Relationships between eating quickly and weight gain in Japanese university students: A longitudinal study

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Running title: eating quickly and overweight

What is already known about this subject

- A relationship exists between overweight/obesity and eating quickly.

What this study adds

- This longitudinal study confirms the relationship between overweight/obesity and eating quickly in younger populations.
- The results confirm that eating quickly can predict being overweight in Japanese university students.

Abstract

Objective: Many cross-sectional studies have reported a relationship between overweight/obesity and eating quickly, but there have been few longitudinal studies to address this relationship in younger populations. The purpose of this prospective longitudinal study was to investigate whether eating quickly was related to being overweight in Japanese university students.

Design and Methods: Of 1,396 students who underwent a general examination and completed questionnaires at the start of university and before graduation, 1,314 students (676 male and 638 female) of normal body composition [body mass index (BMI) < 25 kg/m^2] at baseline were included in the analysis. The questionnaires included speed of eating and other lifestyle factors. After a 3-year follow-up, the students whose BMIs were ≥ 25 kg/m^2 were defined as overweight.

Results: In this study, 38 participants (2.9%) became overweight. In the logistic regression analysis, the risk of being overweight was increased in males [adjusted odds ratio (OR): 2.77; 95% confidence interval (CI): 1.33-5.79; $p < 0.01$] and in those who ate quickly at baseline (OR: 4.40; 95% CI: 2.22-8.75; $p < 0.001$).

Conclusion: Eating quickly may predict risk of being overweight in Japanese university students.

Introduction

Obesity is defined as abnormal or excessive fat accumulation and is a risk factor for periodontitis, diabetes, ischemic heart disease, stroke, and certain cancers (1-4). A systemic analysis of epidemiological studies from 199 countries show that more than one billion adults worldwide were overweight in 2008, and of these 502 million were obese (5). Furthermore, a simulation model predicts that the prevalence of overweight and obesity will increase (6). More specifically in Japan, this prevalence [body mass index (BMI) $\geq$ 25 kg/m^2] has increased among males (7).

Most cross-sectional studies have found significant positive associations between obesity status and eating quickly (8-16). Eating quickly has been associated with increased total energy intake (17), reduced satiety (18) and insulin resistance (9), and may lead to being overweight or obese (19). A systemic review (20) suggests that the relationship is biologically plausible. However, the review also points out that there are too few longitudinal studies regarding the influence of eating quickly on body weight. Furthermore, this small body of evidence does not establish a positive relationship with obesity. Only one retrospective study has been conducted on a Japanese population (21). The study showed that the relationship between eating quickly and weight change was statistically significant even after adjusting for age and body mass index at baseline, drinking, smoking, and exercise. A limitation in the study was that eating behavior was not confirmed at baseline. Thus, prospective longitudinal studies are needed to confirm whether eating quickly can predict weight gain and obesity.

It is important to evaluate the association between eating quickly and weight gain/obesity in young adults, since control of the risk factors for obesity at an early stage is essential for its prevention (22). Thus, we hypothesized that eating quickly may affect weight gain among young adults. Furthermore, this study focused on the effects of other eating behaviors on weight gain, including skipping breakfast, snacking, irregular meals, fast food intake, and eating until full, since eating behaviors may contribute to weight gain (20). The aim of the present prospective longitudinal study was to explain the associations between weight gain and eating behaviors, specifically eating quickly, in university students.

MATERIALS AND METHODS

Study population

Of 2,087 first-year students who underwent a general examination (pre-university) and completed questionnaires at the Health Service Center of Okayama University in April 2010, 1,396 students volunteered to receive a 3-year follow-up examination before graduation in April 2013 (follow-up rate; 66.9%). For this analysis, we considered participants with a BMI of ≥ 25.0 kg/m^2 as overweight (16). We excluded 82 participants who were overweight (BMI ≥ 25 kg/m^2) at their baseline health examination. Finally, data from 1,314 students (676 male and 638 female; 65.3%) were analyzed. The study was approved by the Ethics Committee of Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences (No. 306). Written consent was obtained from all participants.

Assessment of Overweight/Obesity

In the general health examination, the height and body weight of participants were measured by the university's public health nurses using the Tanita body fat analyser (Model No. BF-220; Tanita Co., Tokyo, Japan). BMI was computed as weight in kilograms divided by height in meters squared (23).

Questionnaire

Participants reported speed of eating relative to others, according to one of four qualitative

categories: slow, normal, fast, and very fast. The validity and reliability of the questionnaire is already confirmed and useful for evaluating associations between self-reported eating speed and obesity (24). We combined fast and very fast responses into a single category of eating quickly and slow and normal responses into a single category of eating slow (8).

For other lifestyle factors, answers were given by participants in a “yes/no” format as follows: an irregular diet (i.e., irregular mealtime), skipping breakfast, eating until full, frequently snacking and/or eating at night, frequently consuming fatty foods, frequently eating green vegetables, frequently eating junk food, frequently eating sweets, frequently drinking (sugar-sweetened) soft drinks, regular physical activity, and habitual drinking (16, 20). The questionnaire was conducted at baseline.

Statistical Analysis

Paired t, unpaired t, Fisher’s exact, and chi-squared tests were used to determine whether there were any significant differences between baseline and re-examination, or normal weight and overweight groups. Using a logistic regression model, both odds ratio (OR) and 95% confidence interval (CI) were calculated. Being overweight at the 3-year follow-up was used as a dependent variable. Gender, eating quickly, and frequently consuming fatty foods at baseline were added as independent variables on multivariate analysis according to the guidelines of a previous study (25). All data were analyzed using the Statistical Package for the Social Sciences (21.0J for Windows; SPSS Japan, Tokyo, Japan).

A $p < 0.05$ was considered statistically significant.

RESULTS

There were no significant differences in prevalence of eating quickly and body composition at baseline between participants who were followed up and those who were not (data not shown). Table 1 shows the characteristics of participants. Overall, 207 male (30.2%) and 198 female (31.0%) participants reported eating quickly. Of the 38 participants (2.9%) who became overweight, none were obese (BMI $\geq$ 30 kg/m^2). There was a significant difference in body composition between baseline and re-examination data ($p < 0.05$).

The relationships between lifestyle factors and being overweight are shown in Table 2. In both male and female participants, a higher prevalence of those who ate quickly was observed in the overweight group compared with the normal weight group ($p < 0.05$). The prevalence of participants who ate quickly and frequently consumed fatty foods was significantly higher in the overweight group than in the normal weight group ($p < 0.05$).

Because of a small number of overweight female participants, further analysis was performed among all participants. On logistic regression analysis, the risk of being overweight after 3 years was significantly affected by gender and eating quickly ($p < 0.01$) (Table 3).

DISCUSSION

Obesity is a risk factor for many diseases (1-4). In Japan, as well as in other countries, the prevalence of overweight/obesity has increased, especially among males (5, 7). To resolve this issue, focusing on eating behaviors, such as eating quickly, is important. Many cross-sectional studies suggest eating quickly relates to overweight/obesity (8-16). However, there are few prospective cohort studies to address this relationship. Our prospective longitudinal study focused on young adults and investigated the effects of eating quickly on becoming overweight, since controlling for overweight/obesity risk factors at an early age is important (22). In this study, the risk of being overweight was significantly increased by eating quickly after adjusting for confounding factors. Our results were supported by previous studies (8-16, 20, 21, 26), and our data suggests that eating quickly predicts the risk of being overweight in young adults.

This study also focused on the effects of other eating behaviors on weight gain, such as skipping breakfast, snacking, irregular meals, fast food intake, eating until full, and frequently consuming fatty foods, because such eating behaviors may contribute to weight gain (20). However, the risk of being overweight after 3 years was not significantly affected by other reported eating behaviors. Although some studies support our data by showing no association between overweight/obesity and eating behaviors as above (20), these previous longitudinal studies obtain heterogeneous results. In some longitudinal studies that show a positive association, skipping breakfast was associated with a $\geq$ 5% increase in BMI after a 1-year follow-up among 598 Japanese male college students (21.6 ±

1.6 years old) (27), and having breakfast reduced the risk of gaining 5 kg over a 10-year period among American males 46 to 81 years of age (28). Self-reported snacking is significantly associated with a higher risk of substantial weight gain (≥ 3 kg/year; ≥ 5 kg/year; ≥ 10% baseline weight) in a longitudinal prospective Spanish dynamic cohort (10,162 university graduates; mean age: 39 years) followed-up for an average of 4.6 years (29). Increased variety of snack consumption is associated with increased risk of becoming overweight (BMI ≥ 23 kg/m^2) in the Hong Kong Chinese population (n=1,010, 45.6 ± 11.7 years) over a 5- to 9-year period (30). Higher consumption of fast food is associated with a 0.20-unit higher BMI in the American population (n=798, 18-30 years) over a 3-year period (31). Eating until full is associated with increased BMI after a 5-year follow-up, but only in healthy Japanese male workers with a high level of self-reported stress (n=668, 46.6 ± 4.1 years) (32). Change in fat intake is positively associated with change in BMI in a China Health and Nutrition Survey (n=3,484, aged 20-45 at baseline) (33). On the other hand, there are no longitudinal studies to address the risk of irregular meals (20). Although eating quickly is not included in the adjustment for potential confounders in previous studies, the discrepancy between our study and previous studies may depend on the difference of study outcome, age, race, number of participants, and follow-up period. Further studies are needed to clarify the relationship between overweight/obesity and eating behaviors.

Possible mechanisms may underlie the relationship between eating quickly and being overweight. The excess energy intake in fast eaters may be related to being overweight because data

have suggested energy intake per day increases with the increase in the rate of eating (34). Next, eating quickly has been associated with a lack of satiety (35). Due to a lack of satiety, eating quickly may cause overeating before the stomach senses fullness. Finally, eating quickly may lead to insulin resistance (34), and eating quickly every day could lead to an intermittent state of decreased insulin sensitivity (34). A possible causal pathway may exist between eating quickly and insulin resistance, disrupted energy balance, and finally being overweight (14).

The Japanese Ministry of Health, Labour, and Welfare introduced a new health check-up system to prevent the onset of diabetes mellitus and metabolic syndromes caused by fat accumulation among adults who are ≥ 40 years old (36). Checking eating speed is included in the guideline questionnaire. Improving eating speed (i.e. eating more slowly) in younger populations may help prevent increased BMI and obesity because BMI increases with age (22). In Japan, health examinations are implemented on a regular basis according to a school health law. Monitoring BMI, interviewing about eating speed, and providing health guidance during regular health examinations might prove useful for not only the middle aged, but also for young populations.

In this study, only 38 participants (2.9%) became overweight, in particular 1.6% of females. In Japan, the prevalence of overweight and obesity (BMI ≥ 25 kg/m^2) has increased among males (7). On the other hand, the prevalence of overweight in the young population (aged 20-29) is lowest among Japanese adults while the prevalence of being underweight is highest in young females. The prevalence of being overweight at baseline in this study was 7.4% for males and 4.5% for females. In

other recent studies of young Japanese subjects, the prevalence of being overweight was 16.7% in males aged 20 to 24 years (37) and 18.5% in males aged 20 to 29 years (7); respective rates for females were 8.5% (37), and 7.2% (7). Other countries show the higher prevalence of overweight in females aged 25-49 than in this study (38). For example, the prevalence in South and Southeast Asia was 13.3%, the lowest in Asia (38). Thus, the small prevalence of overweight students in this study may be reasonable according to Japanese demographics. Although the prevalence of being overweight was low in this study, our data can be valuable for preventing young populations from becoming overweight in the future.

We also investigated the relationship between pre-overweight and eating behaviors using the cut-off points for pre-overweight as per the WHO expert consultation (39), i.e., BMI $\geq$ 23.0 kg/m^2. Only 72 participants (6.1%) became pre-overweight. As a result, eating quickly was significantly associated to pre-overweight ($p < 0.05$). Our data suggests that eating quickly also predicted the risk of being pre-overweight as young adults. Furthermore, we investigated the relationship between obesity and eating behaviors in participants who were already overweight at baseline. Of the 82 participants, 10 participants (12.2%) became obese (BMI $\geq$ 30 kg/m^2) in 2013. There was no significant association between eating quickly and obesity in these participants, but eating until full was related to obesity ($p < 0.05$). Therefore, eating until full, but not eating quickly, may be a risk factor for obesity in young adults who are already overweight.

In order to evaluate eating speed we used four qualitative categories: slow, normal, fast, and

very fast, since our cross-sectional study used the same categories (16) and the validity and reliability of the questionnaire has already been confirmed (14). However, the answer “normal” speed of eating that participants reported compared to others in this study might be subject to individual interpretation. One person’s normal might differ from another’s. Because other studies in this area have used the term “medium” (8-11), we should consider using “medium” in future studies.

We evaluated self-reported eating behaviors at baseline. The validity and reliability of the questionnaire is already confirmed and used for many epidemiological studies (8-16, 20). At re-examination, eating quickly was not confirmed in this study because it is uncertain whether eating speed changed over the 3 years. Although it is unlikely that people who are obese change their eating habits (40), it is unclear whether people who are normal weight altered theirs. This was a limitation to our study.

Our study had other limitations. First, all participants were recruited from students at Okayama University. This may limit the ability to extrapolate these findings to the general population. Second, we cannot deny the possibility that other potential confounding factors, such as total energy intake (8), daily eating frequency (20) and eating out (20), may have affected the observed associations. Because our study was combined with routine health screening, the data obtained were limited and could not survey total energy intake. However, previous studies report that speed of eating is significantly and positively correlated with total energy intake (8, 9). Furthermore, the effects of eating away from home on obesity are discussed in prospective studies (20). Thus, our results may be

relatively unaffected by these limitations. Finally, being overweight was determined with BMI. Although BMI has been widely used to assess general body composition, it is difficult to assess visceral fat.

In conclusion, eating quickly may predict the risk of being overweight in Japanese university students. Evaluation of BMI and eating quickly, and their improvements during regular health examinations, may prove useful in young populations.

Conflicts of interest statement

The authors declare that they have no competing interests.

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