Analysis of Energy Intake at Breakfast and Physical Activity in College Students Yields the Ideal Breakfast Size

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Abstract

Background and Objective: Skipping breakfast in young adults is a growing nutritional problem in Japan that results in lower energy expenditure in the morning. Here, we examined the relationship between energy intake at breakfast and physical activity to determine the ideal breakfast size (in kcal).
Study Design: Cross-sectional.
Participants: Twenty healthy undergraduate student volunteers (5 males and 15 females), recruited from Shukutoku University, Japan.
Measurable Outcome/Analysis: We assessed dietary intake over the course of seven consecutive days using the dietary recall method. We calculated energy/nutrition intake using standard tables of food composition in Japan. After excluding days of self-reported unusual dietary consumption, the remaining 133 days were analyzed. Intensity of physical activity and step counts were measured with a Polar V800 accelerometer. When recorded activity was 2.0 METs (standing intensity) or higher, it was regarded as "active time." A breakfast-skipping day was defined as no-energy intake before 10:00 am. Data were analyzed with unpaired t-tests and regression analyses.
Results: Active time and step count were significantly lower on days when breakfast was skipped (n = 38/133) than when it was not (active time: 187.6 vs. 267.1 min/day, $p < 0.005$; step count: 6,275 vs. 9,458 steps/day, $p < 0.005$). Linear regression showed a significant positive correlation between energy intake at breakfast and active time. An inverted U-shaped quadratic curve was a better fit than a straight line. The resulting regression formula indicated that an energy intake of 526 kcal would yield the longest active time.
Conclusions: Our study suggests that too little breakfast, as well as too much breakfast, can lead college students to be less physically active. Knowing the ideal morning energy intake and the effects of skipping breakfast can help design more effective nutritional education and maybe reduce breakfast-skipping habits in young adults.

Background and Objective

- Breakfast skipping has been a long-standing nutritional problem among young people in Japan, and little improvement has been seen in more than a decade.
- It is unlikely to be feasible to recommend an ideal balanced breakfast to those who habitually miss breakfast.
- To provide nutritional education for those who do not consume any energy at all for breakfast, it is necessary to indicate how much (in kcal) they need to aim for the first step to maintain their health, but there is little evidence to define a meaningful breakfast in terms of quantity.
- In order to determine the minimum breakfast energy intake required for a healthy lifestyle, we conducted a cross-sectional study on the relationship between physical activity and breakfast energy intake. (Fig. 1)

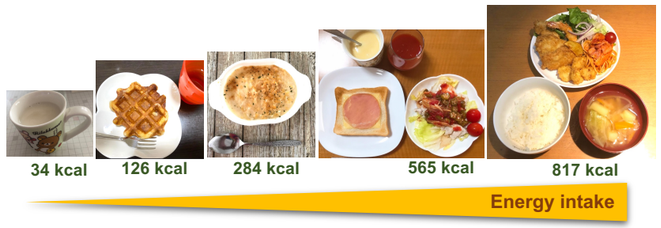

Figure 1. How much (kcal) is enough to make breakfast worthwhile?

Method

Participants

- Twenty healthy undergraduate student volunteers (5 males and 15 females) recruited at Shukutoku University, Japan.

Data collection

- Dietary intake over the course of seven consecutive days using the dietary recall method. In this study, a breakfast-skipping day was defined as no-energy intake before 10:00 am.
- Energy/nutrition intake calculated using standard tables of food composition in Japan 2015 (seventh revised version).
- Intensity of physical activity and step counts were measured using a Polar V800 3D accelerometer and H10 heart rate monitor. Participants wore the device 24 hours a day including during sleep, except when bathing. When recorded activity was 2.0 METs (standing intensity) or higher, it was regarded as "active time." (Fig. 2)

Data analyses and ethics

- Seven days were excluded because of self-reported unusual dietary consumption (e.g., only one meal per day or a day of drinking and eating too much). The remaining 133 days were analyzed.
- All statistical analyses were performed using JMP PRO version 15.0 (SAS Institute Inc., Cary, NC, USA). Data were analyzed using unpaired t-tests and regression analyses. P-values < 0.05 using two-tailed tests were considered statistically significant.
- This research was approved by the Ethics Committee of Shukutoku University (approval number #F19-01).

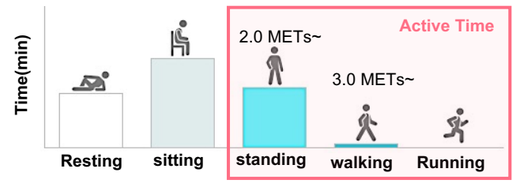

Figure 2. "Definition of active time"

Results

- Average breakfast energy intake was 379 kcal, and the percentage of energy intake at breakfast was 22.5 %.
  The maximum and minimum breakfast energy intake were 1,006 kcal (32.9%) and 23 kcal (1.9 %), respectively. (Table 1).
- Days when breakfast was skipped (n = 38) and days when breakfast was ate (n = 95) was compared,
  active time and step count were significantly lower on days when breakfast was skipped than when it was not (Fig. 3).
- Linear regression showed a significant positive correlation between energy intake at breakfast and active time.
  An inverted U-shaped quadratic curve was a better fit than a straight line (Fig. 4).

Straight line Formula: Active time = 212.3187+0.1188617* Breakfast energy intake

Quadratic curve formula: Active time = 226.16821+0.1544575* Breakfast energy intake -0.0003042(Breakfast energy intake-273.014)^2

- The breakfast energy intake that resulted in the longest active time in this study was 526 kcal (Fig. 4).
- Similarly, regression analysis of the relationship between active time and breakfast energy intake as a percentage of daily energy intake showed a significant correlation with an inverted U-shaped quadratic curve. The percentage of energy intake at breakfast, where active time is the longest, was 34 %.

	correlation coefficient	p-value
Linear straight line	0.228	0.007
Quadratic curve	0.279	0.001

Table 1. Characteristics of participants

	(Average ± SE)
Age	21.5 ± 0.6
Sex	
Male (n)	5
Female (n)	15
BMI	20.9 ± 0.5
Physical activity	
Active time (min/day)	250.2 ± 16.9
Step count (steps/day)	8563 ± 718
Dietary intake	
Total energy intake (kcal/day)	1853 ± 113
Breakfast energy intake (kcal)	379 ± 39
Breakfast energy intake (%)	22.5 ± 1.5

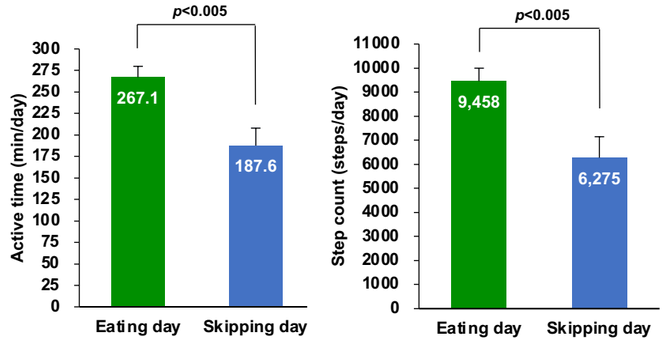

Figure 3. Comparison of physical activity between breakfast eating day and skipping day

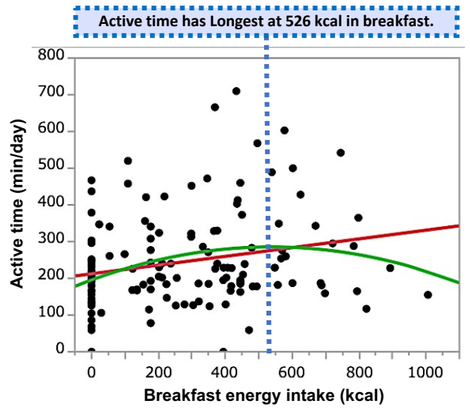

Figure 4. Relationship between energy intake from breakfast and active time

Discussion and Conclusion

- Breakfast skipping and too little breakfast lead college students to be less physically active.
- Just as too little breakfast, too much breakfast can lead college students to be less physically active.
- To increase physical activity, it may be helpful to increase breakfast energy intake to approximately 1/3 of the daily energy intake.
- To nutritionally educate the habitual breakfast skipper, the minimum size of breakfast to improve physical activity should be determined.

Future Research

- We will conduct an intervention study to direct breakfast energy intake and examine the minimum breakfast energy intake that can be expected to increase physical activity compared to breakfast skipping.
- To determine the ideal range of the percentage of daily energy intake that is accounted for by breakfast, we will examine the relationship between higher breakfast energy intake and physical activity.

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