

Dietary patterns of obese high school girls: snack consumption and energy intake

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Abstract

In order to develop an obesity management program for teenagers, we compared obese and non-obese girls attending high schools in terms of their dietary practices related to snack consumption. Dietary records were collected for 7 days. No significant differences were found for the average daily energy intake between obese and non-obese girls. However, the highest energy intake was greater for obese girls while not much difference was found for the lowest amount of energy intake. Obese girls had significantly lower intakes in calcium ($P < 0.01$), vitamin A ($P < 0.001$) and folate ($P < 0.01$). Mean energy intake from snack (594.1 ± 312.1 kcal) was significantly higher for obese girls than for non-obese girls (360.1 ± 173.1 kcal) ($P < 0.001$). A significant, positive correlation was observed between energy intake from snack and total daily energy intake ($r = 0.34$, $P < 0.01$) only for obese girls. In case of dietary behaviors, obese adolescent girls consumed significantly greater number of items for snacks and fewer foods for regular meals compared to non-obese girls ($P < 0.05$). This study suggested that obesity management programs for adolescents should focus on providing strategies to reduce snack through enhancing balanced regular meals.

Key Words: Obesity, snack consumption, daily variation, energy intake, adolescents

Introduction

Obesity is an important health risk factor for adults as well as adolescents in the modern society [1]. The prevalence of obesity among young age group has explosively increased in the past 3 decades in Korea [2,3]. The National Health and Nutrition Examination Survey for Koreans (KNHANES) conducted in 2005 demonstrated that the incidence of obesity is 17.3% for boys, and 11.5% for girls 13-19 yrs according to relative body weight [4].

The fact that obese adolescents are at a significant risk of becoming obese adults, and that adolescent obesity predisposes to a range of medical and psychosocial problems call attention for effective prevention and treatment strategies for teenagers [3]. However, long-term success in weight reducing without repeated weight gain is difficult for obese person.

Researches on dietary patterns showed that obese adolescents possess undesirable dietary patterns in terms of food preferences and consumption frequencies [5-7]. Sugar-sweetened carbonated beverages, fast foods, and instant foods are favorite food items in their diet, which are categorized as high energy density, poor quality foods [8,9]. In-depth analysis of KNHANES indicated that adolescent girls showed higher frequency of skipping breakfast, irregularity of meal time than the other age groups [10]. Therefore, irregular meal patterns including skipping breakfast are regarded as one of influential factors explaining

nutritional imbalance of adolescents [11,12]. Carbonated drink consumption has doubled between 1998 and 2005, along with the increased consumption of instant noodles and fast foods, thereby contributed more energy intake from fat and sugar, eventually plays a major role in high prevalence obesity among adolescent [10].

Yet, reported energy intakes did not show significant differences between overweight and normal weight groups [10,13]. Most of cross-sectional studies collect dietary information for one day or 2-3 days at most for participants' convenience [2,11,12], because repeated measurement of dietary intake requires a high degree of cooperation from the participants. Estimation of habitual energy intake requires a repeated measurement of dietary intake for longer periods. Therefore, we have limited information on whether dietary intake of the obese subjects shows a larger day-to-day variation compared to the non-obese subjects. In Korea, the KNHANES conducted dietary assessment for one day per each subject by 24 hour recall method. Thus, it is not possible to figure out the day-to-day variation of dietary intake among the Korean population with the KNHANES data.

Therefore, in this study, we assessed the nutrients intake from regular meals and snacks separately, by using repeated 7 days dietary records to figure out the daily variation of energy intake and the association among energy intake, snack consumption, and obesity. In particular, we aimed to explain 1) How does the nutrients intake of the obese girls differ from the normal-

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weight girls? 2) Does the energy intake from snack consumption differ between obese and normal weight girls?

Subjects and Methods

Selection of subjects

The participants of this study were 36 obese adolescent girls and 32 non-obese girls attending the same high school in Daegu, South Korea. All subjects were evaluated as apparently healthy by the annual health examination and gave informed consent to participate in this study.

Assessment of dietary intake

Information on the dietary intake of each subject was collected for seven days by the food record method. Subjects were encouraged to report their food intakes without changing their usual dietary pattern. Food pictures of full-scale were shown to the subjects to improve the accuracy of quantity estimation of the actual intake. From the collected diet records of each subject, we examined food items consumed between meals as well as for regular meals. The types of foods consumed were described by the percentage of daily energy intake. Collected food intakes were also converted to the amount of daily nutrients intake by CAN-Pro 3.0 [14].

Anthropometric measurements

Standing height without shoes was measured to the nearest millimeter, by using a portable, direct-reading stadiometer. Body weight was measured to the nearest 0.1 kg, by using digital scales while the subjects wore light indoor clothing but no shoes. Body mass index (BMI) was calculated as weight (in kg) divided by the square of height (in m) with measured height and weight. Subjects with BMI greater than 25 were classified as obese subjects and those with BMI (18.5 < BMI < 25) were classified as normal weight subjects.

Statistical analysis

We used the Statistical Package for the Social Sciences (SPSS) software for windows, release 14.0. Descriptive analysis was carried out to analyze the association of snack consumption, energy intake and obesity. Data were presented as mean \pm SD. Student t-test was used for comparison between obese and non-obese group. To examine the association between food consumption and weight status, Pearson correlation coefficients were calculated between energy intake from snacks and total daily nutrient intake.

Results

Subject characteristics

General characteristics of the participants including anthropometric measurements are presented in Table 1. There were no significant differences in age and height between the obese and the non-obese groups. BMI was 27.8 ± 2.9 for the obese group, 20.0 ± 2.6 for normal group.

Nutrient intake and Dietary quality

Average dietary intake of the subjects is demonstrated in Table 2. Daily energy intake of obese girls (1,825.8 kcal) was not significantly different from that of non-obese girls (1,739.5 kcal). No significant differences of dietary intake were observed in protein, vitamin E, thiamin, riboflavin, vitamin B₆, niacin, vitamin C, P, Fe and zinc as well. By contrast, nutrients intake such as calcium, vitamin A, folate was significantly lower in the obese group compared to the normal group ($P < 0.01$). The obese group had a larger standard deviation for dietary intake of energy, than the non-obese group (28.4%, 19.6% of coefficient of variation, respectively). Maximum and minimum daily energy intakes for each individual are illustrated in Fig. 1. While obese girls showed higher maximum daily energy intake than non-obese

Table 1. General characteristics of the subjects

	Non-obese	Obese	Total	Significance
N (%)	32 (47.1)	36 (52.9)	68 (100)	
Age (yr)	16.2 \pm 0.5	15.3 \pm 0.5	15.8 \pm 0.7	***
Height (cm)	161.4 \pm 5.5	159.3 \pm 6.1	160.3 \pm 5.9	NS
Weight (kg)	52.1 \pm 6.6	70.7 \pm 9.8	62.0 \pm 12.6	***
BMI	20.0 \pm 2.6	27.8 \pm 2.9	24.2 \pm 4.8	***

*** $P < 0.001$

NS : Not Significantly different by t-test at $P < 0.05$

BMI : body mass index = body weight (kg)/ height (m²)

Table 2. Average daily nutrients intake

	Non-obese	Obese	Significance
Energy (kcal)	1,739.5 \pm 341.1	1,825.8 \pm 519.3	NS
Protein (g)	69.4 \pm 14.8	69.6 \pm 23.8	NS
Vitamin A (μ gRE)	772.6 \pm 213.0	518.1 \pm 200.8	***
Vitamin E (mg α -TE)	13.6 \pm 4.3	13.9 \pm 5.8	NS
Thiamin (mg)	1.2 \pm 0.3	1.2 \pm 0.4	NS
Riboflavin (mg)	1.1 \pm 0.4	1.2 \pm 1.0	NS
Vitamin B ₆ (mg)	1.9 \pm 0.4	1.8 \pm 0.7	NS
Niacin (mg NE)	14.3 \pm 4.5	14.5 \pm 5.5	NS
Vitamin C (mg)	71.2 \pm 40.6	81.3 \pm 52.3	NS
Folate (μ g)	193.0 \pm 61.7	150.6 \pm 51.9	**
Ca (mg)	498.5 \pm 173.6	396.0 \pm 141.3	**
P (mg)	880.9 \pm 174.7	792.1 \pm 259.6	NS
Fe (mg)	12.3 \pm 5.9	14.0 \pm 6.3	NS
Zn (mg)	8.4 \pm 1.8	7.6 \pm 2.3	NS

** $P < 0.01$, *** $P < 0.001$

NS : Not Significantly different by t-test at $P < 0.05$

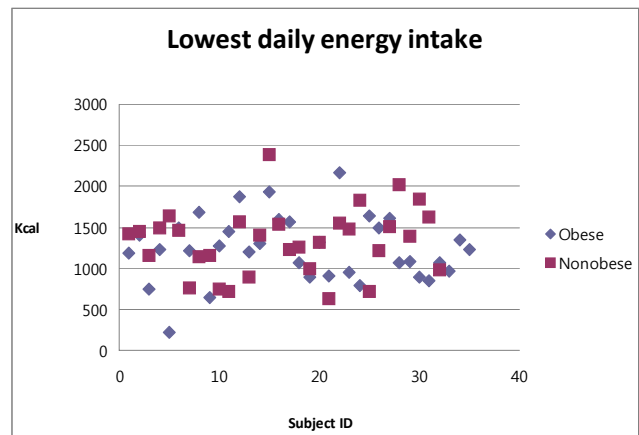
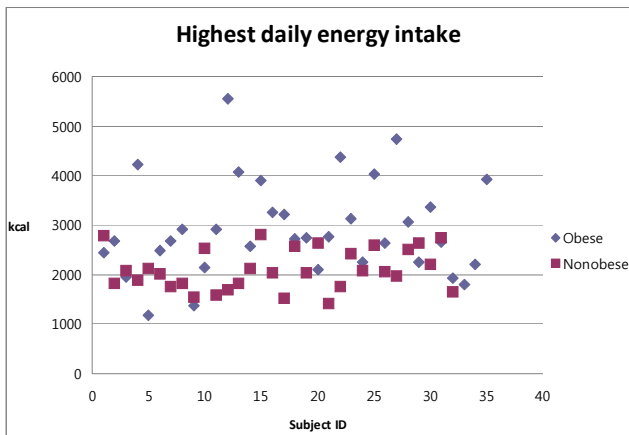


Fig. 1. Comparison of maximum and minimum daily energy intake of obese and non-obese girls

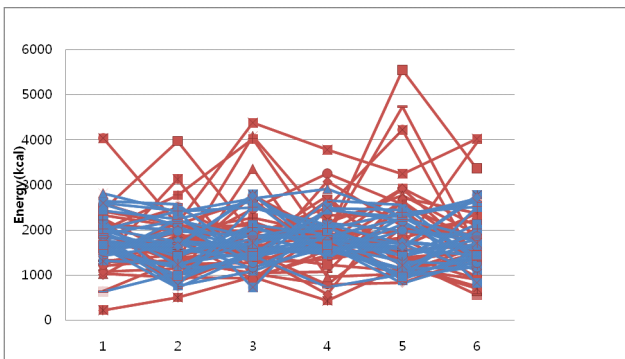


Fig. 2. Daily variation of total energy intake of obese and non-obese girls; Red lines and blue lines represent obese girls and non-obese girls, respectively.

girls, the minimum daily energy intakes of both groups were maintained at similar levels.

Daily energy intakes of individual subject are shown in Fig. 2. Variation of daily energy intake was larger for obese subjects than non-obese subjects.

Comparison of snack intake between obese and non-obese girls

As indicated in Table 3, there were significant differences of energy intake from snacks in terms of the absolute amount and the relative proportion to total daily energy intake. Energy intake from snack was 594.1 ± 312.1 kcal in obese group, which constituted 31.2% of the total daily energy intake. By contrast, non-obese girls showed significantly less amount of energy intake from snack (360.1 ± 173.11 kcal), which constituted 21.1 % of total daily energy intake (*P* < 0.001).

The associations between energy intake from snacks and daily nutrients intake are reported in Table 4. A significantly positive correlation between energy intake from snack and total energy intake (*r* = 0.34, *P* < 0.01) was observed for obese girls, but not for non-obese girls. There was a positive association between energy intake from snack and calcium intake in both groups (obese group; *r* = 0.52, *P* < 0.001, non-obese group *r* = 0.40, *P*

Table 3. Energy intake from snack foods and proportion of snack energy to total energy intake

	Non-obese	Obese	Significance
Energy intake from snacks (kcal)	360.1 ± 173.1	594.1 ± 312.1	***
Energy intake from snacks to total energy intake (%)	21.1 ± 9.9	31.2 ± 10.4	***

****P* < 0,001

Table 4. Correlation between the energy intake from snacks and other nutrients intake

	Energy intake from snacks	
	Non-obese	Obese
Energy	0.136	0.344*
Protein	-0.005	0.282
Vitamin A	0.342	0.101
Vitamin E	-0.059	0.133
Thiamin	0.082	0.176
Riboflavin	0.171	-0.010
Vitamin B	0.012	0.295
Niacin	0.032	0.282
Folate	0.206	0.225
Vitamin C	0.128	0.214
Ca	0.408*	0.528***
P	0.095	0.291
Fe	0.053	0.196
Zn	0.037	0.177

P* < 0,05, **P* < 0,001

Table 5. The number of food items consumed for snacks and regular meals

Food frequencies	Non-obese	Obese	Significance
Meals	8.7 ± 1.3	7.3 ± 1.5	***
Snacks	2.1 ± 1.0	3.7 ± 1.5	***
Total	10.5 ± 1.5	10.6 ± 2.3	

***Significantly different by t-test at *P* < 0,001

< 0.01).

The diversity of food items consumed for snacks or regular meals are shown in Table 5. While obese girls consumed more

food items for snacks (3.7 ± 1.5) than non-obese girls (2.1 ± 1.0), they consumed fewer food items for regular meals (7.3 ± 1.5) than non-obese girls (8.7 ± 1.3). By contrast, the total number of food items including snacks and meals was not significantly different between two groups.

Discussion

This study demonstrated that snack consumption is associated with daily energy intake and diet quality among Korean adolescent obese girls, from repeated measurement of daily food intake for 7 days. We examined how much snacks and what types of foods adolescent girls ate for snacks between meals.

The current study reveals four major findings. First, our results showed that the contribution of snack consumption on daily energy intake was substantially larger in adolescent obese girls as compared to non-obese girls, while total daily energy intake of obese and non-obese girls were at similar level. Second, when we compared daily nutrients intakes of both groups, the nutritional quality of diet was poorer for obese girls than for non-obese girls. Third, obese girls were found to exhibit less diversity in regular meals while consuming more snack items, when compared to non-obese girls. Fourth, we observed larger variation of daily energy intake among obese girls.

To understand the role of diet in adolescent obesity, accurate measurement of energy intake is necessary. Under-reporting or day-to-day variation of dietary intake is a concern in studies examining the relationship between self-reported food intake and obesity [14,15]. Previous studies reported no differences in daily energy intakes between obese and normal weight group or lower energy intakes among obese subjects [10,13]. Our results confirmed their findings.

The observations by Champagne *et al.* [16] indicated that mean daily energy intake was substantially under-reported in boys and girls. The tendency of under-reporting increased with age and more frequently observed among obese subjects. Energy under-reporting bias in adolescents has been reported from another study using doubly labeled water method [15]. A reporting bias of 42% from diet records was found in obese adolescents as compared with 20% in non-obese adolescents [15]. A recent study also confirmed the increased underreporting of dietary intake with increasing body mass index in teenagers [17].

Food consumption pattern of obese girls differs from that of normal-weight girls. Therefore, repeated observations throughout the week, including weekends as well as weekdays, should be employed. Higher fluctuation of energy intake has been generally expected for obese population. We observed higher maximum energy intake, but no lower minimum energy intake, for obese girls in our study. When we extrapolate above findings to our subjects, actual energy intake of obese girls would be higher than normal weight girls.

The key elements of the dietary strategy for overcoming obesity

include providing less energy than the person needs to maintain current body weight, and maintaining nutritional adequacy without excess. In general, the nutrient intake pattern of our subjects coincides with the findings from in-depth analysis of 2005 KNHANES data [10]. Lower intake tendency of vitamin A and calcium among obese teenager girls has been previously reported [4].

It has been suggested that the snacking habit per se is not related to weight gain, but the nature of snack consumption is a matter of concern [18]. However, in the present study, there were significant differences in the relative energy contributions of snack foods to daily energy intake between obese and non-obese girls. Specifically, the percentage of energy from snacks was significantly higher for obese girls than for non-obese girls. Furthermore, obese girls consumed more food items for snacks, and they may be more dependent on snacks than regular meals compared to non-obese girls. A positive association of energy intake from snacks with total daily energy intake was only observed for obese girls. Previous studies report that snacks and fast foods consumption appear to be associated with overweight/obesity, as the majority of snacks and fast foods are high-energy, high-fat foods [7,19-23]. A recent longitudinal study from Hong Kong indicated that increased variety of snack consumption could be a predisposing factor of obesity/overweight [19].

Statistical analysis showed a positive association between energy intake from snacks and calcium intake for adolescents. While obese girls consumed less calcium than non-obese girls, however, a greater association between calcium intake and energy intake from snacks was observed for obese girls. This might be related to the snack items (such as ice creams and sweetened milk) that adolescents girls favored.

There are some limitations to the methods used in these studies. First, although daily dietary intake was collected from obese girls for 7 days to cover the week-day and weekend variation, we were not able to measure the intra-individual variation in dietary intakes over a longer period, which is necessary to accurately estimate the energy intake reflecting seasonal changes. Second, we selected our study subjects from volunteer pools. Therefore research findings observed in this study may not be generalized to the whole population without further research. Third, diet assessment by food records has another limitation in terms of collecting accurate dietary information.

However, our study has strengths over KNHANES results in explaining dietary behaviors relevant to obesity. We tried to minimize the effects of confounding variables such as age, gender, education level, and physical activity by selecting female subjects with similar age (15-16 yrs) and from same school. We also collected dietary data over the week, thereby we intended to minimize the day-to-day variation of dietary intake.

In sum, this study shows that a significant proportion of obese girls' daily energy is derived from frequent snacks consumed between meals, and the variation of daily energy intake was

higher among obese girls than non-obese girls. These findings suggest that eating snacks between meals may serve as an important factor leading to obesity. Interventions designed to help adolescent girls overcome obesity must focus on changing the type of snacks consumed at school, reducing snack consumption, and maintaining balanced regular meals.

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