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Eating until feeling full and rapid eating both increase metabolic risk factors in Japanese men and women

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Abstract

Objective: To investigate the association between eating behaviour and metabolic risk in the broader population.
Design: The association between metabolic risk factors (overweight, hypertension, hyperglycaemia, hypertriacylglycerolaemia, low HDL cholesterol, hyperuricaemia and fatty liver) and various eating behaviours were compared for four groups defined by subjective reporting: not eating until feeling full and not eating rapidly (G1); eating until feeling full only (G2); eating rapidly only (G3); and eating both rapidly and until feeling full (G4).
Setting: A medical centre for health examinations in Tokyo, Japan.
Subjects: Men (*n* 8240) and women (*n* 2955) who underwent health examinations.
Results: The distribution of participants in G1 to G4 was 49·8%, 11·5%, 26·3% and 12·4% among men and 55·3%, 15·0%, 19·0% and 10·7% among women, respectively. Compared with G1, the age-adjusted OR (95% CI) for overweight were significantly higher in G2 to G4, being respectively 1·85 (1·58, 2·17), 1·98 (1·76, 2·23) and 3·46 (2·99, 4·01) for men and 2·20 (1·62, 2·97), 2·59 (1·97, 3·39) and 3·12 (2·27, 4·26) for women. The age-adjusted OR were also significantly higher for hypertriacylglycerolaemia, hyperuricaemia and fatty liver in G2 and for all risks in G3 and G4 among men; and for hyperuricaemia in G2, for hyperglycaemia, hypertriacylglycerolaemia and fatty liver in G3 and for hypertriacylglycerolaemia and fatty liver in G4 among women.
Conclusions: Both eating until feeling full and eating rapidly increase metabolic risk factors. Although the mechanism between rapid eating and metabolic risk requires further exploration, eating slowly and ending meals shortly before feeling full are important public health messages for reducing metabolic risk factors.

Keywords
Eating behaviour
Metabolic risk factor

Obesity-related disorders constitute a major global health burden[1]. Weight reduction deserves first priority in individuals with obesity and metabolic syndrome[2], and certain eating behaviours may increase metabolic risk[3]. However, people living in today's fast-paced society tend to do many things, including eating, in a hurried manner. While eating is one of life's simple pleasures, some people tend to overeat when opportunities permit. Traditional Japanese maxims concerning eating include 'Eat only until you are eighty per cent full' and 'Eat slowly'. Although little data exist on eating behaviours in the general population at large and the extent of metabolic risks, the Japanese government and companies encourage periodic health examinations, providing an opportunity to investigate eating behaviours and the associated metabolic risks for a large population.

Materials and methods

Participants and data collection

Participants comprised 8240 men (mean age 51·6 (SD 9·4) years) and 2955 women (mean age 52·9 (SD 10·1) years) who underwent health examinations at a medical centre in Tokyo. Most examinees were government employees and office workers whose examination expenses were subsidized by their employers. Before examinations, participants completed a simple questionnaire on eating behaviour, which included the following items: (i) whether they ate until feeling full; and (ii) whether they felt that they ate rapidly compared with other people. Both male and female participants were divided into four groups to investigate potential links between subjective evaluations of eating behaviour and objective metabolic

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risk factors: those who reported not eating until feeling full and not eating rapidly (G1); those who ate until feeling full but did not eat rapidly (G2); those who ate rapidly but did not eat until feeling full (G3); and those who both ate until feeling full and ate rapidly (G4).

Measurements

Participants were examined after overnight fasting. Body height and weight were measured by an automatic weight scale (Tanita Company, Tokyo, Japan), and BMI was calculated. Blood pressure was measured with the participant in a seated position by an electronic sphygmomanometer. Levels of plasma glucose, serum TAG, HDL cholesterol (HDL-C) and uric acid were measured by an autoanalyser (LABOSPECT; Hitachi High Technologies Company, Ibaraki, Japan) using enzymatic methods. Abdominal ultrasonographic examination was performed using an SAA-250A device (Toshiba, Tokyo, Japan).

Definitions of metabolic risk factors

The following definitions were used in the present study: (i) overweight as BMI $\geq 25\,kg/m^2$; (ii) hypertension as systolic blood pressure $\geq$130 mmHg and/or diastolic blood pressure $\geq$85 mmHg[2]; (iii) hyperglycaemia as plasma glucose $\geq$100 mg/dl[2]; (iv) hypertriacylglycerolaemia as serum TAG $\geq$150 mg/dl[2]; (v) low HDL-C as serum HDL-C $<$40 mg/dl for men and $<$50 mg/dl for women[2]; (vi) hyperuricaemia as serum uric acid $>$7 mg/dl; and (vii) fatty liver as bright liver, increased liver echotexture compared with kidneys, vascular blurring and deep attenuation of liver on ultrasonography[4].

Statistical analyses

The ages among the four groups were compared by ANOVA. The prevalence of metabolic risks among the four groups was compared by the χ^2 test. The age-adjusted odds ratios for metabolic risk factors of G1 to G4 were compared by logistic regression, with G1 as the reference category. The JMP statistical software package version 4 (SAS Institute Inc., Cary, NC, USA) was used in analyses.

Results

Distribution of participants, ages and prevalence of metabolic risk factors classified by eating behaviour

Men

G1 constituted just under half the male population (49·8%), while G3 constituted the second largest sector (26·3%). There were significant differences in age and prevalence of all metabolic risk factors among the four groups. G4 was slightly younger than the other groups, while G1 had the lowest prevalence of all metabolic risk factors (Table 1).

Women

For women as well, G1 constituted the largest segment (55·3%), followed by G3 (19·0%). There were significant differences in age and prevalence of overweight, hypertriacylglycerolaemia and fatty liver among the four groups. G4 was slightly younger than the other groups, while G1 had the lowest prevalence of the metabolic risk factors that showed significant differences among the groups (Table 2).

Age-adjusted OR (95% CI) of metabolic risk factors classified by eating behaviour

Men

Compared with G1, the age-adjusted OR (95% CI) for overweight were significantly higher in G2 to G4, being 1·85 (1·58, 2·17), 1·98 (1·76, 2·23) and 3·46 (2·99, 4·01) respectively. In addition to overweight, the age-adjusted OR were also significantly higher for hypertriacylglycerolaemia, hyperuricaemia and fatty liver (OR = 1·26–1·44) in G2, and for all metabolic risks in G3 (OR = 1·25–1·69) and G4 (OR = 1·30–2·31; Table 3).

Table 1 Distribution of participants, age and prevalence of metabolic risk factors among men classified by eating behaviour, Tokyo, Japan

	Eating behaviour				
	G1	G2	G3	G4	*P* value
n	4101	949	2168	1022	
Distribution (%)	49·8	11·5	26·3	12·4	
Age (years)					
Mean	52·5	49·9	51·9	49·0	<0·0001
SD	9·6	9·7	8·7	9·3	
Overweight (%)	19·4	31·5	32·4	46·6	<0·0001
Hypertension (%)	37·9	38·8	44·8	41·8	<0·0001
Hyperglycaemia (%)	39·9	40·5	45·6	46·1	<0·0001
Hypertriacylglycerolaemia (%)	22·3	27·5	29·3	34·6	<0·0001
Low HDL-C (%)	9·3	9·8	11·9	13·3	<0·001
Hyperuricaemia (%)	18·3	22·4	22·1	26·0	<0·0001
Fatty liver (%)	31·0	40·0	43·3	51·8	<0·0001

G1, not eating until feeling full and not eating rapidly; G2, eating until feeling full only; G3, eating rapidly only; G4, eating both rapidly and until feeling full; HDL-C, HDL cholesterol.

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Table 2 Distribution of participants, ages and prevalence of metabolic risk factors among women classified by eating behaviour, Tokyo, Japan

	Eating behaviour				
	G1	G2	G3	G4	*P* value
n	1635	442	562	316	
Distribution (%)	55·3	15·0	19·0	10·7	
Age (years)					
Mean	53·2	52·3	53·3	51·1	<0·005
SD	10·4	9·7	9·7	9·6	
Overweight (%)	8·7	17·2	19·8	22·8	<0·0001
Hypertension (%)	26·6	26·9	29·4	28·8	NS (0·58)
Hyperglycaemia (%)	18·4	17·0	23·1	18·7	NS (0·055)
Hypertriacylglycerolaemia (%)	6·8	5·9	10·3	9·2	<0·05
Low HDL-C (%)	10·9	9·7	13·4	13·9	NS (0·14)
Hyperuricaemia (%)	0·6	1·6	1·4	0·6	NS (0·15)
Fatty liver (%)	12·6	14·3	18·7	23·1	<0·0001

G1, not eating until feeling full and not eating rapidly; G2, eating until feeling full only; G3, eating rapidly only; G4, eating both rapidly and until feeling full; HDL-C, HDL cholesterol.

Table 3 Age-adjusted odds ratios and 95 % confidence intervals of metabolic risk factors among men classified by eating behaviour, Tokyo, Japan

	Eating behaviour							
	G1		G2		G3		G4	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Overweight	1·00	Ref.	1·85***	1·58, 2·17	1·98***	1·76, 2·23	3·46***	2·99, 4·01
Hypertension	1·00	Ref.	1·12	0·96, 1·29	1·36***	1·22, 1·51	1·30**	1·13, 1·50
Hyperglycaemia	1·00	Ref.	1·10	0·95, 1·27	1·29***	1·16, 1·43	1·44***	1·25, 1·65
Hypertriacylglycerolaemia	1·00	Ref.	1·27**	1·08, 1·50	1·43***	1·27, 1·61	1·75***	1·51, 2·04
Low HDL-C	1·00	Ref.	1·04	0·81, 1·31	1·30**	1·10, 1·54	1·44**	1·16, 1·77
Hyperuricaemia	1·00	Ref.	1·26*	1·06, 1·49	1·25**	1·10, 1·42	1·54***	1·31, 1·81
Fatty liver	1·00	Ref.	1·44***	1·25, 1·67	1·69***	1·52, 1·88	2·31***	2·01, 2·66

G1, not eating until feeling full and not eating rapidly; G2, eating until feeling full only; G3, eating rapidly only; G4, eating both rapidly and until feeling full; HDL-C, HDL cholesterol; Ref., referent category.
Significance of OR and 95 % CI: *$P<0·05$, **$P<0·005$, ***$P<0·0001$.

Table 4 Age-adjusted odds ratios and 95 % confidence intervals of metabolic risk factors among women classified by eating behaviour, Tokyo, Japan

	Eating behaviour							
	G1		G2		G3		G4	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Overweight	1·00	Ref.	2·20***	1·62, 2·97	2·59***	1·97, 3·39	3·12***	2·27, 4·26
Hypertension	1·00	Ref.	1·08	0·84, 1·38	1·16	0·93, 1·44	1·29	0·98, 1·70
Hyperglycaemia	1·00	Ref.	0·96	0·72, 1·27	1·37*	1·07, 1·73	1·15	0·83, 1·57
Hypertriacylglycerolaemia	1·00	Ref.	0·86	0·54, 1·33	1·59*	1·13, 2·22	1·57*	1·00, 2·40
Low HDL-C	1·00	Ref.	0·88	0·61, 1·23	1·26	0·94, 1·68	1·31	0·91, 1·86
Hyperuricaemia	1·00	Ref.	2·88*	1·03, 7·61	2·52	0·95, 6·47	1·34	0·20, 5·25
Fatty liver	1·00	Ref.	1·20	0·88, 1·62	1·62**	1·24, 2·10	2·34***	1·72, 3·17

G1, not eating until feeling full and not eating rapidly; G2, eating until feeling full only; G3, eating rapidly only; G4, eating both rapidly and until feeling full; HDL-C, HDL cholesterol; Ref., referent category.
Significance of OR and 95 % CI: *$P<0·05$, **$P<0·005$, ***$P<0·0001$.

Women

Compared with G1, the age-adjusted OR (95 % CI) for overweight were significantly higher in G2 to G4, being 2·20 (1·62, 2·97), 2·59 (1·97, 3·39) and 3·12 (2·27, 4·26) respectively. In addition to overweight, the age-adjusted OR were also significantly higher for hyperuricaemia (OR = 2·88) in G2, for hyperglycaemia, hypertriacylglycerolaemia and fatty liver (OR = 1·37–1·62) in G3, and for hypertriacylglycerolaemia and fatty liver (OR = 1·57 and 2·34) in G4 (Table 4).

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Discussion

In the present study, the number of male participants was larger than that of female participants as men account for a higher percentage of government employees and office workers than women. However, the distribution of eating behaviours was similar in both genders, as about half of them reported eating until feeling full and/or eating more rapidly than others. Although our findings relied on simple self-reporting, the reports may be a true reflection of eating behaviours in daily life. Some people might continue eating after feeling full; it is assumed that those who ate beyond satiety also answered 'yes' for until eating feeling full in the present study.

The reasons for higher metabolic risk among participants who reported eating until feeling full would appear to be relatively straightforward: excessive food intake and overnutrition. However, as one interesting finding, the metabolic risks faced by participants who ate rapidly but not until feeling full were not lower than those of the participants who ate until feeling full but did not eat rapidly. Reports concerning the metabolic risk of rapid eating are extremely rare[5,6]. People who eat rapidly may overeat before the signals of fullness are recognized by the satiety centre of the brain[7–9]. Habitual rapid eaters may also be under greater pressure to limit meal time and return to work than slow eaters. These suppositions would explain why the components of metabolic risk in the participants who reported eating rapidly only were high. Further study is required to clarify the mechanism of increased metabolic risk in habitual rapid eaters. Although people may eat more rapidly during breakfast and lunch due to work-related pressures, we think that one's habit does not change greatly at dinner, i.e. those who eat faster than other people at breakfast and lunch may also eat faster at other times. It is worth noting that behaviour modification is reported as necessary in treating obesity effectively[10].

Although overweight, obesity and diabetes are more common in economically developed countries, the absolute numbers of individuals with these conditions are considerably larger in developing countries. Moreover, the developing regions are also projected to experience much larger increases in population in future years[11,12]. Various individuals and ethnicities may sense 'feeling full' and 'rapid eating' differently. East and South Asians may have perceptions of eating patterns similar to Japanese, suggesting they may share similar patterns of metabolic risk. On the other hand, in Western countries, where food is abundant, cheap and highly flavoured, people may no longer recognize the signals of hunger and satiety. Further exploration of all these issues is necessary.

In any case, increased awareness of one's eating behaviour is a useful public health message. If you eat faster than the average of surrounding people, eating more slowly (e.g. simply by chewing more thoroughly) may be beneficial to your health. Greater study of this important field is desired, as it has the potential to reduce global metabolic risks.

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