Eating and Weight Disorders - Studies on Anorexia, Bulimia and Obesity (2020) 25:91–98
https://doi.org/10.1007/s40519-018-0522-1

ORIGINAL ARTICLE

Association between intensive health guidance focusing on eating quickly and metabolic syndrome in Japanese middle-aged citizens

Daisuke Ekuni[1,2] · Michiko Furuta[3] · Toshihide Kimura[4] · Naoki Toyama[1] · Daiki Fukuhara[1] · Yoko Uchida[1] · Nanami Sawada[1] · Manabu Morita[1]

Received: 26 February 2018 / Accepted: 15 May 2018 / Published online: 7 June 2018

Abstract

Purpose The purpose of this intervention study was to investigate whether intensive health guidance focusing on eating quickly can prevent metabolic syndrome (MetS) more effectively than standard routine guidance in Japanese citizens living in rural areas.

Methods This controlled, non-randomized, intervention study analyzed 141 participants with MetS at baseline. Participants in the intervention group received health guidance focusing on eating quickly and standard health guidance about MetS in accordance with the guidelines of the Ministry of Health, Labour and Welfare in Japan, whereas participants in the control group received only standard health guidance about MetS. The primary study outcome was the prevalence of MetS at a 1-year follow-up.

Results At 1-year follow-up, the prevalence of MetS in the intervention group was significantly lower than that in the control group ($p = 0.003$). The decreases in body weight, body mass index, waist circumference and triglycerides from baseline to 1 year were significantly greater in the intervention group than in the control group ($p < 0.05$).

Conclusion Intensive health guidance focusing on eating quickly is more effective for improving MetS than standard Japanese health guidance alone.

Level of evidence Level II, Evidence obtained from well-designed controlled trials without randomization.

Trial registry name, registration identification number, and URL for the registry UMIN, UMIN000030600, http://www.umin.ac.jp/ctr/index-j.htm.

Keywords Eating quickly · Metabolic syndrome · Intervention studies · Body mass index

Introduction

Although various definitions for metabolic syndrome (MetS) have been published by different organizations, it typically includes abdominal obesity, hypertension, hypertriglyceridemia, hyperglycemia, and dyslipidemia. MetS is a risk factor of cardiovascular and metabolic complications that is associated with cardiovascular disease, type 2 diabetes, and nonalcoholic fatty liver disease [1–4], and thus an important public health target. However, the prevalence of MetS remains high worldwide [5–12]; therefore, it is important to find effective strategies for controlling MetS [13].

Lifestyle change, including eating behaviors, is a recommended strategy to control lipid levels and address-associated metabolic abnormalities [14]. Among eating behaviors, eating quickly has been considered an especially important factor that contributes to the development of obesity and

✉ Daisuke Ekuni
dekuni7@md.okayama-u.ac.jp

1 Departments of Preventive Dentistry, Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, 2-5-1 Shikata-cho, Kita-ku, Okayama 700-8558, Japan

2 Advanced Research Center for Oral and Craniofacial Sciences, Okayama University Dental School, Okayama, Japan

3 Section of Preventive and Public Health Dentistry, Division of Oral Health, Growth and Development, Faculty of Dental Science, Kyushu University, Fukuoka, Japan

4 Mannoucho Kokuho Soda Dental Clinic, Nakatado, Japan

diabetes [15, 16], because eating quickly has been associated with increased total energy intake [17], reduced satiety [18], and insulin resistance [19]. Recent observational studies have shown that in addition to obesity and diabetes, eating quickly is also associated with MetS [20, 21]. However, whether improvements in eating quickly contribute to the prevention of MetS remains unclear.

In 2008, the Japanese Ministry of Health, Labour, and Welfare started a new health care strategy that targeted the early diagnosis of MetS and interventions to decrease its associated morbidity. Under the new health care system, people diagnosed with MetS receive standardized and individualized lifestyle guidance, followed by additional repeated counselling over a 6-month period. However, according to a national survey in Japan, more than 3 million middle-aged people have still MetS [22]. Therefore, more effective preventive strategies are desired to reduce the morbidity associated with MetS. Here, we hypothesize that health guidance combining improvements in eating quickly with or guidance would have additive effects in preventing MetS-related morbidity. The aim of this study was to investigate the effects of health guidance combining improvements in eating quickly with standard guidance on MetS compared with standard guidance alone among participants in the health care system in Japan.

Materials and methods

Residents ($n = 24{,}996$) aged 40–74 years in two adjacent cities in Kagawa Prefecture in Japan were informed of the public health service including MetS checkups; among these residents, 9065 participated in the checkups. Among the residents who were diagnosed with MetS according to the Japanese criteria [23], 259 received health guidance. Inclusion criteria were having MetS and agreeing to participate. Exclusion criteria included the residents who are incapable of participating. After explaining the study aims and procedures, a sufficient number of participants were enrolled on a voluntary basis in both cities ($n = 100$ in one city and $n = 93$ in the other). The recruitment period was from July to October 2009. We excluded participants who dropped out ($n = 43$) and had incomplete data ($n = 9$). Finally, data from 141 participants (mean age, 65.0 ± 6.7 years; range, 41–74 years) were analyzed (Fig. 1). The study protocol was approved by the Ethics Committee of Okayama University Graduate School of Medicine, Dentistry, and Pharmaceutical Sciences (No. 306, 383), and written informed consent was obtained from all participants.

Following the recommendations from the Japanese Committee for the Diagnostic Criteria of MetS [23], we defined MetS as the presence of central obesity [waist circumference (WC) ≥ 85 cm in males or ≥ 90 cm in females], as well as two or more of the following risk factors: lipid abnormality [triglycerides (TG) ≥ 150 mg/dL and/or high-density lipoprotein cholesterol (HDL-C) < 40 mg/dL or use of medications for dyslipidemia], high blood pressure (BP; systolic BP ≥ 130 mmHg and/or diastolic BP ≥ 85 mmHg or use of medications for hypertension), and hyperglycemia [hemoglobin A1c (HbA1c) ≥ 5.2% or use of medications for diabetes] [24].

This was a controlled, non-randomized, intervention study conducted in two cities. The participants in one city were allocated to the intervention group, and those in the

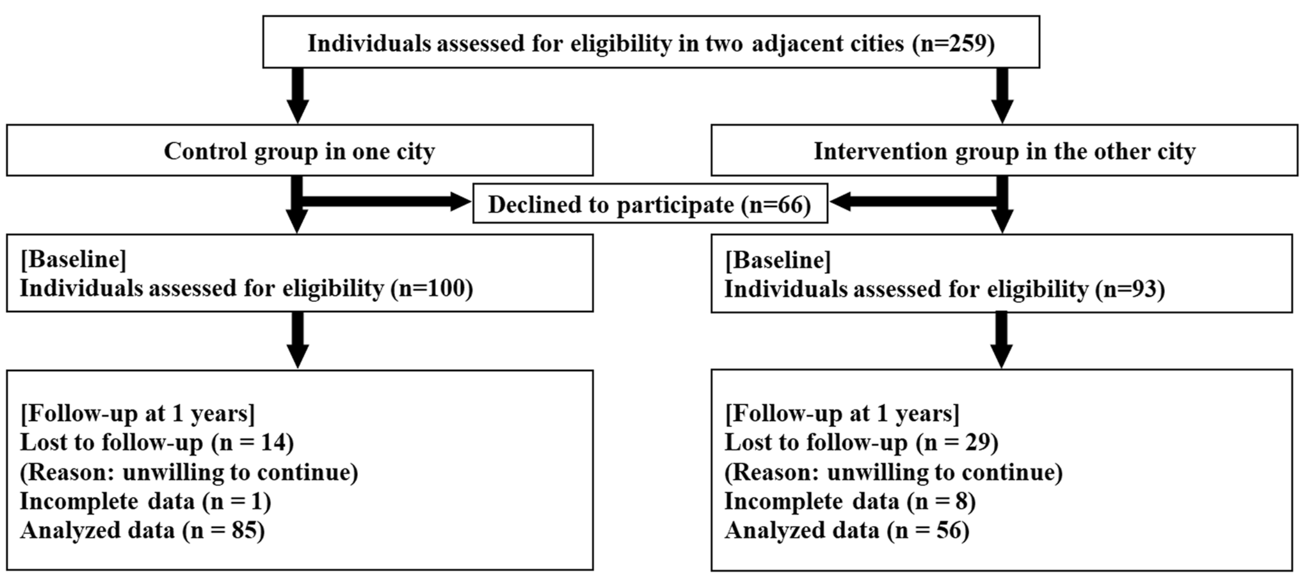

Fig. 1 Flow diagram

other city were allocated to the control group. Both groups were assessed at baseline (July–October 2009) and again at a 1-year follow-up (July–October 2010).

At baseline, the participants in both the control and intervention groups received standard health guidance about MetS in accordance with the guidelines of the Ministry of Health, Labour and Welfare in Japan. Briefly, physicians explained the following: (1) the pathophysiology of MetS; (2) the risk of future cardiovascular events associated with this condition; (3) the rationale for prescribing weight loss; and (4) its importance in the maintenance of each participant's health [25]. Trained nurses and dieticians conducted motivational support at baseline and at 1–3 months. The motivational support included the following: (1) recognition of an unhealthy lifestyle based on the results of participants' health examinations and questionnaires; (2) an explanation of the advantages of having an improved lifestyle and the disadvantages of having an unhealthy lifestyle; (3) guidance regarding nutrition, exercise, and health records to maintain healthy body weight, WC, and levels of physical activity; (4) setting of goals to achieve during the study period; and (5) encouragement for adopting a healthier lifestyle. An intermediate examination was performed at 6 months to check the achievement status of the participants in accordance with the guidelines.

In addition to the standard health guidance about MetS described above, the participants in the intervention group received further health guidance focusing on eating quickly, which included the following: (1) a lecture on the appropriate eating speed for health self-management; and (2) monitoring of the total duration of chewing and number of chews from the start of eating to the first swallow. A dentist (T.K.) performed the 1-h lecture at baseline. The contents of the lecture focused on the importance of mastication for health, appropriate eating speeds, and the ideal number of chews (30 chews) until first swallow. After giving the lecture, the dentist explained how to monitor the total duration of chewing and number of chews until first swallow. Next, the participants received a self-monitoring sheet and checked their behaviors, including the total duration of chewing and number of chews three times a day for 3 months at home, in addition to self-assessments of exercise and body weight.

The primary study outcome was the prevalence of MetS at the 1-year follow-up. Secondary outcomes included changes in body composition, BP, lipid profiles, aspartate aminotransferase, alanine transaminase, creatinine and HbA1c from baseline to 1 year. In addition, we evaluated the participants' lifestyles at follow-up as described below.

In addition to the data about MetS from the two cities, we obtained other clinical data, including body mass index (BMI) and serum levels of low-density lipoprotein cholesterol (LDL-C), aspartate aminotransferase, alanine transaminase, gamma-glutamyl transpeptidase and creatinine.

In addition to sex and age, responses to self-reported questionnaires regarding past and current medical history and lifestyle (i.e., smoking status, regular exercise, restful sleep, walking at least 1 h/day, walking fast, eating late-night dinners, eating a fourth meal, and skipping breakfast) were examined using part of a standardized questionnaire for specific health examinations in "yes/no" format [21]. For the questionnaire item of eating quickly, participants reported their eating speed relative to others, according to one of three qualitative categories: slow, normal, or fast [26]. We combined the "slow" and "normal" responses into the single category of "eating slow" [16]. For habitual drinking habit, the participants reported their frequency of alcohol intake according to one of three categories: every day, sometimes, or rare (no drinking) [27]. We combined the "every day" and "sometimes" responses into the single category of "habitual drinking habit". Furthermore, we asked the participants about their desire to improve their lifestyles according to one of five qualitative categories: "never"; "planning within 6 months"; "planning within 1 month"; "starting within 6 months"; and "starting after 6 months". We then combined the "never", "planning within 6 months" and "planning within 1 month" responses into the single category of "non-improving lifestyle", and the "starting within 6 months" and "starting after 6 months" responses into the single category of "improving lifestyle".

Power analysis and sample size determination were calculated using statistical software (SamplePower ver. 3.0, IBM, Tokyo, Japan) based on the results of a previous study [28]. A two-way table was calculated to detect positive or negative differences in the prevalence of MetS after the interventions. The minimum sample size to detect statistically significant differences in the positive and negative groups was 80 with 80% power and a two-sided significance level of 5%. Assuming an attrition rate of 23.1% [26], the planned sample size was a minimum of 98 participants (49 in each treatment group).

All study personnel, including the clinical examiners, the laboratory staff who performed the blood analyses, and the investigator responsible for the data analysis, were blinded to the treatment assignment. None of the participants were given any information about the other group.

Data were summarized using means (± standard deviations) for continuous variables and frequencies (percentages) for categorical variables. We used an analysis of covariance (ANCOVA) for primary and secondary outcomes. The ANCOVA model included age, sex, BMI, WC, walking habit, walking speed and eating quickly as covariates. Adjusted differences and 95% confidence intervals were determined. *P* values were based on *t* tests comparing continuous parameters between the control and intervention groups from ANCOVA. A per-protocol analysis based on data available both at baseline and the follow-up was performed. The significance level was $p < 0.05$. Data analysis was performed using the Statistical Package for the Social Sciences (SPSS version 23, IBM, Tokyo, Japan).

Results

We analyzed data from 141 participants (follow-up rate: 73.1%). No significant differences were observed for any variables at baseline between participants who were and were not followed up (data not shown). No participants used any medications for dyslipidemia, hypertension, or diabetes at baseline. The intervention in this study was low risk, and no study-related serious adverse events were reported in any of the participants.

Table 1 shows the differences in all variables between the control and intervention groups at baseline. Overall, 39 participants (27.7%) reported eating quickly. The number of participants who reported walking fast at baseline was significantly higher in the intervention group than in the control group ($p = 0.020$).

Differences in binary data between the control and intervention groups at follow-up are shown in Table 2. The prevalence of MetS in the intervention group was significantly lower than that in the control group ($p = 0.003$). The number of participants who had already started improving their lifestyle was significantly higher in the intervention group than in the control group ($p = 0.002$). However, no significant differences were observed between the two groups in the percentage of participants who reported eating quickly ($p > 0.05$).

The decreases seen in body weight, BMI, WC and TG from baseline to 1 year were significantly greater in the intervention group than in the control group ($p < 0.05$) (Table 3). No significant differences were observed between the two groups in any other parameters ($p > 0.05$).

Table 1 Differences between control and instruction groups at baseline ($n = 141$)

Variable	Control ($n = 85$)	Intervention ($n = 56$)	P value[c]
% Male	44 (51.8)[a]	31 (55.4)	0.676
Eating quickly	24 (28.2)	15 (26.8)	0.851
Improving lifestyle	19 (22.4)	11 (19.6)	0.700
Current smoking	10 (11.8)	9 (16.1)	0.464
Regular exercise	29 (34.1)	26 (46.4)	0.143
Restful sleep	73 (85.9)	46 (82.1)	0.549
Walking at least 1 h/day	37 (43.5)	36 (64.3)	0.016
Walking fast	26 (30.6)	28 (50.0)	0.020
Eating fourth meal	21 (24.7)	13 (23.2)	0.839
Late-night dinners	16 (18.8)	8 (14.3)	0.483
Skipping breakfast	7 (8.2)	2 (3.6)	0.268
Habitual drinking habit	20 (23.5)	12 (21.4)	0.771
Age (year)	64.5 ± 6.6[b]	65.8 ± 7.0	0.267
Hight (cm)	157.8 ± 8.7	159.4 ± 9.6	0.304
Body weight (kg)	67.0 ± 8.1	66.6 ± 10.6	0.797
Body mass index (kg/m^2)	26.9 ± 3.1	26.1 ± 3.1	0.136
Waist circumference (cm)	94.1 ± 6.5	93.1 ± 5.8	0.326
Systolic blood pressure (mm Hg)	137.9 ± 16.1	138.0 ± 18.4	0.976
Diastolic blood pressure (mm Hg)	81.3 ± 10.6	82.8 ± 10.9	0.436
Triglyceride (mg/dL)	180.9 ± 84.5	211.4 ± 123.6	0.084
High-density lipoprotein (mg/dL)	49.6 ± 11.4	52.8 ± 12.5	0.113
Low-density lipoprotein (mg/dL)	139.9 ± 32.7	139.5 ± 35.4	0.940
Aspartate aminotransferase (IU/L)	25.2 ± 9.5	26.5 ± 12.6	0.477
Alanine transaminase (IU/L)	27.7 ± 16.3	24.2 ± 14.3	0.191
Gamma-glutamyl transpeptidase (IU/L)	43.3 ± 69.4	35.2 ± 24.5	0.402
Creatinine (mg/dL)	0.7 ± 0.2	0.7 ± 0.2	0.148
Hemoglobin A1c (%)	5.6 ± 0.4	5.6 ± 0.7	0.612

[a]Number (%)

[b]Mean ± SD

[c]Chi-square test or *t* test

Table 2 Differences in binary data between control and intervention groups at follow-up ($n = 141$)

Variable	Control ($n = 85$)	Intervention ($n = 56$)	P value[b]
Metabolic syndrome	59 (69.4)[a]	24 (42.9)	0.003
Eating quickly	20 (23.5)	13 (23.2)	0.966
Improving lifestyle	31 (36.5)	35 (62.5)	0.002
Current smoking	10 (11.8)	6 (10.7)	0.847
Regular exercise	39 (45.9)	32 (57.1)	0.191
Restful sleep	71 (84.5)	42 (76.4)	0.228
Walking at least 1 h/day	36 (42.4)	31 (55.4)	0.130
Walking fast	28 (32.9)	30 (53.6)	0.015
Eating fourth meal	20 (23.5)	8 (14.3)	0.178
Late-night dinners	17 (20.0)	9 (16.1)	0.556
Skipping breakfast	8 (9.4)	3 (5.4)	0.380
Habitual drinking habit	19 (22.4)	12 (21.4)	0.897

[a]Number (%)

[b]Chi-square test

Discussion

As MetS is a risk factor for many diseases [1–4], it has become an important public health target. It is, therefore, important to find effective strategies for controlling MetS [13]. In 2008, the Japanese Ministry of Health, Labour, and Welfare introduced a new health checkup system and health guidance measures to prevent the onset of MetS among adults aged ≥ 40 years. However, whether improvements in eating quickly contribute to the prevention of MetS remains unclear. Therefore, we examined a new strategy, based on the concept of a working hypothesis that eating slowly may decrease total energy intake, induce satiety or improve insulin sensitivity [29]. The results showed that the combination of standard health guidance about MetS and health guidance focusing on eating quickly significantly decreased the prevalence of MetS as well as BMI, WC and TG among middle-aged participants. Our data suggest that the additional effects of health guidance focusing on eating quickly on reducing the prevalence of MetS contribute to public health.

In the intervention group, we implemented health guidance focusing on eating quickly to improve MetS. However, no significant differences were observed between the intervention and control groups in the percentage of participants who reported eating quickly. Nevertheless, in the intervention group, a significant reduction in MetS was seen. The reason for this may depend on the self-monitoring effects of eating behavior. A previous study reported the effects of self-monitoring of risk factors on the prevalence MetS [30]. In the present study, self-monitoring was, therefore, included in health guidance focusing on eating quickly. The participants checked their physical activity levels and body weight, as well as their total duration of chewing and number of chews until first swallow by themselves every day. Furthermore, the number of participants

Table 3 Differences in continuous values between control and intervention groups at follow-up ($n = 141$)

Variable	Control ($n = 85$)	Intervention ($n = 56$)	Adjusted difference[b] (95% confidence interval)	P value[c]
Hight (cm)	157.7 ± 8.6[a]	159.3 ± 9.6	0.072 (− .0196 to 0.339)	0.596
Body weight (kg)	65.7 ± 7.9	63.8 ± 9.7	− 1.987 (− 3.036 to − 0.937)	< 0.001
Body mass index (kg/m^2)	26.5 ± 2.7	25.1 ± 3.0	− 0.741 (− 1.143 to − 0.338)	< 0.001
Waist circumference (cm)	93.4 ± 6.2	88.6 ± 7.2	− 3.942 (− 5.372 to − 2.513)	< 0.001
Systolic blood pressure (mm Hg)	133.5 ± 16.6	131.3 ± 17.1	− 1.232 (− 6.902 to 4.437)	0.668
Diastolic blood pressure (mm Hg)	77.9 ± 10.8	79.0 ± 10.4	− 0.125 (− 3.277 to 3.528)	0.942
Triglyceride (mg/dL)	179.1 ± 117.2	155.9 ± 77.4	− 57.611 (− 94.249 to − 20.972)	0.002
High-density lipoprotein cholesterol (mg/dL)	50.8 ± 12.5	55.0 ± 14.4	1.737 (− 1.187 to 4.660)	0.242
Low-density lipoprotein cholesterol (mg/dL)	140.4 ± 30.8	132.3 ± 35.9	− 6.094 (− 15.343 to 3.154)	0.195
Aspartate aminotransferase (IU/L)	23.2 ± 8.3	23.5 ± 8.7	− 1.711 (− 5.024 to 1.603)	0.309
Alanine transaminase (IU/L)	23.7 ± 12.5	19.8 ± 8.1	− 1.220 (− 6.454 to 4.013)	0.645
Gamma-glutamyl transpeptidase (IU/L)	41.1 ± 71.1	31.1 ± 23.5	− 2.290 (− 7.919 to 3.340)	0.423
Creatinine (mg/dL)	0.7 ± 0.2	0.7 ± 0.1	− 0.009 (− 0.039 to 0.020)	0.532
Hemoglobin A1c (%)	5.5 ± 0.3	5.5 ± 0.5	− 0.048 (− 0.151 to 0.054)	0.351

[a]Mean ± SD

[b]Adjusted for age, sex, Body Mass Index, waist circumference, walking habit, walking speed and eating quickly

[c]Change in each parameter between the control and intervention group based on *t* test from ANCOVA

who had already started improving their lifestyles significantly increased in the intervention study. The aspect of self-monitoring in health guidance focusing on eating quickly may contribute to reducing the prevalence of MetS through improved lifestyles.

After 1 year, the prevalence of MetS decreased by 57.1% in the intervention group and by 30.6% in the control group. Previous Japanese intervention studies reported a 34.7–66.6% decrease in the prevalence of MetS using the same Japanese definition [31–33]. Although both the experimental period and type of intervention were different in the present study, the rate of decrease in the intervention group was within the same range.

In this study, BMI, WC, and TG significantly decreased in intervention group compared with the control group. Improvements in obesity and dyslipidemia (risk factors for MetS) may contribute to a decrease in the prevalence of MetS. Previous studies have also investigated the effectiveness of lifestyle modification approaches for individuals with MetS using dietary and/or exercise interventions [25, 28, 31–35] The changes in WC and BMI in previous studies using a 1-year period [28, 34, 35] were from − 2.2 to − 4.6 cm and from − 0.3 to − 0.6 kg/m^2, respectively. In the present study, these values were − 3.9 cm and − 0.7 kg/m^2, respectively, which were similar to those in the previous studies [28, 34, 35]. Among these studies, repeated interventions involving physical activity and diet modification decreased the serum level of TG among Italian participants [28]. Although the type of intervention in that study was different from that in the present study, the results were similar, which suggests that lifestyle modification approaches that include interventions for eating quickly can contribute to improved lipid profiles. Furthermore, even if we excluded the participants who took lipid-lowering drugs during the period, the results were same.

In this study, the changes in BP and HbA1c did not differ between the two groups. Previous studies have reported various results regarding BP and glycemic control [25, 28, 31–35]. In particular, one study suggested that compared with other components of MetS, it is more difficult to improve BP with repeated counselling, and at least a 5% reduction in body weight may be required to control high BP [25]. Because the participants in our intervention study did not achieve a 5% reduction in body weight, we should seek more effective lifestyle guidance that focuses on controlling BP in patients with MetS. On the other hand, only one previous study reported finding an effect of interventions on glycemic control within a 1-year period [28]. We should, therefore, refer to and combine guidance that includes repeated sessions with individual recommendations from trained professionals (e.g., family physicians, nutritionists, and specialists in endocrinology and internal medicine) to improve hyperglycemia [28].

Eating quickly has been associated with excess body weight [36], increased total energy intake [17], reduced satiety [18], and insulin resistance [19]. A recent observational study showed that changes in eating speed can affect changes in obesity in patients with type 2 diabetes [37]. It also suggests a possibility that interventions to reduce eating speed may be effective in preventing obesity. Further studies are required for establishing an intervention program to effectively improve eating quickly.

A major strength of the present study is its controlled design. Blinding (in participants, examiners, and analysts) was performed to reduce the chance of any biases. In addition, we performed a sample size estimation to obtain the necessary and sufficient number of participants. Finally, we encouraged the participants to complete the study, which resulted in a lower than expected dropout rate.

However, our study did have some limitations. First, all participants were recruited from citizens in two small cities in Kagawa Prefecture. This may limit the ability to extrapolate these findings to the general population. Second, although we attempted to minimize the sampling bias, we could not perform a randomized clinical trial. Third, the attrition rate in this study was 26.9%, which was higher than the estimated rate (23.1%). However, there were no significant differences in parameters of MetS at baseline between the retained and dropout groups. Thus, the bias may be small. Fourth, we did not investigate dietary energy intake. The previous studies report that speed of eating is significantly and positively correlated with total energy intake [19, 38]. In this study, the percentage of participants who reported eating quickly did not change during the period, suggesting that dietary energy intake may be stable. Therefore, we may exclude the effect of changes in dietary energy intake on our results. Finally, the follow-up period was short (1 year). Longer term effects should be investigated in future studies.

In conclusion, health guidance combining improvements in eating quickly with standard guidance significantly reduced the prevalence of MetS compared with standard health guidance only. These results suggest that health guidance focusing on eating quickly may be an effective public health strategy for controlling MetS.

Acknowledgements This work was supported by a Grant from the Ministry of Health, Labour and Welfare, Tokyo, Japan.

Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interests.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

1. Calle EE, Rodriguez C, Walker-Thurmond K, Thun MJ (2003) Overweight, obesity, and mortality from cancer in a prospectively studied cohort of U.S. adults. N Engl J Med 348:1625–1638. https://doi.org/10.1056/NEJMoa021423
2. Clemmensen C, Müller TD, Woods SC et al (2017) Gut-brain cross-talk in metabolic control. Cell 168:758–774
3. Aguilar-Olivos NE, Almeda-Valdes P, Aguilar-Salinas CA et al (2016) The role of bariatric surgery in the management of nonalcoholic fatty liver disease and metabolic syndrome. Metabolism 65:1196–1207. https://doi.org/10.1016/j.metabol.2015.09.004
4. Heinl RE, Dhindsa DS, Mahlof EN et al (2016) Comprehensive cardiovascular risk reduction and cardiac rehabilitation in diabetes and the metabolic syndrome. Can J Cardiol 32:S349–S357
5. Shiwaku K, Nogi A, Kitajima K et al (2005) Prevalence of the metabolic syndrome using the modified ATP III definitions for workers in Japan, Korea and Mongolia. J Occup Health 47:126–135. https://doi.org/10.1539/joh.47.126
6. Grundy SM (2008) Metabolic syndrome pandemic. Arterioscler Thromb Vasc Biol 28:629–636
7. O'Neill S, O'Driscoll L (2015) Metabolic syndrome: a closer look at the growing epidemic and its associated pathologies. Obes Rev 16:1–12. https://doi.org/10.1111/obr.12229
8. Smith CJ, Ryckman KK (2015) Epigenetic and developmental influences on the risk of obesity, diabetes, and metabolic syndrome. Diabetes Metab Syndr Obes Targets Ther 8:295–302
9. Wong-McClure RA, Gregg EW, Barcelo A et al (2015) Prevalence of metabolic syndrome in Central America: a cross-sectional population-based study. Rev Panam Salud Publica 38:202–208
10. Aguilar M, Bhuket T, Torres S et al (2015) Prevalence of the metabolic syndrome in the United States, 2003–2012. JAMA 313:1973. https://doi.org/10.1001/jama.2015.4260
11. Kolovou GD, Anagnostopoulou KK, Salpea KD, Mikhailidis DP (2007) The prevalence of metabolic syndrome in various populations. Am J Med Sci 333:362–371. https://doi.org/10.1097/MAJ.0b013e318065c3a1
12. Cameron AJ, Shaw JE, Zimmet PZ (2004) The metabolic syndrome: prevalence in worldwide populations. Endocrinol Metab Clin North Am 33:351–375
13. Wang J, Ke W, Bao R et al (2017) Beneficial effects of ginger Zingiber officinale Roscoe on obesity and metabolic syndrome: a review. Ann N Y Acad Sci 1398:83–98
14. Jellinger PS, Handelsman Y, Rosenblit PD et al (2017) AMERICAN Association of Clinical Endocrinologists and American College of Endocrinology guidelines for management of dyslipidemia and prevention of cardiovascular disease. Endocr Pract 23:1–87. https://doi.org/10.4158/EP171764.APPGL
15. Sakurai M, Nakamura K, Miura K et al (2012) Self-reported speed of eating and 7-year risk of type 2 diabetes mellitus in middle-aged Japanese men. Metabolism 61:1566–1571. https://doi.org/10.1016/j.metabol.2012.04.005
16. Yamane M, Ekuni D, Mizutani S et al (2014) Relationships between eating quickly and weight gain in Japanese University students: a longitudinal study. Obesity 22:2262–2266. https://doi.org/10.1002/oby.20842
17. Carnell S, Wardle J (2007) Measuring behavioural susceptibility to obesity: validation of the child eating behaviour questionnaire. Appetite 48:104–113
18. Guertin TL (1999) Eating behavior of bulimics, self-identified binge eaters, and non-eating-disordered individuals: what differentiates these populations? Clin Psychol Rev 19:1-23
19. Maruyama K, Sato S, Ohira T et al (2008) The joint impact on being overweight of self reported behaviors of eating quickly and eating until full: cross sectional survey. Br Med J 337:a2002. https://doi.org/10.1136/bmj.a 2002
20. Kral JG, Buckley MC, Kissileff HR, Schaffner F (2001) Metabolic correlates of eating behavior in severe obesity. Int J Obes 25:258–264. https://doi.org/10.1038/sj.ijo.0801469
21. Nohara A, Maejima Y, Shimomura K et al (2015) Self-awareness of fast eating and its impact on diagnostic components of metabolic syndrome among middle-aged Japanese males and females. Endocr Regul 49:91–96. https://doi.org/10.4149/endo_2015_02_91
22. Ministry of Health, Labour and Welfare (2015) Implementation status of specific health examination and specific health guidance in 2013 (Japanese). http://www.mhlw.go.jp/bunya/shakaihosho/iryouseido01/info02a-2.html. Accessed Apr 2017
23. Committee to Evaluate Diagnostic Standards for Metabolic Syndrome (2005) Definition and the diagnostic standard for metabolic syndrome. Nihon Naika Gakkai Zasshi 94:794–809 (Japanese). https://www.ncbi.nlm.nih.gov/pubmed/15865013
24. Hattori T, Konno S, Munakata M (2017) Gender differences in lifestyle factors associated with metabolic syndrome and preliminary metabolic syndrome in the general population: the watari study. Intern Med 56:2253–2259. https://doi.org/10.2169/internalmedicine.8578-16
25. Munakata M, Honma H, Akasi M et al (2011) Repeated counselling improves the antidiabetic effects of limited individualized lifestyle guidance in metabolic syndrome: J-STOP-METS final results. Hypertens Res 34:612–616. https://doi.org/10.1038/hr.2010.272
26. Tajima M, Lee JS, Watanabe E et al (2014) Association between changes in 12 lifestyle behaviors and the development of metabolic syndrome during 1 year among workers in the Tokyo metropolitan area. Circ J 78:1152–1159. https://doi.org/10.1253/circj.CJ-13-1082
27. Zhu B, Haruyama Y, Muto T et al (2013) Evaluation of a community intervention program in Japan using Framingham risk score and estimated 10-year coronary heart disease risk as outcome variables: a non-randomized controlled trial. BMC Public Health 13:219. https://doi.org/10.1186/1471-2458-13-219
28. Bo S, Ciccone G, Baldi C et al (2007) Effectiveness of a lifestyle intervention on metabolic syndrome. A randomized controlled trial. J Gen Intern Med 22:1695–1703. https://doi.org/10.1007/s11606-007-0399-6
29. Reddy NL, Peng C, Carreira MC et al (2015) Enhanced thermic effect of food, postprandial NEFA suppression and raised adiponectin in obese women who eat slowly. Clin Endocrinol (Oxf) 82(6):831–837. https://doi.org/10.1111/cen.12652
30. Stuckey M, Russell-Minda E, Read E et al (2011) Diabetes and technology for increased activity (DaTA) study: results of a remote monitoring intervention for prevention of metabolic syndrome. J Diabetes Sci Technol 5:928–935. https://doi.org/10.1177/193229681100500416
31. Matsuo T, Kim MK, Murotake Y et al (2010) Indirect lifestyle intervention through wives improves metabolic syndrome components in men. Int J Obes 34:136–145. https://doi.org/10.1038/ijo.2009.226
32. Nanri A, Tomita K, Matsushita Y et al (2012) Effect of six months lifestyle intervention in Japanese men with metabolic

syndrome: randomized controlled trial. J Occup Health 54:215–222. https://doi.org/10.1539/joh.11-0238-OA
33. Miyatake N, Fujii M, Miyachi M et al (2010) Changes in metabolic syndrome and its components with lifestyle modification in Japanese men. Intern Med 49:261–265. https://doi.org/10.2169/internalmedicine.49.2900
34. Christian JG, Byers TE, Christian KK et al (2011) A computer support program that helps clinicians provide patients with metabolic syndrome tailored counseling to promote weight loss. J Am Diet Assoc 111:75–83. https://doi.org/10.1016/j.jada.2010.10.006
35. Watanabe M, Yokotsuka M, Yamaoka K et al (2017) Effects of a lifestyle modification programme to reduce the number of risk factors for metabolic syndrome: a randomised controlled trial. Public Health Nutr 20:142–153. https://doi.org/10.1017/S1368980016001920
36. Ohkuma T, Hirakawa Y, Nakamura U et al (2015) Association between eating rate and obesity: a systematic review and meta-analysis. Int J Obes (Lond) 39(11):1589–1596. https://doi.org/10.1038/ijo.2015.96
37. Hurst Y, Fukuda H (2018) Effects of changes in eating speed on obesity in patients with diabetes: a secondary analysis of longitudinal health check-up data. BMJ Open 8(1):e019589. https://doi.org/10.1136/bmjopen-2017-019589
38. Otsuka R, Tamakoshi K, Yatsuya H et al (2006) Eating fast leads to obesity: findings based on self-administered questionnaires among middle-aged Japanese men and women. J Epidemiol 16:117–124