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The Correlation of Anthropometric Measurements, Physical Performance and Biochemical Measurements with Nutrient Intakes in Male College Students

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Possible correlations between nutrient intake and health status-as assessed by anthropometric measurements, physical performance and biochemical measurements-were investigated, using 514 healthy young men aged 20 years old who had no apparent health problems. The intakes of nutrients were estimated using a three-day dietary recall method. Height and body weight were measured, and body mass index (BMI) was calculated. Physical performance was tested using sit-ups, push-ups, a 100m sprint and a 1,500m run. When compared with the Korean recommended dietary allowances (Korean RDA), the subjects' nutrient intakes were adequate except for calcium. The intake of calcium was 516.66±293.43mg/day, which is 73.80 % of the Korean RDA. The subjects averaged 174.51±7.07cm in height, 68.17±9.25kg in body weight and 22.23±2.16 in BMI. The associations between nutrient intakes and anthropometric measurements, and between nutrient intakes and physical performance, were weak. The intake of vegetable fat was positively correlated to body weight, whereas the intake of carbohydrate was negatively correlated to BMI. The intake of carbohydrate was positively correlated to the level of performance in the 100m sprint, and the intake of vegetable fat was positively correlated to the level of performance of sit-ups. No correlation was found between nutrient intakes and the following biochemical measurements of the blood: the levels of glucose, total protein, total cholesterol, triglyceride, hemoglobin and hematocrit. These results suggest that anthropometric measurements and level of physical performance can be associated with energy nutrient intakes, even in moderately active, well-nourished, young men. No correlation was found between nutrient intake and biochemical measurements, probably because all subjects had a reasonably well-balanced diet.

Key words : nutrient intakes, anthropometric measurements, physical performance, biochemical indices, college students

INTRODUCTION

Several epidemiological studies have demonstrated an increased mortality rate in people with abnormal nutritional status, and mounting scientific evidence indicates that changes in dietary intake by adults could produce measurable gains in the health and longevity of the population.[1-5] Anthropometry is a portable, universally applicable, inexpensive, and non-invasive method of assessing the proportions, size, and the composition of the human body.[6] Biochemical measurements and the capacity for physical performance reflect both health and nutritional status, and can predict survival. For these reasons, the physical health status of a person is determined by anthropometric measurements, biochemical measurements-especially in the blood and urine, a clinical examination, and a test of physical performance. Although the physical health status in normal healthy young men tends to be constant due to metabolic adaptation,[7-9] it is still important to know whether nutrient intake is correlated to their anthropometric parameters, biochemical status and capacity for physical performance; nutrition interventions are essential components of programs to promote nutrient and physical health status in young adults such as college students, as inadequate nutrition is implicated in the beginning of many diseases not manifested until much later in life. In recent years, the dietary practices of young adults, particularly relating to the variety of foods, dietary intake, and food patterns, have been studied[10-15]. However, the relevance of nutrient intake to anthropometric status and biochemical measurements in healthy young adults has been little studied. Moreover, there is a general lack of data on the association between nutrient intake and capacity for physical performance. Therefore, the aim of this study is to investigate possible correlations between nutrient

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intake in male college students and their anthropometric status, capacity for physical performance, and biochemical status.

SUBJECTS AND METHODS

1. Subjects and dietary intakes

Five hundred and fourteen male college students with no apparent health problems participated in this study. Subjects recorded their 3-day food intake on the same days that the physical performance tests were undertaken. Participants were given instructions on how to fill in records with the exact amounts of all foods and drinks consumed. Recorded food intakes were converted into nutrient intakes by using a computerized dietary analysis program[16].

2. Anthropometric measurements, physical performance, and biochemical analysis

Weights and heights were measured. Body mass index (BMI) and percent ideal body weight (PIBW) were calculated. The subjects' capacity for physical performance was tested using the evaluation standards of the college entrance examination, which consist of sit-ups, push-ups, a 100m sprint and a 1,500m run. The time allowed to perform sit-ups and push-ups was 2 minutes. Sit-up performance was measured on a scale from 4 to 8 according to the number of sit-ups performed. Push-up performance was measured on a scale of 3 to 6 according to the number of push-ups performed. Performance in the 100m sprint was measured on a scale from 3 to 6 according to the speed attained. Performance in the 1,500m run was measured on a scale from 5 to 10 according to the speed attained. Plasma glucose and total cholesterol levels were determined using a commercial kit based on an enzymatic method (Asan Pharmaceutical Co., Korea). Triglyceride levels were determined using a commercial kit based on the Trinder method (Asan Pharmaceutical Co., Korea). Total protein was determined using a commercial kit based on the Biuret reaction (Asan Pharmaceutical Co., Korea). Microhematocrit was determined by measuring the percent packed cells after centrifuging the whole blood. Hemoglobin concentration was determined using a commercial kit based on the cyanmethemoglobin method (Asan Pharmaceutical Co., Korea).

3. Statistical analysis

The data were analyzed for correlations between nutrient intakes and anthropometric measurements, capacity for physical performance, and biochemical indices, using Pearson's correlation coefficients.

RESULTS

In comparison with the Korean recommended dietary allowances (Korean RDA), all subjects' intakes of nutrients were adequate except for calcium. Subjects' intakes of most nutrients ranged from 96.85 to 151.83% of the Korean RDA. The intake of calcium averaged 516.66±293.43mg/day, which is 73.80 % of the Korean RDA (Table 1). The mean anthropometric values of the subjects were found to be 174.51±7.07cm in height, 68.17±9.25kg in body weight and 22.23±2.16 in BMI. As shown in Table 2, there was little correlation between nutrient intakes and anthropometric measurements. Contrary to our expectations, energy intake and protein intake were not found to be correlated with height, weight and BMI. The intake of vegetable fat was positively correlated to body weight, whereas the intake of carbohydrate was negatively correlated to BMI. No correlation was shown between intakes of non-energy nutrients and anthropometric values. As shown in Table 3, no correlation was found between nutrient intakes and biochemical measurements of the blood such as the levels of glucose, total protein, total cholesterol, triglyceride, hemoglobin and hematocrit. Table 4 shows the correlations between nutrient intakes and capacity for physical performance; the intake of carbohydrate was positively correlated to performance in the 100 m sprint and the intake of vegetable fat was positively correlated to sit-up performance.

Table 1. Daily nutrient intakes of the male college students

Category	Intakes(%)[1]
Energy(kcal)	2614.19±1042.32 (96.85)
Carbohydrate(g)	386.16±129.24
Protein(g)	104.88±108.65(139.84)
Animal protein(g)	57.29±62.68
Vegetable protein(g)	47.58±50.17
Fat(g)	82.35±116.97
Animal fat(g)	41.84±54.55
Vegetable fat(g)	41.84±54.55
Ca(mg)	516.66±293.43 (57.41)
P(mg)	1366.4±679.62 (151.83)
Fe(mg)	18.03±10.75 (112.69)
Na(mg)	5257.06±2898.69
K(mg)	2956.39±1568.57
Vitamin A(R.E)	1023.62±2221.82(146.24)
Vitamin B_1(mg)	1.79±0.90(127.86)
Vitamin B_2(mg)	1.56±0.98 (98.13)
Vitamin B_6(mg)	1.44±0.78 (96.00)
Niacin(mg)	20.97±11.47 (116.50)
Vitamin C(mg)	99.79±105.37(142.56)
Cholesterol(mg)	447.17±338.62

1) Percent of Korean RDA. 7th Revision, 2000 Values are Mean±S.D

Table 2. Correlation coefficients between nutrient intake and anthropometric values in the male college students

Category	height	weight	BMI[1)]	PIBW[1)]
Energy(kcal)	.0224	-.0183	-.0651	-.0575
Carbohydrate(g)	.0237	-.0301	-.1075*	-.0749
Protein(g)	.0055	.0139	-.0616	-.0442
Animal protein(g)	-.0191	.0437	-.0520	-.0387
Vegetable protein(g)	.0358	-.0244	-.0685	-.0475
Fat(g)	.0705	.0563	.0231	-.0049
Animal fat(g)	.0455	-.0093	-.0463	-.0413
Vegetable fat(g)	.0759	.0935*	.0690	.0222
Ca(mg)	-.0002	.0188	.0084	-0053.
P(mg)	.0084	-.0096	-.0409	.0023
Fe(mg)	.0233	.0545	-.0124	-.0468
Na(mg)	.0195	-.0153	-.0319	-.0355
K(mg)	.0086	-.0218	-.0492	-.0503
Vitamin A(R.E)	-.0059	-.0319	-.0418	-.0336
Vitamin B_1(mg)	.0253	.0005	-.0416	-.0583
Vitamin B_2(mg)	.0478	.0623	.0423	-.0045
Vitamin B_6(mg)	.0129	-.0010	-.0275	-.0390
Niacin(mg)	.0258	-.0179	-.0430	-.0537
Vitamin C(mg)	.0553	.0011	-.0385	-.0387
Cholesterol(mg)	.0313	.0124	.0247	-.0198

1) BMI: body mass index, PIBW: percent of ideal body weight
*: Significant at p 〈0.05,

Table 3. Correlation coefficients between nutrient intake and biochemical measurements in the blood of the male college students

Category	Glucose	Total Protein	Cholesterol	Tri-glyceride	Hemo-globin	Hema-tocrit
Energy(kcal)	-.0092	.0290	-.0198	.0143	-.0150	.0062
Carbohydrate(g)	-.0027	.0254	-.0131	.0565	-.0166	-.0196
Protein(g)	-.0169	.0023	.0061	.0327	-.0130	-.0332
Animal protein(g)	-.0162	.0205	.0110	.0347	-.0162	-.0344
Vegetable protein(g)	-.0163	-.0205	-.0005	.0373	-.0080	-.0289
Fat(g)	.0037	-.0086	-.0086	.0204	-.0160	-.0302
Animal fat(g)	-.0046	-.0088	-.0219	.0248	-.0113	-.0219
Vegetable fat(g)	.0090	-.0070	.0024	.0136	-.0166	-.0308
Ca(mg)	-.0249	.0537	-.0048	.0384	-.0138	.0243
P(mg)	.0269	.0633	-.0457	.0214	-.0183	-.0298
Fe(mg)	-.0243	.0103	.0118	.0432	-.0133	-.0034
Na(mg)	-.0055	.0523	-.0410	.0232	-.0131	-.0302
K(mg)	.0367	.0394	-.0101	.0211	-.0099	-.0090
Vitamin A(R.E)	-.0056	.0100	-.0633	.0036	-.0052	-.0754
Vitamin B_1(mg)	-.0138	.0280	.0151	-.0053	-.0237	-.0369
Vitamin B_2(mg)	.0086	.0422	.0030	-.0102	-.0269	-.0388
Vitamin B_6(mg)	.0198	.0363	-.0176	-.0002	-.0074	-.0243
Niacin(mg)	.0040	.639	-.0099	.0200	-.0200	-.0307
Vitamin C(mg)	.000	-.0075	-.0225	.0239	-.0070	-.0322
Cholesterol(mg)	.0327	-.0184	-.0190	-.0205	-.0131	-.0212

Table 4. Correlation coefficients between nutrient intake and physical performance in the male college students

Category	100M-splint	Sit-up	Push-up	1500M	Total
Energy(kcal)	.0962	.0097	-.0032	.0475	.0579
Carbohydrate(g)	.0957*	.0428	.0440	.0721	.0860
Protein(g)	.0136	.0621	-.0087	.0241	.0267
Animal protein(g)	.0137	.0586	-.0045	.0300	.0309
Vegetable protein(g)	.0122	.0613	-.0134	.0148	.0192
Fat(g)	-.0221	.0367	-.0530	.0405	.0035
Animal fat(g)	.0135	.0625	.0069	.0091	.0258
Vegetable fat(g)	-.0438	.0117*	-.0867	.0559	-.0132
Ca(mg)	.0329	.0740	.0387	.0427	.0619
P(mg)	.0768	.0573	.0625	.0451	.0787
Fe(mg)	.0245	-.0140	-.0032	.0367	.0191
Na(mg)	.0617	.0432	.0455	.0376	.0609
K(mg)	.0388	.0274	.0519	.0215	.0465
Vitamin A(R.E)	.0290	.0699	.0529	.0406	.0672
Vitamin B_1(mg)	.0546	.0251	.0564	.0372	.0609
Vitamin B_2(mg)	.0028	.0360	.0002	.0659	.0431
Vitamin B_6(mg)	.0667	.0351	.0435	.0384	.0615
Niacin(mg)	.0702	.0439	.0292	.0498	.0637
Vitamin C(mg)	.0312	.0550	.0009	.0153	.0287
Cholesterol(mg)	.0072	-.0088	.0156	.0006	.0043

*: Significant at p 〈0.05

DISCUSSION

The subjects' intakes of most nutrients were at levels close to or above Korean RDA levels,[17)], except for calcium. Even the subjects' calcium intake was similar to the average intake of Koreans[18)], and was above the subclinical deficiency. Moreover, a high percentage of Korean teenagers take vitamin/mineral supplements[19)], if the intakes of calcium from the dietary recall were combined with those potentially gained from the supplements, the actual average intake of calcium would be higher. Thus, the overall nutrient intake of subjects was good.

Contrary to our expectations, energy intake and protein intake were not correlated with the heights, weights and BMIs of the subjects. The intake of vegetable fat was positively correlated to body weight whereas the intake of carbohydrate was negatively correlated to BMI. These are the nutrients generally known as anabolic nutrients; energy and protein intake are known to have a strong positive correlation with the heights and weights of highly active persons.[20)] Thus, in moderately active young men whose overall nutrient intake was good, the level of intake of anabolic nutrients may not be associated with weight and height. Although the intake of vegetable fat was positively correlated to body weight, and the intake of carbohydrate was negatively correlated to BMI, the associations between nutrient intakes and anthropometric values were weak and had little clinical meaning.

Further support for possible associations between energy nutrients and anthropometric values in young men is provided by the correlations in this study between energy nutrient intakes and some physical performance measurements. Physical activity is associated with an increased energy requirement and the energy used for exercise in humans is derived predominantly from carbohydrate and fat; the metabolism of energy nutrients involve coenzyme reactions, which frequently need vitamins as essential components. The intake of carbohydrate was positively correlated to performance in the 100m sprint and the intake of vegetable fat was positively correlated to sit-up performance. The active muscles rely almost completely on blood glucose and their own store of glycogen to fuel bursts of intense activity. In order to increase the availability of carbohydrate to working muscles, endurance athletes are usually advised to consume high carbohydrate diets[21]. Thus, the intake of carbohydrate would help to supply more available energy for exercise and would lead to a lower BMI. Also, the increased intake of carbohydrate would help to store sufficient glycogen to be delivered as an energy substrate to the exercising muscles in untrained persons, for performing exercises such as the 100m sprint. Because fat is generally accepted as a concentrated energy source and fat could be an alternative energy source for the exercising muscle[22], the intake of vegetable fat might be positively correlated to body weight even in young men although animal fat had no correlations on body weight.

The lack of any correlation between nutrient intake and the levels of glucose, total protein, total cholesterol, triglyceride, hemoglobin and hematocrit in the blood, could be due to the influence of the homeostatic system; it is well known that biochemical measurements of the blood of healthy young adults are fairly consistent and well controlled.[7,9,23] Although it is reported that intakes of vitamin C, protein, haem and non-haem iron, and antioxidants, are positively associated with hematologic status and nutritional status[24,25], no correlation was found between erythropoietic nutrients and hematologic status in this study. This result is consistent with a previous study[20] involving highly active persons.

These results suggest that anthropometric values and physical performance can be associated with levels and types of energy nutrient intakes, even in moderately active and well-nourished young men. However, it appears that biochemical values of the blood may not be associated with differences in nutrient intake in moderately and highly active young men that are well nourished.

Literature Cited

1) Melodion MF, Manuck SB, Matthews KA. Lowering cholesterol concentrations and mortality: a quantitative review of primary prevention trials. *Br Med J* 301:309-314, 1990
2) Verdery BB, Goldberg AP. Hypocholesterolemia as a predictor of death: a prospective study of 224 nursing home residents. *J Gerontol* 46:84-90, 1991
3) Ausman LM, Russell RM. Nutrition in the elderly. In : Shills ME, Olson JA, Shike M, ed. Modern Nutrition in Health and Disease, pp770-780, Lea & Febiger. Philadelphia, 1994
4) Mowe M, Bhmer T, Kindt E. Reduced nutritional status in an elderly population is probable before disease and possibly contributes to the development of disease. *Am J Clin Nutr* 59 : 317-324, 1994
5) Hubert HB, Feinleib M, McNamara PM, Castelli WP. Obesity as an independent risk factor for cardiovascular disease: a 26-year follow-up of participants in the Framingham Heart Study. *Circulation* 67:968-977, 1983
6) de Onis M, Habicht J. Anthropometric reference data for international use : recommendations from a world Health Organization Expert Committee. *Am J Clin Nutr* 64:650-658, 1998
7) Di Toro A, Marotta A, Todisco N, Ponticiello E, C et.al. Unchanged iron and copper and increased zinc in the blood of obese children after two hypocaloric diets. *Biol Trace Elem Res* 57:97-104, 1997
8) Miller AB. Dietary advice and competing risks. *Nutrition* 11:57, 1994
9) Zamboni M, Armellini F, Turcato E, Robbi R, Micciolo R Todesco T, Mandragona R, et. al. Effect of altitude on body composition during mountaineering expeditions : interrelationships with changes in dietary habits. *Ann Nutr Metab* 40: 315-324, 1996
10) Kim, I. S. : A study on food habit and food preference of college students in Incheon area. Master's thesis, Graduate School of Education, Inha University, 1988
11) Lee KS, Kim KN. Effects of nutrition education on nutrition knowledge, dietary attitudes, and food behavior of college students. *Korean J community* Nutr 2 : 86-93, 1997
12) Lee MS, Woo MK. Changes in food habit, nutrition knowledge and nutrition attitude of university students during nutrition course. *Korean J Nutr* 32: 739-745, 1999
13) Ro HK. Factors in food selection and eating out behavior of college students. *Korean J Dietary Culture* 14:241 ~ 248, 1999
14) Lee KW, Lee YM. Nutritional knowledge, attitude and behavior of college students in Seoul and Kyunggido area. *Korean J. Dietary Culture* 10:125 -132, 1995
15) Dwyer JT, Evans M, Stone EJ, Feldman HA. Adolescents' eatting patterns influence their nutrient intakes. *J Amer Diet Assoc* 101: 798-802, 2001
16) Computer aided nutritional analysis program for professionals. Korean nutrition society. 1998
17) Recommended dietary allowance for Koreans, 7th revision. Korean nutrition society, 2000

18) National nutrition survey report, Ministry of health and welfare, 1999
19) Kim SH, Han JH, Keen CL, Vitamin and mineral supplement use by healthy teenagers in Korea: motivating factors and dietary consequences. *Nutrition* 17:373-380, 2001
20) Kim YN, Cho YO. Association between nutrients and nutritional status in young men. *Nutr Sci* 3:57-65, 2000
21) Driskell J. Sports Nutrition, pp 29-84. CRC Press, London, 2000
22) Jeukendrup AE, Saris WHM, Wagenmakers AJM. Fat metabolism during exercise: a review. Part I: Fatty acid mobilization and muscle metabolism. *Int J Sports Med* 1:15-20. 1998
23) Oopik V, Timpmann S, Medijainen, Lemberg H. Effects of daily medium-chain triglyceride ingestion on energy metabolis m and endurance performance capacity in well trained runners. Nutr Res 21:1125-1135, 2001
24) Van het Hof KH, Tijburg LB, de Boer HS, Wiseman SA, Weststrate JA. Antioxidant fortified margarine increases the antioxidant status. *Eur J Clin Nutr* 52:292-299, 1998
25) Doyle W, Crawley H, Robert H, Bates CJ. Iron deficiency in older people: interactions between food and nutrient intakes with biochemical measures of iron; further analysis of the National Diet and Nutrition Survey of people aged 65 years and over. *Eur J Clin Nutr* 53:552-559, 1999