ORIGINAL

The impact of snack and vegetable intake on body composition in young healthy subjects

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Abstract : Background/Objectives : Although dietary intake has been shown to affect various diseases, the effect of dietary intake on body composition remains unclear. Therefore, this study aimed to assess the effects of dietary intake on body composition. Methods : A total of 51 Japanese dietetic students (11 men and 40 women ; average age : 20.9±2.8) participated in this study. We assessed their body composition (i.e., muscle mass, body fat, and total body water) using the Physion MD® system. The subjects also completed an FFQg that was used to analyze dietary intake. Results : The mean body mass index was 21.09±3.28 kg/m², the mean percentage of body muscle was 35.9±6.2%, and the mean percentage of body fat was 21.1±6.7%. The body fat percentage was negatively correlated with vegetable intake (r=-0.5872, p<0.0001) and positively correlated with snack intake (r=0.6853, p<0.0001). Conclusions : Daily dietary intake, especially intake of vegetables and snacks, was independently associated with body fat percentage in healthy subjects. This suggests that intake of vegetables and snacks has a direct impact on body composition. J. Med. Invest. 72 : 281-285, August, 2025

Keywords : *Dietary intake, body composition, snacks, vegetables*

INTRODUCTION

Dietary intake has been shown to impact the occurrence of diseases, such as diabetes and cardiovascular disease. For example, an increased intake of vegetables and fruits has been shown to reduce the risk of cardiovascular disease (1) and decrease the concentration of glucose and insulin secretion after meals (2). Vegetable and fruit consumption has also been shown to decrease the risk of hypertension (3) and lead to changes in high-density lipoprotein subfractions 2 and 3 potentially increasing their antiatherogenic potential (4). In addition, increased dietary fiber, particularly soluble fiber, is clearly associated with a lower incidence of stroke (5) and colon cancer. Furthermore, consuming a higher proportion of dietary energy as vegetables may support greater short-term weight loss (6).

On the other hand, snack intake has been shown to be related to diseases, such as obesity. For example, a Japanese study investigated sugar intake from snacks and beverages in children (7) and another found that increased calories from snacking, frequency of snacking, and evening snacking were independently associated with overweight/obesity in children (8). However, few studies have targeted adults (9), and most of these focus on obesity (not healthy eating).

Furthermore, even though dietary intake is important for everyone and contributes greatly to disease progression or prevention, most studies do not target healthy subjects. However, dietary intake may also affect the body composition of healthy individuals, but the lack of evidence limits conclusions. In addition, most cross-sectional studies examining the association between food intake and physique have used weight and the body mass index (BMI) to measure obesity. However, BMI is not a perfect surrogate measure for obesity, as body mass is made up of lean and fatty tissue as well as bone. In addition, we cannot know the difference enough by using BMI because it is almost no individual difference. On the other hand, body composition measures that assess the mass of each type of tissue provide a better description of the physical makeup and adiposity of an individual.

Therefore, to address these gaps in the literature, we aimed to investigate the relationship between dietary intake and body composition among young healthy subjects.

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MATERIALS AND METHODS

Subjects

This study was approved by the Human Investigations Committee of Tokushima University Hospital (2284). Healthy, nonsmoking dietetic students were eligible for enrollment in this cross-sectional study. All participants were recruited from the Department of Nutrition at Tokushima University. Healthy individuals with no diagnosed chronic diseases such as diabetes or kidney disease were included in the study. Those who were taking medication for their illnesses were also excluded.

Body composition

Body composition was measured by the Physion MD® system (Nihon Shuter, Kyoto, Japan) using a bioelectrical impedance analysis. We measured body composition between 9:00 a.m. and 10:00 a.m. and before breakfast because it is low influence about water at this time. In addition, subjects avoided participating in excessive exercise just before measurement and did not eat or drink much during the 2 hours preceding the measurement.

Dietary survey

At the time of body composition measurement, participants also completed a FFQg to report their dietary intake within the past 3 months.

Statistical analyses

We analyzed the data using GraphPad Prism 5.0 (San Diego, CA). A multivariate analysis was used to assess the association between dietary intake and body composition, and a Spearman's rank correlation coefficient test was then used to assess the strength of the correlations.

RESULTS

Subjects characteristics

The basic characteristics of the study subjects are shown in Table 1. Fifty-one subjects (11 men and 40 women) participated in this study. The average age was 21.0 ± 2.84 years (median age : 20 years), and average BMI was 21.09 ± 3.28 kg/m^2.

The body fat percentage was between 4.0 and 29.8% (21.1 ± 6.7%), and the body muscle percentage was between 27.6 and 55.8% (35.9 ± 6.2%). The percentage of muscle and fat are different among individuals.

Table 1. Baseline characteristics.

Subjects	
N	51
Age, years (range)	21.0 (19 to 34)
Male : Female	11 : 40
Body mass index, kg/m^2 (range)	21.09±3.28 (17.30 to 33.65)
Body muscle percentage, % (range)	35.9±6.2 (27.6 to 55.8)
Body fat percentage, % (range)	21.1±6.7 (4.0 to 29.8)

Correlation between food intake and body composition

There was no correlation between the body fat percentage and energy or nutrient intake, including protein, carbohydrate, and fat intake.

On the other hand, body fat percentage was negatively correlated with the intake of vegetables (r=-0.5872, p<0.0001) and positively correlated with the intake of snacks (r=0.6853, p<0.0001 ; Fig. 1A-B). As shown in Table 2, vegetable intake was very low among study subjects (131 ± 108.8 g/day ; range : 6-381 g), and 92% of subjects took in less than 350 g of vegetables per day. Intake of brightly colored vegetables was 52 ± 41.4 g/day (3-175 g) and intake of other vegetables was 79 ± 70.8 g/day (3-282 g). Furthermore, when students ate snacks they mainly ate snack breads, fried snacks, or chocolate but not traditional Japanese sweets (Table 3).

Body muscle percentage showed a positive correlation with energy intake (r=0.4027, p=0.0037) and protein intake (r=0.3138,

Table 2. Food intake by food type.

Food intake, g (range)	
Grains	466±173.9 (139 to 921)
Rice	360±155.3 (96 to 781)
Bread	52±62.2 (0 to 357)
Noodles	53±62.4 (0 to 309)
Potatoes	23±24.1 (0 to 86)
Green and yellow vegetables	52±41.4 (3 to 175)
Other vegetables (containing mushrooms)	79±70.8 (3 to 282)
Seaweeds	2±3.0 (0 to 13)
Beans	60±46.6 (0 to 192)
Seafood	43±37.3 (0 to 169)
Meat	166±114.2 (17 to 533)
Egg	38±22.4 (7 to 108)
Milk	179±169.4 (0 to 1101)
Fruits	46±74.7 (0 to 450)
Snacks	134±117.4 (0 to 537)

Table 3. Snack intake by snack type.

Snacks intake, g	
Japanese confectionery	32.5±47.2
Sweet baked goods and cakes	82.5±53.7
Snacks	66.7±103.3
Cookies and rice crackers	15.4±18.9
Ice cream	165.6±185.4
Chocolates	63.5±65.6
Candies and caramels	6.5±11.7
Pudding and jelly	146.9±237.3

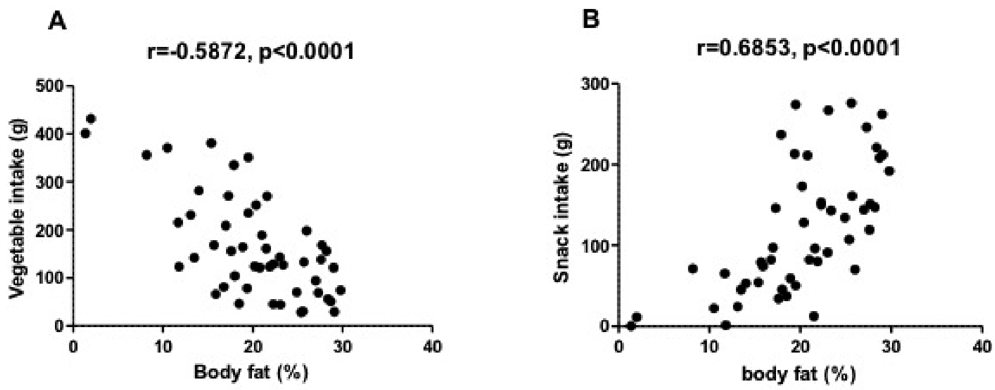

Fig.1. Correlation between body fat percentage and food intake. A Spearman's rank correlation test was used to assess the strength of the correlation between body fat percentage and food intake.
A : Relationship between body fat (%) and vegetable intake (g) ; r=-0.5872, p<0.0001.
B : Relationship between body fat (%) and snack intake (g) ; r=0.6853, p<0.0001.

p=0.0265 ; Fig. 2A-B), while carbohydrate and fat intake did not affect muscle percentage (data not shown). There was no association between body muscle percentage and food intake, including meat, fish, eggs, or soy (r=-0.1904, r=0.3660, r=0.1634, r=-0.0182, respectively).

Association between energy density and food intake

The correlation between energy density (ED), calculated as the ratio of food intake (g) per energy intake (kcal), and food intake was also investigated. ED showed a negative correlation with intake of vegetables (r=-0.4062, p=0.0034), but there was no correlation between ED and intake of snacks (Fig. 3). ED was a negatively correlated with body muscle percentage (r=-0.4655, p=0.0007) but positively correlated with body fat percentage (r=0.5301, p=0.0001 ; Fig. 4).

The relationship between estimated energy expenditure and body composition

We also estimated the energy expenditure per day using the FFQg data. Subjects answered the time of each activity and exercise including each exercise intensity. Energy expenditure showed a positive correlation with body muscle percentage (r=0.4062, p=0.0034) but a negative correlation with body fat percentage (r=-0.2617, p=0.0664 ; Fig. 5A-B).

DISCUSSION

In current study, we showed that body fat percentage was significantly and positively correlated with snack intake and significantly and negatively correlated with vegetable consumption. In addition, ED was negatively correlated with vegetable intake, but there was no correlation between ED and snack intake. Furthermore, body muscle percentage was positively correlated with energy expenditure.

There is some evidence to indicate that the intake of snacks and vegetables is associated with several factors (7, 8). Snacks include mainly sugar and fat, but Takeichi *et al*. emphasized that the sugar intake from snacks and beverage is an important regulator of children's health (7). However, although previous reports have shown that excessive snack intake is associated with obesity in children, no such studies found among adults. In our study, adult students did not show that they did not take sugar from beverage, i.e., mainly snacks. Given that snack foods tend to be high in fat and sugar, this has implications for weight gain and obesity (10). For example, a study conducted in Finland showed that snacks appear to have a higher ED and a lower micronutrient content than main meals ; therefore, a meal pattern based primarily on snacks is inadvisable (11). In our study, we found a clear association between body fat percentage and snack

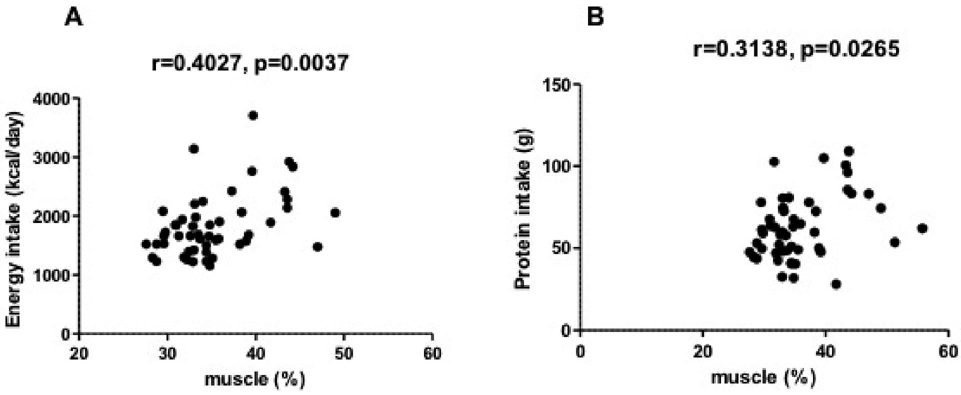

Fig.2. Correlation between body muscle percentage and nutrient intake. A Spearman's rank correlation test was used to assess the strength of the correlation between body muscle percentage and nutrient intake.
A : Relationship between body muscle (%) and energy intake (kcal/day) ; r=0.4027, p=0.0037.
B : Relationship between body muscle (%) and protein intake (g) ; r=0.3138, p=0.0265.

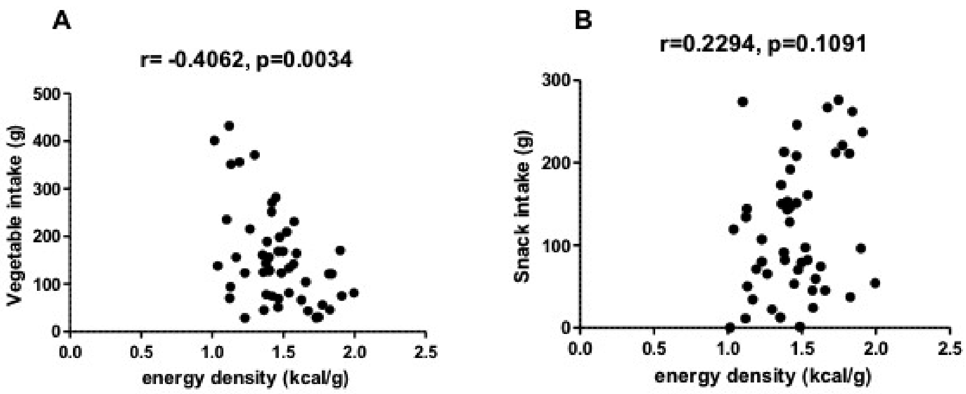

Fig.3. Correlation between energy density (the total energy intake per total food intake) and food intake. A Spearman's rank correlation test was used to assess the strength of the correlation between energy density and food intake.
A : Relationship between energy density (kcal/g) and vegetable intake (g) ; r=-0.4062, p=0.0034.
B : Relationship between energy intake (kcal/g) and snack intake (g) ; r=0.2294, p=0.1091.

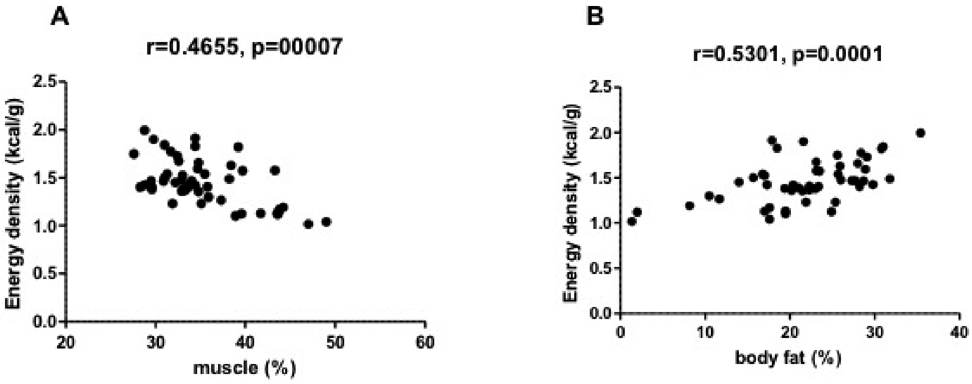

Fig.4. Correlation between body composition and energy density (the total energy intake per total food intake). A Spearman's rank correlation test was used to assess the strength of the correlation between body composition and energy density.
A : Relationship between body muscle (%) and energy density (kcal/g) ; r=0.465, p=0.0007.
B : Relationship between body fat (%) and energy density (kcal/g) ; r=0.5301, p=0.0001.

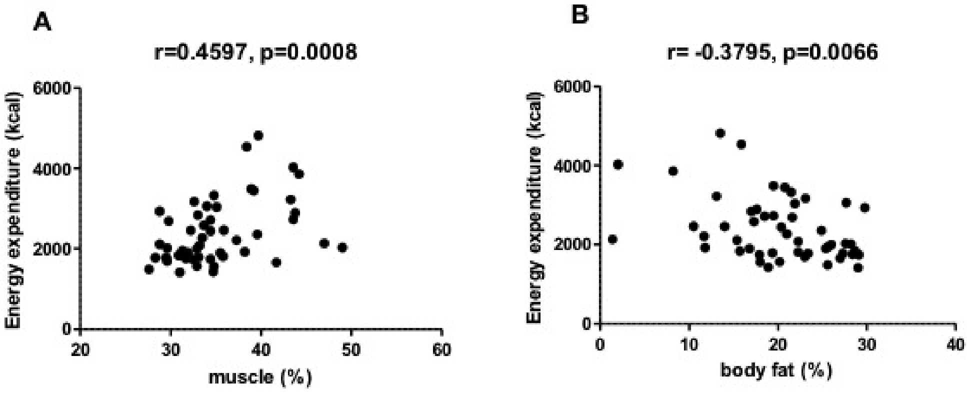

Fig.5. Correlation between body composition and energy expenditure. A Spearman's rank correlation test was used to assess the strength of the correlation between body composition and energy expenditure.
A : Relationship between body muscle (%) and energy expenditure (kcal) ; r=0.4597, p=0.0008.
B : Relationship between body fat (%) and energy expenditure (kcal/g) ; r=-0.3795, p=0.0066.

intake, supporting the results of the Finnish study. The FFQg is able to assess various types of snacks, such as ice cream, chocolate, candy, cookies, and fried snacks like potato chips. Our results also showed that adult students had a tendency to eat more snack breads, fried snacks, chocolates than traditional Japanese sweets. However, even though our results showed that some students had an elevated snack intake and that body fat percentage was positively correlated with snack intake, we did not detect overweight/obesity because their energy intake remained in the normal range. Therefore, further follow-up studies are needed to monitor whether these students will develop obesity or metabolic syndrome later in life and whether a nutritional education program would be effective among this population.

On the other hand, an increased vegetable intake has been shown to be associated with a decreased risk of several diseases. For example, some reports have determined that an increased vegetable and fruit intake is associated with a lower risk of gastric cancer (12, 13), and the Multiethnic Cohort Study demonstrated that vegetable intake was inversely related to the risk of colorectal cancer among men (14). However, in our study, most students did not have a sufficient intake of vegetables. In Japan, the daily recommended intake of vegetables is 350 g, but the average intake of vegetables for subjects was 131±108.8 g/day (6-381 g), and 92% of subjects did not have a sufficient intake (less than 350 g/day). In particular, subjects who lived alone (the majority) had a lower vegetable intake when compared to subjects who lived with their family. This may be because most subjects who lived alone selected their own meals. Although the intake of vegetables is important for health, student awareness of the health benefits of vegetable intake may be low. However, there is also no report with healthy subjects as same as snacks.

Several studies have also shown an association between dietary ED and body fat in children (15, 16) as well as adults. For example, in Japan, reports have shown that dietary ED is associated with an increased risk of being overweight in male children (17) and that dietary ED is positively associated with BMI and waist circumference in adult women (18). In our study, ED was negatively correlated with the intake of vegetables. This may be because the intake of vegetables can decrease the total ED suggesting that vegetable intake affects body composition (i.e., muscle and fat). On the other hand, snack intake was not correlated with ED. This is most likely because students who had a higher snack intake ate snacks instead of meals. Our data suggest that having an unbalanced meal (e.g., a lower vegetable intake) can lead to changes in body composition. However, a study of ED in US adults indicated that ED among the group consuming a high-energy-dense diet could be lowered by adding fruits and vegetables (19).

Several limitations of the present study warrant mentioning. First, the cross-sectional nature of the study precluded an assessment of causality. Second, we used a convenience sample of dietetic students and not a random sample from the Japanese population. In addition, the eating habits of college students differ greatly depending on whether they are home students or boarding house students, or whether they have the habit of cooking for themselves, but we were unable to account for such participant background bias in this study. Third, most subjects (78%) were women. Finally, we collected data for food intake and exercise habits using the FFQg and not direct observation. Therefore, the results of this study should be interpreted with caution, and prospective studies and trials are needed to confirm the relationship between food intake and exercise habits as well as to clarify whether improvements in life style (i.e., increasing vegetable intake or/and decreasing snack intake) can change body composition and prevent future disease.

In summary, we determined that eating habits, especially vegetable and snack intake, have a strong correlation with body composition in healthy subjects.

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