

The impact of eating quickly on anthropometric variables among schoolgirls: a prospective cohort study in Japan

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Background: Because most studies about the relationship between eating quickly and overweight/obesity have been cross-sectional, it is necessary to investigate prospectively the influence of eating quickly on anthropometric variables in order to examine the causal relationship. The aim of the present study was to investigate the impact of eating quickly on anthropometric variables among schoolgirls in a prospective cohort study. **Methods:** We investigated 427 non-overweight/obese schoolgirls from fourth grade (aged 9 or 10 years) in Ina-town, Japan from 2004 to 2006. Physical examinations and a questionnaire survey were conducted in fourth grade and 3 years later (in seventh grade). Height, weight, percent body fat (%BF) and waist circumference (WC) were measured in physical examinations, and information on eating speed was collected in a questionnaire survey. **Results:** The differences in anthropometric variables (body mass index, %BF, WC and waist-to-height ratio) between fourth and seventh grade were significantly greater in girls who continued to eat quickly from fourth to seventh grade than in those who did not continue to eat quickly during this 3-year period. In contrast, these differences were not statistically significant in girls who ate quickly in fourth grade but not in seventh grade compared with those who did not continue to eat quickly during the 3-year period. **Conclusion:** Eating quickly was associated with excess gains in anthropometric variables. The present study also suggested that stopping a habit of eating quickly prevents these excess gains in non-overweight/obese girls, which could contribute to the prevention of childhood overweight and obesity.

Introduction

Obesity in childhood has significant adverse effects on health.¹ Many obese children manifest a number of metabolic complications, such as impaired glucose regulation, hypertension, dyslipidemia, fatty liver disease and systemic low-grade inflammation.² In addition, obese children are more likely than non-obese children to experience psychological or psychiatric problems, and girls are at greater risk than boys.¹ For example, the stigma associated with obesity is thought to be greater for girls than for boys.³ Furthermore, a previous study showed that overweight girls, but not boys, have more symptoms of depression than their normal-weight peers.⁴ Thus, childhood overweight and obesity, particularly among girls, are a serious public health problem.

Obese and overweight girls were reported to have significantly lower self-esteem with regards to their physical appearance and athletic competence compared with normal weight girls.⁵ Moreover, a recent study reported that persistent child and adult obesity in women is associated with poorer employment and relationship outcomes.⁶ Since adolescence is a critical period for the development of obesity, and obesity that begins during this period appears to increase the risk of persistent obesity and its complications,⁷ it is very important to prevent non-overweight/obese girls from becoming overweight/obese before they reach adolescence.

In general, the causes of overweight and obesity among children can be divided into genetic and lifestyle factors. Since lifestyle factors can be changed, it is necessary to improve lifestyles for the prevention of

childhood overweight/obesity. Several studies have shown a relationship between eating quickly and overweight/obesity. For example, rapid eating was reported to be associated with overweight among adolescents and adults,^{8–10} while a high eating speed was identified as a risk factor for obesity in preschool children.¹¹ However, most of these studies have been cross-sectional. Therefore, it is necessary to investigate prospectively the impact of eating speed on anthropometric variables in order to examine the causal relationship between eating quickly and overweight/obesity.

Accordingly, the aim of the present study was to investigate the impact of eating quickly on anthropometric variables among population-based schoolgirls in a prospective cohort study.

Methods

In addition to annual national health checkups performed in accordance with the School Health Law, the town of Ina, which is located in Saitama Prefecture, Japan, has conducted a unique pediatric health promotion programme since 1994. Of the fourth and seventh graders who had undergone regular health checkups, those who volunteered to take part in the programme underwent blood and physical examinations. The present study was conducted as a part of the programme.

Study subjects

Subjects enrolled in this study included all schoolgirls from the fourth grade (aged 9 or 10 years) in Ina-town during 2004–6.

Informed consent to participate in the study was obtained from the parent or guardian of each child. This study was approved by the Medical Ethics Committee of Showa University School of Medicine.

Of 568 schoolgirls, 565 participated in this study at baseline (participation rate: 99.5%). Among the 565 schoolgirls, 507 were followed up (follow-up rate: 89.7%). In the analysis, the following girls were excluded: missing data about anthropometric variables and eating speed (20 children) and overweight or obese at baseline (60 children), as defined by the criteria of the International Obesity Task Force,¹² because of examining the relationship of eating quickly to being overweight/obesity in a prospective cohort study. Thus, 427 non-overweight/obesity girls were analysed in the present study.

Anthropometric measurements

Physical examinations were conducted in fourth grade. The follow-up examinations were performed after 3 years (in seventh grade).

The measurements for height, weight, percent body fat (%BF) and waist circumference (WC) were carried out in the school's infirmary or in a designated room to ensure that the participants' privacy was protected during the procedures. Subjects were asked to remove shoes and socks before the measurements. Height was measured to the nearest 0.1 cm using a stadiometer, and body weight was measured with a scale to the nearest 0.1 kg. Body mass index (BMI) was calculated as weight (kg) divided by height (m) squared. %BF was measured in the morning with a bipedal biometrical impedance analysis device (Model TBF-102, Tanita, Tokyo, Japan) to the nearest 0.1%, over light clothing in a standing position. WC was measured in a standing position at the navel level while another examiner checked verticality from the side. Waist-to-height ratio (WHtR) was calculated as WC divided by height. All anthropometric measurements were performed using the same procedures in fourth and seventh grade.

Questionnaire survey

A questionnaire survey was performed in fourth grade and the follow-up survey was conducted after 3 years (in seventh grade).

A self-administered questionnaire was distributed to each subject by a teacher from the school. Thereafter, the subject completed the questionnaire. The questionnaire was returned to the teacher.

The following information was obtained from each subject: sex, age, exercise other than physical education class (daily, sometimes, or none) and eating speed. The information regarding eating speed was collected according to three qualitative categories (fast, medium or slow) from the question: 'How fast is your eating speed compared to others?'

Data analysis

In accordance with previous studies,^{10,13} self-reported eating speed was divided into two categories: eating quickly (fast) and not eating quickly (medium or slow). The Shapiro–Wilk test was used to test the normality of distribution. A paired *t*-test or McNemar's test was used to compare various characteristics between fourth and seventh grade. An unpaired *t*-test was used to compare anthropometric variables between the 'not eating quickly group' and 'eating quickly group' according to each grade.

Based on eating speed in fourth and seventh grade, patterns of eating speed from fourth grade (at baseline) to seventh grade (3 years later) were classified into the following four groups in longitudinal analysis: 'not eating quickly continued' (not eating quickly at baseline; not eating quickly 3 years later), 'from eating quickly to not eating quickly' (eating quickly at baseline; not eating quickly 3 years later), 'from not eating quickly to eating quickly' (not eating quickly at baseline; eating quickly 3 years later) and 'eating quickly continued' (eating quickly at baseline; eating quickly 3 years later). Analysis of variance with *post hoc* test (dunnet method) was used to

compare the following three items in the 'not eating quickly continued' group with those in the other groups ('from eating quickly to not eating quickly' group, 'from not eating quickly to eating quickly' group and 'eating quickly continued' group): anthropometric variables at baseline, 'anthropometric variables 3 years later' and 'the difference in these variables between baseline and 3 years later'.

Analysis of covariance (ANCOVA) was performed using the difference between baseline and 3 years later in each anthropometric variable as a dependent variable, patterns of eating speed as an independent variable, and age and exercise at baseline as covariates. A *P*-value less than 0.05 was considered statistically significant. All statistical analyses were performed using Statistical Analysis System (Version 9.2).

Results

Characteristics of the study participants (*N*=427) in fourth and seventh grade are documented in table 1. All anthropometric variables were significantly different between fourth and seventh grade; height, weight, BMI, %BF and WC were significantly higher or heavier in seventh grade compared with fourth grade, whereas WHtR was significantly lower in seventh grade. There was a statistically significant difference between fourth graders and seventh graders in exercise. The proportion of girls eating quickly in seventh grade was higher than that in fourth grade.

Table 2 shows a comparison of anthropometric variables between the not eating quickly and eating quickly groups, according to grade. In fourth grade, a statistically significant difference was only observed in WC. In contrast, all anthropometric variables were significantly higher in the eating quickly group compared with the not eating quickly group in seventh grade. Although Wilcoxon rank-sum test was performed to compare 'WHtR in the eating quickly group' with 'it in the not eating quickly group' for seventh graders because the data of WHtR was not normally distributed in both the eating quickly group and the not eating quickly group, WHtR was significantly higher in the eating quickly group than in the not eating quickly group (*P*=0.007). The proportion of overweight/obesity was significantly higher in the eating quickly group than in the not eating quickly group in seventh grade (12.7% vs. 2.2%, *P*<0.001).

Anthropometric variables in fourth grade (baseline) and in seventh grade (3 years later), grouped according to patterns of eating speed from fourth to seventh grade, are shown in table 3. Statistically significant differences in each anthropometric variable at

Table 1 Characteristics of study participants at baseline and 3 years later (*N*=427)

Characteristics	Fourth graders (at baseline)	Seventh graders (3 years later)	<i>P</i> -value ^a
Age (years)	9.5 (0.5)	12.2 (0.4)	<0.001
Height (cm)	134.9 (6.2)	151.7 (5.8)	<0.001
Weight (kg)	29.5 (4.4)	41.7 (6.2)	<0.001
BMI (kg/m ²)	16.1 (1.5)	18.1 (2.0)	<0.001
%BF	15.2 (3.4)	19.9 (4.6)	<0.001
WC (cm)	57.1 (4.2)	63.3 (5.2)	<0.001
WHtR	0.423 (0.028)	0.417 (0.030)	<0.001
Exercise (%)			
Daily	39.8	64.0	<0.001
Sometimes	35.1	10.1	
None	25.2	25.9	
Eating quickly (%)	6.8	12.9	<0.001

Values are means (standard deviation) or percentage.

a: Paired *t*-test or McNemar's test.

Table 2 Comparison of anthropometric variables between the not eating quickly group and eating quickly group according to grade

Variables	Fourth grade			Seventh grade		
	Not eating quickly (n = 398)	Eating quickly (n = 29)	P-value ^a	Not eating quickly (n = 372)	Eating quickly (n = 55)	P-value ^a
BMI (kg/m ⁻²)						
Mean (SD)	16.1 (1.5)	16.5 (1.1)	0.052	17.9 (1.9)	19.0 (2.2)	<0.001
Median (IQR: Q ₃ -Q ₁)	16.0 (17.2-15.0)	16.7 (17.3-16.0)		17.8 (19.1-16.6)	18.7 (20.4-17.5)	
Range (maximum-minimum)	7.5 (19.8-12.3)	4.2 (18.2-14.0)		12.2 (25.4-13.2)	8.8 (24.3-15.4)	
%BF						
Mean (SD)	15.2 (3.5)	15.8 (2.4)	0.236	19.6 (4.5)	21.9 (4.8)	<0.001
Median (IQR: Q ₃ -Q ₁)	14.8 (17.7-12.8)	16.0 (17.7-14.5)		19.3 (22.3-16.7)	21.1 (24.7-19.0)	
Range (maximum-minimum)	19.2 (25.1-5.9)	10.4 (20.4-10.0)		34.2 (39.0-4.8)	20.5 (33.7-13.2)	
WC (cm)						
Mean (SD)	56.9 (4.2)	58.7 (3.8)	0.028	63.0 (5.0)	65.6 (5.7)	<0.001
Median (IQR: Q ₃ -Q ₁)	56.6 (59.3-54.0)	58.2 (60.5-56.4)		62.5 (66.4-59.5)	65.7 (68.8-61.1)	
Range (maximum-minimum)	23.9 (70.5-46.6)	16.9 (67.8-50.9)		32.1 (82.9-50.8)	22.6 (78.2-55.6)	
WHtR						
Mean (SD)	0.42 (0.03)	0.42 (0.03)	0.739	0.42 (0.03)	0.43 (0.03)	0.003
Median (IQR: Q ₃ -Q ₁)	0.42 (0.44-0.41)	0.42 (0.44-0.40)		0.41 (0.43-0.40)	0.43 (0.44-0.41)	
Range (maximum-minimum)	0.15 (0.51-0.36)	0.09 (0.47-0.38)		0.20 (0.54-0.34)	0.17 (0.53-0.36)	

IQR: interquartile range; Q₃-Q₁: 75th percentile-25th percentile.

a: Unpaired t-test.

Table 3 Anthropometric variables at baseline (fourth grade), 3 years later (seventh grade) and the difference in these values between fourth and seventh grade, grouped according to patterns of eating speed from fourth to seventh grade

Variables	Patterns of eating speed from fourth to seventh grade			
	Not eating quickly continued (n = 357)	From eating quickly to not eating quickly (n = 15)	From not eating quickly to eating quickly (n = 41)	Eating quickly continued (n = 14)
BMI (kg/m ⁻²)				
At baseline	16.0 (1.5)	16.6 (1.1)	16.6 (1.3)	16.4 (1.0)
Three years later	17.9 (1.9)	18.9 (1.6)	18.8 ^a (2.1)	19.5 ^a (2.3)
Difference ^b	1.8 (1.2)	2.3 (1.0)	2.2 (1.3)	3.1 ^a (1.8)
%BF				
At baseline	15.1 (3.6)	15.9 (2.7)	16.1 (2.8)	15.6 (2.2)
Three years later	19.5 (4.5)	21.4 (4.1)	21.6 ^a (4.7)	22.9 ^a (5.2)
Difference ^b	4.5 (3.2)	5.5 (2.4)	5.4 (3.4)	7.3 ^a (4.4)
WC (cm)				
At baseline	56.9 (4.3)	58.9 (3.5)	57.7 (3.3)	58.5 (4.2)
Three years later	62.9 (5.0)	65.8 (3.6)	64.9 ^a (5.5)	67.7 ^a (5.8)
Difference ^b	6.0 (3.5)	6.9 (3.5)	7.2 (4.3)	9.2 ^a (4.2)
WHtR				
At baseline	0.42 (0.03)	0.42 (0.03)	0.43 (0.02)	0.42 (0.03)
Three years later	0.42 (0.03)	0.42 (0.03)	0.43 (0.04)	0.44 ^a (0.03)
Difference ^b	-0.75*10 ⁻² (0.03)	-0.33*10 ⁻² (0.02)	-0.10*10 ⁻² (0.03)	0.02 ^a (0.03)

Values are mean (SD).

a: Statistically significant difference at $P < 0.05$ when compared with 'not eating quickly continued' by analysis of variance with *post hoc* test (Dunnett method).

b: Difference between variable from baseline to 3 years later.

baseline were not observed between the 'not eating quickly continued' group and the other groups. The differences in the values for all of the anthropometric variables between baseline and 3 years later were significantly larger in the 'eating quickly continued' group compared with the 'not eating quickly continued' group. BMI, %BF and WC at 3 years later were significantly larger in the 'from not eating quickly to eating quickly' group than in the 'not eating quickly continued' group. In contrast, the differences in each anthropometric variable from baseline to 3 years later and each anthropometric variable at 3 years later were not statistically significant between the 'from eating quickly to not eating quickly' group and the 'not eating quickly continued' group. There was a statistically significant difference in the proportion of overweight/obesity in seventh grade among patterns

of eating speed; 2.2% in the 'not eating quickly continued' group, 0% in the 'from eating quickly to not eating quickly' group, 14.6% in the 'from not eating quickly to eating quickly' group and 7.1% in the 'eating quickly continued' group.

Next, we performed an ANCOVA to examine the effect of eating speed on the gain in each anthropometric variable from baseline to 3 years later, adjusting for age and exercise at baseline (table 4). The adjusted differences in the gains in the anthropometric variables (BMI, %BF, WC and WHtR) in the 'eating quickly continued' girls and 'not eating quickly continued' girls were 1.05 kg/m⁻², 2.46%, 3.09 cm and 0.03, respectively, which were statistically significant. Moreover, significant differences in gains in anthropometric variables were observed in the 'from not eating quickly to eating quickly' group (BMI: 0.45 kg/m⁻², %BF: 1.13%, WC: 1.39 cm,

Table 4 Adjusted differences^a in the change in each anthropometric variable from fourth grade (at baseline) to seventh grade (3 years later) between the 'not eating quickly continued' group (reference) and the other patterns of eating speed

Variables	Patterns of eating speed from fourth grade to seventh grade			
	Not eating quickly continued (n = 357)	From eating quickly to not eating quickly (n = 15)	From not eating quickly to eating quickly (n = 41)	Eating quickly continued (n = 14)
BMI (kg/m ⁻²)	Reference	0.55 (-0.09 to 1.19)	0.45 ^b (0.05–0.84)	1.05 ^b (0.38–1.72)
%BF	Reference	1.21 (-0.50 to 2.92)	1.13 ^b (0.07–2.19)	2.46 ^b (0.67–4.24)
WC (cm)	Reference	0.70 (-1.19 to 2.60)	1.39 ^b (0.22–2.56)	3.09 ^b (1.12–5.07)
WhtR	Reference	0.03*10 ⁻¹ (-0.01 to 0.02)	0.01 ^b (0.02*10 ⁻² –0.02)	0.03 ^b (0.01–0.04)

Values are adjusted differences (95% confidence intervals).

a: Adjusted for age and exercise at baseline.

b: Statistically significant difference at $P < 0.05$ by analysis of covariance.

WhtR: 0.01), as compared with the 'not eating quickly continued' group. In contrast, the adjusted differences in the gain in each anthropometric variable between the 'from eating quickly to not eating quickly' girls and 'not eating quickly continued' girls were not statistically significant.

Discussion

The present study showed the relationship between eating quickly and anthropometric variables among population-based schoolgirls. BMI, %BF, WC and WhtR were significantly higher in the eating quickly group compared with the not eating quickly group in seventh grade, while WC was significantly higher in the eating quickly group compared with the not eating quickly group in fourth grade (table 2). In addition, the proportion of overweight/obesity in the eating quickly group was significantly higher than that in the not eating quickly group in seventh grade (12.7% vs. 2.2%, $P < 0.001$). Some cross-sectional studies have shown a statistically significant positive association between rate of eating and BMI,^{14,15} and a recent study reported that eating rapidly was associated with a larger WC.¹⁶ Furthermore, eating quickly was reported to be associated with overweight or obesity among children and adolescents.^{8,11} Therefore, the results from the present study are consistent with those from previous studies.

In the present study, the differences in anthropometric variables (BMI, %BF, WC and WhtR) between fourth and seventh grade were significantly larger in girls who ate quickly in both fourth and seventh grade ('eating quickly continued' girls) compared with those who did not eat quickly in both fourth and seventh grade ('not eating quickly continued' girls) (table 3). These results persisted even after adjusting for age and exercise in fourth grade in the analysis (table 4). In a retrospective longitudinal study, the relationship between eating fast and weight change was statistically significant, demonstrating that the speed of eating is related to the rate of weight gain.¹⁵ Although the study involved retrospective observation and it was conducted among adults, our current findings in girls are not inconsistent with their results. A recent study reported that energy intake per day increased significantly with an increase in the rate of eating.¹⁴ Therefore, it is possible that total energy intake during the 3 years from fourth to seventh grade was greater among girls in the 'eating quickly continued' group compared with those in the 'not eating quickly continued' group, resulting in the observed differences in the change in each anthropometric variable. Since total energy intake was not assessed in our study, further studies will be needed to verify the current findings.

In comparison to girls in the 'not eating quickly continued' group, the differences in anthropometric variables at seventh grade and these at fourth grade were significantly larger in girls in the group that did not eat quickly in fourth grade but ate quickly in seventh grade ('from not eating quickly to eating quickly' girls). In contrast,

there were no significant differences in the gains in anthropometric variables between girls in the 'not eating quickly continued' group and those who ate quickly in fourth grade but did not eat quickly in seventh grade ('from eating quickly to not eating quickly' girls). These findings led us to two conclusions. The first is that non-overweight/obese girls may have excess gains in anthropometric variables if they begin to eat quickly during the 3-year period from fourth to seventh grade. Secondly, stopping a previous habit of eating quickly during this 3-year period may prevent excess gains in anthropometric variables in schoolgirls, which could contribute to the prevention of overweight/obesity. This conclusion is supported by the finding that the proportion of overweight/obese girls from fourth grade to seventh grade was lower in the 'from eating quickly to not eating quickly' group than in the 'eating quickly continued' group in the present study (0% vs. 7.1%).

To the best of our knowledge, our study is the first to investigate prospectively the impact of eating speed on anthropometric variables (BMI, %BF, WC and WhtR) and to examine the relationship between eating quickly and being overweight/obese among population-based schoolgirls. The strength of this study is that the follow-up rate was approximately 90%. Moreover, all anthropometric variables including %BF and WC, which are not usually measured in annual health examinations at elementary schools and at junior high schools in Japan, were based on direct measurements in our study. There are, however, a few limitations in the present study. First, since the information on eating quickly was collected by a self-administered questionnaire, it might not be objective and the self-reported eating speed might affect the reliability of the change of eating speed. For instance, the subjects who changed their eating speed during 3 years may have both 'those who actually changed it' and 'those who did not change it but misunderstood the question and then response the other eating speed'. Therefore, our findings would have been stronger if we had used objective methods, such as laboratory-based measurements, to evaluate eating speed;¹⁷ however, it would be difficult to apply this methodology to a population-based cohort study such as the current study. Furthermore, Sasaki *et al.* showed a high level of concordance between self-reported rate of eating and rate of eating reported by a friend,¹⁵ and a recent study showed that the reproducibility of self-reported eating quickly was reasonably good.¹⁰ Secondly, the impact of eating speed on anthropometric variables could differ by anthropometric variables at baseline. For example, the difference in BMI during 3 years for lean subjects at baseline might be larger than that for normal weight subjects at baseline. However, even if each anthropometric variable at baseline was adjusted in the analysis in table 4, the study results still remained. Furthermore, the results persisted even when the analysis was limited to normal weight subjects at baseline (thin subjects at baseline, who were defined by the cut-off points for thinness in children and adolescents,¹⁸ were excluded from the analysis). Thirdly, the exact time

that the change in eating behaviour occurred during the 3 years from fourth to seventh grade was not determined in our study. For example, some girls who were regarded as 'from not eating quickly to eating quickly' might have started to eat quickly in fifth grade, whereas other girls who were classified in the 'from not eating quickly to eating quickly' group might have begun to eat quickly in sixth grade. In addition, some girls who were categorized into the 'eating quickly continued' group may have stopped eating quickly temporarily in fifth grade but restarted eating quickly in seventh grade, while other girls who were categorized as 'eating quickly continued' might have temporarily stopped eating quickly in sixth grade and restarted in seventh grade. Therefore, future studies will be needed to consider the specific timing in change of eating speed during the follow-up periods. Fourthly, our study results may have been affected by some potential confounding factors. For example, socio-economic status, which has been reported to be associated with childhood overweight or obesity,^{19–21} was not evaluated in the present study, because this item was not included in the questionnaire of our study. Furthermore, some factors such as physical activity status could change one or more times from fourth grade to seventh grade. According to the National Survey Results of the Physical Strength, Exercise Ability and Exercise Habits in Japan, the proportion of those who do not exercise was higher in junior high school girls than in elementary school girls in 2008 and 2009, and the proportion in junior high school girls had increased from 2008 to 2009.²² Therefore, the possibility of residual confounding is not deniable in this study. Finally, this prospective cohort study results were based on the data of schoolgirls from one town. Thus, further longitudinal studies will be required to apply the present study results to boys and schoolgirls in other areas, although recent cross-sectional studies have shown that eating quickly was associated with anthropometric variables and overweight/obesity for each sex in other areas.^{8,10,14,15}

In conclusion, eating quickly was associated with excess gains in anthropometric variables. The present study also suggested that stopping a habit of eating quickly is the key to prevent non-overweight/obese girls from excess gain in anthropometric variables, which could contribute to the prevention of childhood overweight and obesity.

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Conflicts of interest: None declared.

Key points

- The impact of eating quickly on anthropometric variables (BMI, %BF, WC and WHtR) was investigated prospectively among schoolgirls.
- Eating quickly was associated with excess gains in the anthropometric variables.
- Stopping a habit of eating quickly prevents schoolgirls from excess gains in the anthropometric variables, which could

contribute to the prevention of childhood overweight and obesity.

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