) and after nutrition education (post) are reported in Table 2. There are no significant differences in body weight, body fat percent, BMI or hip circumferences were found between pre and post measures in lean, obese and total subjects. The paired t tests revealed an increase of skeletal muscle content from pre- to post measures regardless of the condition of obesity. The degree of increase in skeletal muscle content was subtle (1.2 - 2.4%), but statistically significant. A statistically significant increase in abdominal fat was demonstrated between pre- and post measured lean subjects (Table 2).

Energy and nutrient intakes

The daily intakes of total energy, protein and fat for obese subjects were higher than those for lean subjects (1875.7 kcal vs. 1790.8 kcal, $p < 0.01$, 72.0 g vs. 68.4 g, $p < 0.05$, 50.5 g vs. 45.6 g, $p < 0.05$). The daily intakes of total energy at the beginning of the study were significantly reduced after the study by 19.5% ($p < 0.05$), 11.9% ($p < 0.05$) and 15.8% ($p < 0.01$) in obese, lean and total subjects, respectively. However, daily in-

takes of protein were significantly decreased and daily intakes of fat were not significantly different between pre and post measurement in both obese and lean subjects (Table 3). The daily mean intakes of the subjects in the beginning of study were 398.6 mg for calcium, 3321.0 mg for sodium, and 11.9 mg for iron (Table 3). The intake ratios of protein and other major nutrition per energy consumption were not significantly different between pre and post measurement in total subjects. Normalized to total energy consumption intake of fat was increased by 18.7% after the study only in total subject ($p < 0.05$) due to the reduction of total energy intake of the subjects.

Change of food consumption

Overall, the consumption of fruit and dairy products was low at the beginning of the study. The average consumption of fruits and dairy products of study participants were 0.4 servings and 0.2-0.4 servings, respectively, only about 25% of the daily recommendation for fruit and dairy product intake (Table 4). Paired t-tests revealed no differences in food consumption from pre- to posttest regardless of an obese condition. The consumption of cereal in lean and total subjects and the consumption of vegetables in obese and total subjects were

Table 3. Changes of energy intake and food consumption of the subjects

Variable		Pre	Post	P value*
Total energy, kcal/day	Obese [†]	1875.7 ± 113.9 [§]	1578.5 ± 104.0	< 0.05
	Lean [†]	1790.8 ± 93.5	1510.3 ± 104.4	< 0.05
	Total	1837.7 ± 74.9	1548.0 ± 73.3	< 0.01
Carbohydrate, g/day	Obese	283.3 ± 20.6	225.7 ± 15.4	< 0.05
	Lean	276.6 ± 17.8	219.3 ± 17.0	< 0.01
	Total	280.3 ± 13.7	222.8 ± 11.3	< 0.001
Protein, g/day	Obese	72.0 ± 4.9	56.0 ± 3.5	< 0.01
	Lean	68.4 ± 6.7	51.7 ± 4.0	< 0.05
	Total	70.4 ± 4.0	54.1 ± 2.6	< 0.001
Fat, g/day	Obese	50.5 ± 4.2	50.2 ± 4.5	0.953
	Lean	45.6 ± 5.1	47.4 ± 3.6	0.807
	Total	48.3 ± 3.2	48.9 ± 2.9	0.889
Calcium, mg/day	Obese	443.6 ± 53.3	366.0 ± 40.7	0.159
	Lean	343.1 ± 41.3	368.1 ± 54.8	0.668
	Total	398.6 ± 35.3	367.0 ± 32.8	0.426
Sodium, mg/day	Obese	3321.3 ± 272.8	2959.1 ± 265.1	0.252
	Lean	3320.7 ± 420.0	2847.0 ± 279.2	0.276
	Total	3321.0 ± 237.4	2909.0 ± 190.2	0.107
Iron, mg/day	Obese	12.1 ± 0.7	10.5 ± 0.6	0.078
	Lean	11.7 ± 1.1	9.7 ± 1.1	0.146
	Total	11.9 ± 0.6	10.1 ± 0.6	0.020
Protein, g/kcal	Obese	0.039 ± 0.002	0.036 ± 0.001	0.211
	Lean	0.038 ± 0.002	0.035 ± 0.002	0.194
	Total	0.038 ± 0.001	0.035 ± 0.001	0.070
Fat, g/kcal	Obese	0.027 ± 0.001	0.031 ± 0.001	0.090
	Lean	0.025 ± 0.003	0.032 ± 0.002	0.060
	Total	0.026 ± 0.001	0.032 ± 0.001	< 0.05
Calcium, mg/kcal	Obese	0.241 ± 0.023	0.241 ± 0.001	0.990
	Lean	0.189 ± 0.018	0.238 ± 0.029	0.144
	Total	0.217 ± 0.015	0.240 ± 0.019	0.308
Sodium, mg/kcal	Obese	1.824 ± 0.135	1.845 ± 0.100	0.903
	Lean	1.806 ± 0.161	1.901 ± 0.134	0.583
	Total	1.816 ± 0.102	1.870 ± 0.089	0.650
Iron, µg/kcal	Obese	6.6 ± 0.4	7.1 ± 0.5	0.457
	Lean	6.4 ± 0.4	6.2 ± 0.4	0.771
	Total	6.5 ± 0.3	6.7 ± 0.3	0.659

*Significance as determined by paired *t*-test; [†]Obese: 23 ≤ BMI; [‡]Lean: 18.5 ≤ BMI ≤ 22.9; [§]Mean ± standard error, ^{||}Significantly different between pre and post of the study.

significantly decreased after the study (Table 4).

Changes in nutrition behavior

Changes in several components of nutritional behaviors during nutrition education in obese, lean and total subjects

Table 4. Changes of food consumption of the subjects

Variable		Pre	Post	P value*
Cereals	Obese [†]	3.1 ± 0.2 [§]	2.8 ± 0.2	0.297
	Lean [‡]	3.5 ± 0.4	2.6 ± 0.2	< 0.05
	Total	3.3 ± 0.2	2.7 ± 0.2	< 0.05
Vegetables	Obese	5.3 ± 0.7	3.5 ± 0.4	< 0.01
	Lean	5.3 ± 0.7	4.1 ± 0.5	0.172
	Total	5.3 ± 0.5	3.8 ± 0.3	< 0.01
Fruits	Obese	0.4 ± 0.2	0.9 ± 0.4	0.876
	Lean	0.4 ± 0.2	0.4 ± 0.2	0.071
	Total	0.4 ± 0.1	0.6 ± 0.2	0.191
Meat and Fish	Obese	4.5 ± 0.6	3.6 ± 0.4	0.288
	Lean	5.3 ± 1.2	3.8 ± 0.4	0.131
	Total	4.9 ± 0.6	3.7 ± 0.3	0.060
Dairy products	Obese	0.5 ± 0.2	0.3 ± 0.1	0.507
	Lean	0.2 ± 0.1	0.6 ± 0.2	0.169
	Total	0.4 ± 0.1	0.5 ± 0.1	0.723
Fats, oils and sweets	Obese	7.3 ± 1.1	6.4 ± 1.0	0.609
	Lean	6.6 ± 1.7	5.2 ± 0.6	0.287
	Total	7.0 ± 1.1	5.8 ± 0.6	0.324

*Significance as determined by paired t-test; [†]Obese: 23 ≤ BMI; [‡]Lean: 18.5 ≤ BMI ≤ 22.9; [§]Mean ± standard error.

are presented in Table 5. Students participating in this study demonstrated an improvement in the utilization of nutritional knowledge (Table 5). The paired t tests revealed that scores on the utilization of nutritional knowledge increased and the numbers of students who received higher scores also significantly increased. An analysis of the nutritional behaviors in obese and total subjects revealed that scores on not hurrying a meal and making a list before grocery shopping were significantly increased after the study. In lean subjects, their scores of nutritional behavior on having a meal on time increased after the study but their scores focusing on eating during a meal decreased. During the coursework period, the frequency of aerobic exercise was slightly increased but was not statistically significant (Table 6). Also, the average frequency of both aerobic and weight training exercises in each individual was not changed.

Discussion

The present study evaluated the effectiveness of a class based nutrition education in college students in their willingness to change food intake to achieve weight loss and to im-

prove general health habits and assessed differences in body composition of study subjects. This research found that exposure to a class based nutrition education for college students induced transitional changes including: decrease of calorie intake, increase of skeletal muscle content and improvement of nutritional habits to help body weight management and meet the recommendations of proper food and nutrient intake.

The most remarkable finding during the nutritional education in this study was the reduction in total energy intake of study subjects. Initially consumption of energy and nutrients of study subjects was similar to the calorie intake of college students reported in previous studies. For example the study of Hong et al. (2012) reported that the average consumption of total calorie in Korean college female students in nutrition education program was in range of 1707 ± 344 kcal [17]. Also, the average total energy intake of Korean male college students was 1695.2 ± 51.9 kcal [18]. Overall nutrients and caloric intake, and food consumption is high in obese subjects, explaining their consumption of certain nutrients and vegetables to be higher. The magnitude of reduction in energy intake after nutrition education in this study was much higher than other study [19] which explored the effect of nutrition education on

Table 5. Change of nutrition behavior of obese subjects during course work period

Variable		Pre	Post	P value*
Skipping meals	Obese	3.0 ± 0.3 [†]	3.0 ± 0.3	0.754
	Lean	3.3 ± 0.4	2.9 ± 0.4	0.210
	Total	3.1 ± 0.2	3.0 ± 0.2	0.612
Skipping breakfast	Obese	3.8 ± 0.3	3.3 ± 0.4	0.273
	Lean	3.1 ± 0.4	3.0 ± 0.4	0.819
	Total	3.5 ± 0.3	3.2 ± 0.3	0.334
Having meals on time	Obese	3.8 ± 0.3	3.8 ± 0.3	0.901
	Lean	4.4 ± 0.2	3.8 ± 0.2	< 0.01
	Total	4.1 ± 0.2	3.8 ± 0.2	0.656
Not being picky about food during meal time	Obese	3.8 ± 0.3	3.7 ± 0.3	0.396
	Lean	3.9 ± 0.3	3.6 ± 0.3	0.387
	Total	3.8 ± 0.2	3.7 ± 0.2	0.372
No binge eating	Obese	2.3 ± 0.3	2.7 ± 0.3	0.336
	Lean	3.0 ± 0.4	2.8 ± 0.4	0.547
	Total	2.6 ± 0.2	2.8 ± 0.2	0.603
Not hurrying in having a meal	Obese	3.0 ± 0.4	3.7 ± 0.4	< 0.05
	Lean	3.1 ± 0.4	3.3 ± 0.3	0.216
	Total	3.0 ± 0.3	3.5 ± 0.2	< 0.05
Chewing a food well before Swallowing	Obese	3.0 ± 0.4	3.4 ± 0.4	0.247
	Lean	2.9 ± 0.4	3.4 ± 0.4	0.070
	Total	3.0 ± 0.3	3.4 ± 0.3	< 0.05
Focusing on eating during meals	Obese	2.8 ± 0.3	2.4 ± 0.3	0.118
	Lean	3.4 ± 0.3	2.4 ± 0.3	< 0.01
	Total	3.1 ± 0.2	2.4 ± 0.2	< 0.01
Being patient with your appetite	Obese	2.0 ± 0.3	2.5 ± 0.3	0.154
	Lean	2.1 ± 0.3	2.1 ± 0.3	0.791
	Total	2.1 ± 0.2	2.3 ± 0.2	0.168
Not eating late at night	Obese	2.8 ± 0.3	3.3 ± 0.3	0.347
	Lean	2.1 ± 0.3	2.2 ± 0.2	0.805
	Total	2.5 ± 0.2	2.8 ± 0.2	0.328
Drinking enough water everyday	Obese	3.5 ± 0.3	3.9 ± 0.3	0.129
	Lean	2.9 ± 0.3	3.2 ± 0.4	0.206
	Total	3.3 ± 0.2	3.6 ± 0.2	< 0.05
The frequency of drinking alcoholic beverages [†]	Obese	1.8 ± 0.2	1.8 ± 0.1	1.000
	Lean	1.8 ± 0.2	1.6 ± 0.2	0.269
	Total	1.8 ± 0.1	1.7 ± 0.1	0.474
Making a list before going to the grocery store	Obese	2.2 ± 0.2	2.6 ± 0.3	< 0.05
	Lean	2.4 ± 0.4	2.6 ± 0.4	0.361
	Total	2.3 ± 0.2	2.6 ± 0.2	< 0.05
The frequency of eating-out	Obese	2.3 ± 0.2	2.6 ± 0.3	0.233
	Lean	2.6 ± 0.3	2.4 ± 0.3	0.260
	Total	2.4 ± 0.2	2.5 ± 0.2	0.855

Table 5. Continued

Variable		Pre	Post	P value*
Not eating salty foods	Obese	2.8 ± 0.3	3.1 ± 0.3	0.229
	Lean	2.2 ± 0.3	2.1 ± 0.3	0.163
	Total	2.5 ± 0.2	2.6 ± 0.2	0.440
Not eating instant food	Obese	2.4 ± 0.3	2.4 ± 0.3	0.874
	Lean	2.1 ± 0.3	2.1 ± 0.3	0.668
	Total	2.3 ± 0.2	2.3 ± 0.2	1.000
Having foods with protein (meat, fish, egg and soy product) at least two meals everyday	Obese	3.2 ± 0.3	3.4 ± 0.3	0.348
	Lean	2.9 ± 0.4	2.9 ± 0.3	0.805
	Total	3.1 ± 0.2	3.2 ± 0.2	0.361
Have fruits or vegetables at every meal	Obese	2.5 ± 0.3	2.5 ± 0.3	1.000
	Lean	3.0 ± 0.4	2.8 ± 0.4	0.421
	Total	2.7 ± 0.2	2.6 ± 0.2	0.667
Having dairy products at every meal	Obese	2.5 ± 0.3	2.6 ± 0.3	0.803
	Lean	2.5 ± 0.3	2.6 ± 0.4	0.875
	Total	2.5 ± 0.2	2.6 ± 0.2	0.785
Utilizing of nutrition knowledge in daily life	Obese	2.3 ± 0.3	2.9 ± 0.3	< 0.01
	Lean	2.5 ± 0.4	2.6 ± 0.4	0.579
	Total	2.4 ± 0.2	2.8 ± 0.2	< 0.01

*Significantly different between pre and post of the study at $p < 0.05$; [†]Mean ± standard error; [‡]Times of alcoholic beverage per week.

Table 6. Change of exercise habits of the subjects during the nutrition education

Variable		Pre	Post	χ^2 value	P value*
Aerobic exercise [†]	Obese [‡]	16/21 (76.2)	19/21 (90.5)	1.5429	0.2142
	Lean [§]	13/17 (76.5)	16/17 (94.1)	2.1103	0.1463
Weight training	Obese	8/21 (38.1)	8/21 (38.1)	0	1.0000
	Lean	8/17 (47.1)	7/17 (41.2)	0.1193	0.7298

*Significance as determined by χ^2 -test; [†]3 times per week and at least 30 minute at a time; [‡]Obese: $23 \leq \text{BMI}$; [§]Lean: $18.5 \leq \text{BMI} \leq 22.9$; ^{||}Numbers of subject/total subjects (%).

weight loss. On the other hand, this study did not show much improvement in food consumption while Ha et al. [20] showed that taking a general nutrition course at college enhanced students' fruit and vegetable consumption after nutrition education. Since the magnitude of calorie reduction is relatively high in this study, the overall food consumption was decreased and led to the reduction in certain types (e.g. cereal) of food which is usually a main source of energy.

The present investigation resulted in significant increases in skeletal muscle content which usually occur in conjunction with the increase of body water content as a part of transitional changes to acquire desirable body composition during

weight management activities [10,21,22]. Those changes, however, are usually accompanied with the increases of energy intake in study participants [21,22]. Since the energy intake is much reduced in this study, the subtle changes in muscle contents of the subjects may not be due to nutritional education but may be due to a change of other behavior such as an increase of physical activity or an increase of hydration rate which has been known to increase of skeletal muscle mass [19,23,24-26]. Though this 13 weeks intervention of nutrition education did not reduce body weight, the increase of muscle content and improvement in nutritional behavior of the subjects in this study still suggest that this class based nutrition

education at least induced promising changes in weight and general health management.

This finding is consistent with previous studies that showed positive changes in dietary behavior such as an improvement in regular meal time and the utilization of nutritional knowledge after nutrition education interventions with college students [6,7,9,19]. At the beginning of the study, only 13% of total study participants ate more than one serving of fruit per day, though the average consumption of fruit (0.4) was similar or less than previous studies [20,27]. After the coursework this number increased up to 26%. However, overall, study participants did not meet the recommended intake of most type of food in this study. The effectiveness of nutrition education in weight management, food choice and nutritional behavior was well addressed in a wide range of literature [27-29]. For example, school based nutrition education decreased soft drink consumption but increased milk and dairy products in female and male college students [27]. Nutrition education via e-mail supply improved the intake of dairy products and self regulation strategies to increase low fat dairy products [28]. Also, improved nutritional knowledge and confidence in the adequacy of their diet after completing a basic college nutrition course was reported [29]. The elective course work regarding diet and weight management in this study was composed of discussing strategies how to prevent weight gain, fat accumulation and how to improve body weight in the context of food and nutrition intake. In addition, class lectures not only encouraged students to try to reduce body weight and calorie intake, but also motivated them to change overall eating behaviors and their lifestyle by using a variety of class activities and contents (self diagnosis of their stress levels, calculate proper energy need based on their physical activity etc.). This approach may have helped students relate the class material more directly to their own dietary habits, thereby giving them more awareness and motivation to change their own dietary behaviors. However, the changes scored in nutrition behaviors are subtle in this study compared to previous studies which assessed the effect of nutrition education on nutrition or health behaviors [6,7,9,19] indicating efficacy of the course work in this study was weaker than that of previous studies.

This study also revealed a few limitations. Male and female students are obviously different in nature in anthropometric conditions and nutritional requirement. Also, several researchers have demonstrated that males tend to resist changing their habit and social pressure for health conscious but fe-

males have a relatively positive attitude toward healthy eating and behaviors than male students [20,30,31]. Though a paired comparison was applied to assess the effectiveness of nutrition education on weight management and behavior in each participant, the result of this study could not differentiate gender differences due to the small number of study subjects. Also students enrolled in the elective course work may already be more conscious about a healthy diet and weight management compared to typical college students. This may lead the result that students were more amenable to respond to course work. In addition, this study could not adjust housing, economic status and social environment of each subject which could be a confounding factor in assessing the effectiveness of this coursework based nutrition education on body composition and nutrition intake [32]. Importantly, results of this study could be biased due to the lack of a "control" group who was subjected to the same anthropometric and dietary assessments without receiving a nutrition education through participating elective course work. These caveats should be considered in future nutrition education intervention by incorporating effective and specific tools reflecting gender differences or each different social status for motivating nutrition behavior.

In conclusion, this research suggested a possibility that class-based nutrition education intervention could lead to an improvement of weight management, body composition, nutrition intake and behavior. Particularly for college students, this result is important since their health habits in this life cycle may extend to their whole life, could affect health of our society in the context of their influence of dietary habits to their household. Though this 13-weeks nutrition education did not reduce the body weight of the subjects in this study, students gained positive consciousness for a desirable weight management and body composition by an increase of muscle content and a decrease of energy consumption. These short-term transitional changes suggest that course work based nutrition education with academic commitment could be a time and cost effective way to improve body composition and nutritional behavior in college students regardless of their major, housing status, gender, and year in college. Future research should account for the limitations of this study in large sample size, follow-up study after nutrition education and adjusting social and family status of participants to validate the long-term effects of a course work based nutrition education on changes in dietary behavior.

Acknowledgments

This research was supported by grants from the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2012R1A1A1019253). This manuscript was also supported by a 2012 general research grant from Kyungil University.

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