

Research Note



Short-Term Effect of Convenience Meal Intake on Glycemic Response and Satiety among Healthy College Students in South Korea

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Conflict of Interest

The authors declare that they have no competing interests.

ABSTRACT

This study examined the effect of convenience meals purchased at convenience stores on glycemic response and satiety in healthy college students. A total of 9 non-obese volunteers (4 males and 5 females) aged 20 to 24 years participated in this study. On 3 separate days, participants consumed a standard diet (cooked rice and side dishes), and type 2 convenience meal (sweet bread and flavored milk). Capillary blood-glucose response and satiety were measured every 30 minutes for 2 hours after consuming the 3 different test meals. Although mean fasting glucose levels were not different, glucose levels at 30 minutes and 120 minutes after the type 1 convenience meal intake were significantly higher than those in the standard meal ($p < 0.05$, $p < 0.01$). Total glucose response was higher after consumption of the type 1 convenience meal, followed by the type 2 convenience meal and standard meal ($p < 0.05$). Though the type 2 convenience meal contained higher calorie than the other meals, satiety of the type 2 convenience meal was lowest at 30 minutes and 60 minutes after consumption ($p < 0.01$, $p < 0.05$). This pilot study suggests that convenience meals may increase glycemic response or induce higher calorie intake with low satiety compared with nutritionally balanced Korean style meal.

Keywords: Convenience meal; Glycemic response; Satiety; Healthy college students

INTRODUCTION

Rapid economic growth and industrial development in Korea have led to a great change in dietary patterns, and the use of convenience foods has increased with development of food industries and tendency to pursue convenience [1]. Recently, convenience stores have been growing rapidly in Korea because of 24-hour operation and easy access. In previous studies, consumption of convenience foods purchased at convenience stores was high especially among college students [1-4]. While several studies investigated the utilization and consumption patterns of the convenience foods [1-4], there was no study examining the relationship between the consumption of the convenience foods and health issues.

It has been known that postprandial glucose concentrations, even within the non-diabetic range, are associated with increased risks of cardiovascular disease [5], diabetes [6], metabolic syndrome [7], and cancer [8]. Therefore, increasing postprandial glucose may be

a risk factor of those diseases. There are prior studies showing that blood glucose responses may be different depending on the type and nutritional composition of the meal [9,10]. These circumstances may cast interest as to whether the consumption of convenience meals has any negative effect on glycemic response. Thus, the purpose of this pilot study was to examine effects of convenience meals purchased at convenience stores on glycemic response and satiety in healthy college students compared to home-made style standard diet.

MATERIALS AND METHODS

A total of 10 college students were recruited and 9 of them completed the study (4 males and 5 females). We measured the glycemic and satiety impact elicited by 3 different test meals in male and female volunteers on non-sequential 3 separate days. Subjects were non-smokers, aged 20–24 years, with mean body mass index (BMI) of $21.8 \pm 2.8 \text{ kg/m}^2$ ($18.6\text{--}24.5 \text{ kg/m}^2$), without diabetes, and in good health. The study protocol was in accordance with the Declaration of Helsinki, and each subject gave informed consent prior to the participation.

Test meals

Three test meals were chosen based on previous reports [1,11] and focus group interview about frequently consumed convenience foods as a meal among college students. In the previous reports, most frequently consumed convenience foods as a meal among college students were instant ramen and kimbap (Korean dish made with cooked rice and various ingredients rolled in laver seaweed). From focus group interview with 10 college students, breads and flavored milk were most frequently consumed convenience foods as a meal when students had no enough time for lunch. The 3 test meals were a standard meal (cooked rice and side dishes), a type 1 convenience meal (kimbap and instant ramen), and a type 2 convenience meal (sweet bread and flavored milk). A standard meal provided about 30% of dietary reference intake for male and female Korean adults aged 19–29 years, and consisted of cooked brown rice (20% brown rice and 80% white rice), seaweed soup, steamed egg, soybean sprouts, lettuce, and Korean cabbage kimchi. The type 1 and type 2 convenience meals were purchased at a convenient store in Jeungpyeong, Chungbuk, Korea. The type 2 convenience meal consisted of sweet bread and flavored milk, and subjects were provided with different serving size of breads (2 for men, 1.5 for women) but the same serving of milk (240 mL).

When different serving sizes of convenience foods were available at convenience stores, we provided different serving sizes of convenience food for male and female subjects. For example, the type 1 convenience meal contained the same serving size of instant ramen but different size of kimbap for male and female subjects (normal size for the female, large size for the male). The standard meal contained 691 kcal, 88 g carbohydrate, 32 g protein, and 24 g fat for males and 516 kcal, 65 g carbohydrate, 22 g protein, and 19 g fat for females. The type 1 convenience meal contained 735 kcal, 89 g carbohydrate, 16 g protein, and 35 g fat for males and 549 kcal, 85 g carbohydrate, 11 g protein, and 18.5 g fat for females. The type 2 convenience meal contained 934 kcal, 115 g carbohydrate, 19 g protein, and 44 g fat for males and 753 kcal, 93 g carbohydrate, 16 g protein, and 35 g fat for females. Water (100 mL) was served as a drink at the end of each test meal.

Procedures

Subjects came to the laboratory at 12 pm after 10–12 hours overnight fasting. Subsequent visits were scheduled at the same time. Subjects were asked to maintain a normal diet, but avoid

alcohol intake and unusual physical activity for 24 hours prior to each visit. Body weight and body composition was measured and a fasting fingerstick blood sample was obtained. After the fasting blood sample collection (0 minutes), participants began consuming the assigned test meal, which they were asked to complete within 20 minutes. Additional fingerstick blood samples were taken at 30, 60, 90, and 120 minutes after starting to consume a test meal.

Glycemic response

Whole blood glucose was measured using a Glucose Analyzer (GlucoDr Plus 2; Allmedicus, Anyang, Korea). To calculate glucose response area under the curve, fasting glucose was determined as the mean of the first glucose measurement at 0 minutes.

Satiety

One-hundred-millimeter continuous-line visual analog scales were used to measure subjective feelings of fullness. Data was expressed as millimeter. Satiety tests were carried at baseline and at 30, 60, 90, and 120 minutes after starting to consume a test meal.

Statistical analysis

Results are expressed as means \pm standard deviation (SD). Statistical significance was determined with one-way repeated measures analysis of variance (ANOVA) using the Statistical Analysis System (version 9.3; SAS Institute Inc., Cary, NC, USA). When ANOVA indicated significant differences among the means, those differences were further evaluated using Tukey's method. The difference was considered significant when $p < 0.05$.

RESULTS

Subjects were (mean \pm SD) 22.0 ± 1.9 years of age with a BMI of 21.8 ± 2.8 kg/m². Although fasting glucose levels were not significantly different at the baseline, glucose levels at 30 minutes and 120 minutes after the type 1 convenience meal intake were significantly higher than those in the standard meal ($p < 0.05$, $p < 0.01$) (**Figure 1**). Glucose response areas (total, left, and right) under the curve were significantly higher after consuming the type 1 convenience meal and type 2 convenience meal compared with those after the standard meal ($p < 0.05$, $p < 0.01$, $p < 0.05$) (**Table 1**). In the satiety evaluation of these experimental meals, although the type 2 convenience meal (sweet bread and flavored milk) contained over 200 kcal more calorie than the other test meals, mean satiety score of the type 2 convenience meal was lowest at 30 and 60 minutes after consumption ($p < 0.01$, $p < 0.05$) (**Figure 2**).

DISCUSSION

In the pilot study, we found that within the first 120 minutes after a meal, the type 1 convenience meal (kimbap and instant ramen) led to a significant increase in postprandial glycemia. Also, we found that total glucose response areas under the curve were significantly higher after consuming the type 1 convenience meal, followed by the type 2 convenience meal, and standard meal. We did not control the serving amount of the convenience meals to match with the calorie contents of the standard meal, because we intended to use actual serving size of products currently sold at convenience stores in Korea. Even though we did not tightly control the test meals in terms of calorie contents to match with the standard meals, the type 1 convenience meal and standard meal contained similar calorie. However,

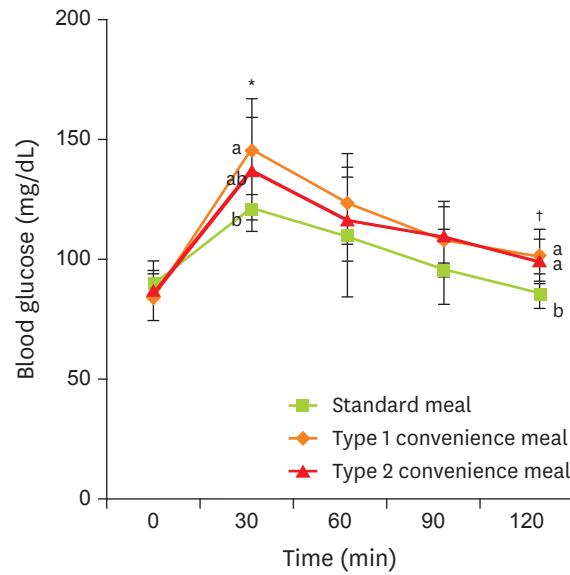


Figure 1. Blood glucose response. Values are mean \pm SD (n = 9). A standard meal contained cooked rice and side dishes, type 1 convenience meal contained kimbab and instant ramen, and type 2 convenience meal contained sweet bread and flavored milk.

SD, standard deviation.

*p < 0.01; †p < 0.05; ^{a,b}Mean for control not sharing the same letter in the superscript differs significantly by Tukey's post-hoc test (p < 0.05).

there were differences in the composition of carbohydrate, protein, and fat between these 2 meals, which could have partially contributed to the difference in glucose response. For example, high carbohydrate contents of the type 1 convenience meal may cause higher glucose response, as instant ramen and kimbab have high carbohydrate. Another possibility is that it may be caused by low dietary fiber in the type 1 convenience meal. Although we did not measure actual dietary fiber contents of the test meals, we could postulate lower dietary fiber contents of the convenience meals than the standard meal based on their ingredients.

The glycemic response and insulin response are highly associated with postprandial rise in plasma glucose in healthy normal-weight individuals [7]. Postprandial glucose concentrations are associated with increased risk of chronic degenerative diseases, such as cardiovascular disease [5], diabetes [6], and metabolic syndrome [7]. Therefore, a long-term effect of instant ramen and kimbab consumption on increasing glycemic response should be studied.

While the type 2 convenience meal (sweet bread and flavored milk) contained higher energy, carbohydrate, and fat than the standard meal and the type 1 convenience meal, satiety of study subjects on the type 2 convenience meal was lowest for 2 hours after consumption of the test meals. Furthermore, our result showed no pattern between glycemic response and satiety. According to the Roberts' review article [12], short-term studies indicated that

Table 1. Area under the curve for postprandial blood glucose after the meals in healthy college students (n = 9)

Area under the curve (mg.min/dL)	Standard meal	Type 1 convenience meal	Type 2 convenience meal	Significance
Total (0–120 min)	1,804.2 \pm 999.5 ^b	4,086.7 \pm 1,128.5 ^a	3,180.0 \pm 1,219.4 ^a	p < 0.05
Left (0–30 min)	483.3 \pm 139.7 ^b	935.0 \pm 228.7 ^a	750.0 \pm 274.3 ^a	p < 0.01
Right (30–120 min)	1,320.9 \pm 974.5 ^b	3,151.7 \pm 1,062.9 ^a	2,430.0 \pm 974.7 ^{a,b}	p < 0.05

Data are shown as mean \pm SD. A standard meal contained cooked rice and side dishes, type 1 convenience meal contained kimbab and instant ramen, and type 2 convenience meal contained sweet bread and flavored milk.

SD, standard deviation.

^{a,b}Mean for control not sharing the same letter in the superscript differs significantly by Tukey's post-hoc test (p < 0.05).

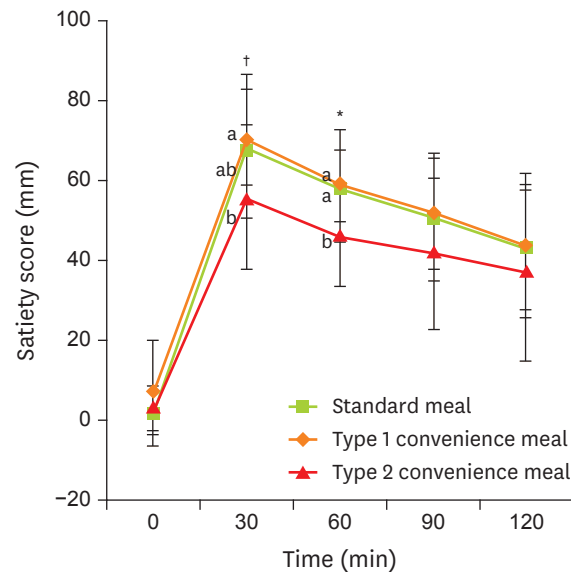


Figure 2. Satiety scores. Values are mean \pm SD (n = 9) reported in millimeters of visual analogue scale for fullness feeling. A standard meal contained cooked rice and side dishes, type 1 convenience meal contained kimbap and instant ramen, and type 2 convenience meal contained sweet bread and flavored milk. SD, standard deviation. *p < 0.01; †p < 0.05; ^{a,b}Mean for control not sharing the same letter in the superscript differs significantly by Tukey's post-hoc test (p < 0.05).

consumption of carbohydrate sources with high-glycemic index (GI) might increase hunger and promote overeating compared to consumption of foods with a lower GI. However, Flint et al. [13] found that insulin was associated with short-term satiety regulation, but glycemic response showed no effect. Rolls [14] reported that fat provides a high level of energy in a given volume of food; however, when given in equal volumes, carbohydrate (sugar) and fat have similar effects on hunger, satiety, and subsequent food intake when infused intragastrically or ingested in foods by normal-weight, unrestrained young men. Although more data are needed, our results suggested that convenience meals consisted of breads and beverages with high fat and sugars may induce overeating and increase the risk of obesity.

The standard meal provided lower energy than convenience meals purchased from a convenience store and showed lower postprandial glycemic response but higher scores in satiety. A previous study reported that consumption of boiled white rice with mixed grains shows higher satiety rates compared to the boiled white rice, despite having lower calories [9]. Also, dietary fiber has shown to increase satiety [10,15], therefore, the improved glycemic response in the standard diet than in the other diets without its effect on satiety may have been counterbalanced by an increase in fiber intake in the standard diet.

This pilot study is subject to limitations. First, the 2 convenience meals may not be representative of all convenience foods available at convenience store, even though we selected these food items based on previous studies [1,11] and focus group interview. Second, this study examined a single time effect of different meals on glycemic response and satiety. Future studies are needed to investigate long-term effects of convenience meal consumption on glycemic response and health outcome with a large sample size. Third, blood glucose response was only assessed from fingerstick blood samples with one type of glucometer, this would not assure accuracy and reliability of the test. Fourth, the test meal provided to male and female subjects had some differences in total calorie and the composition of carbohydrate, protein, and

fat. However, future studies should consider separate studies by gender or studies investigating a smaller variation in the composition of carbohydrate, protein, and fat.

Despite these limitations, this pilot research suggests that convenience meals may increase glycemic response or induce higher calorie intake among college students. Moreover, college students should limit the consumption of convenience foods for their health and have a nutritionally balanced diet.

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