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Large-scale web-based survey on eating behaviour in the Japanese general population using a dietary behaviour questionnaire

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Abstract

Aims: Identifying habitual patterns of eating behaviour underlying obesity is essential for effective weight loss interventions. This study aimed to clarify differences in eating behaviours among obese individuals in a large-scale Japanese population.

Materials and Methods: We analysed data from an online survey completed by 17 766 individuals aged 20–69 years. Eating behaviours were assessed using the Dietary Behaviour Questionnaire from the Japan Society for the Study of Obesity. Differences in the seven eating behaviour domains were examined by sex (Wilcoxon rank-sum test), age (Steel test with the 20s as the reference), and BMI category (Steel–Dwass test), classified as normal weight (18.5 to <25 kg/m^2), overweight (25 to <30 kg/m^2), or obese (≥30 kg/m^2).

Results: Among the normal-weight subjects, females scored higher than males in all domains except 'Way of Eating' and 'Dietary Content', whereas the eating behaviour scores declined with age across all of the domains in both sexes. Across the BMI categories, scores for all of the domains significantly increased with increasing obesity levels in both sexes. Particularly in males, significant differences were also observed between overweight and obese subjects. Additionally, age-related declines in scores were less pronounced among obese individuals. Furthermore, significant positive correlations between scores for all domains and BMI were observed in both sexes, even after adjusting for age.

Conclusions: Our findings revealed significant differences in a wide range of eating behaviours across sex, age, and obesity levels. These results may contribute to the development of evidence-based strategies for the treatment of obesity disease.

KEYWORDS
eating behaviour, obesity, population-based online survey, questionnaire

1 | INTRODUCTION

The prevalence of obesity is increasing worldwide.[1] The World Health Organization (WHO) defines obesity as a body mass index (BMI) of ≥30 kg/m^2. However, due to the greater susceptibility of Japanese individuals to obesity-related diseases, such as type 2 diabetes and cardiovascular diseases, even at lower BMI levels, the Japan Society for the Study of Obesity (JASSO) defines obesity as a BMI of ≥25 kg/m^2, which corresponds to the overweight or preobese category in Western countries.[2] Furthermore, obesity is diagnosed as 'obesity disease' when it is accompanied by obesity-associated health disorders or there is a high risk of their development, thereby necessitating weight reduction.[2,3] Specifically, JASSO defines obesity disease as obesity (BMI ≥25 kg/m^2) accompanied by at least one of 11 obesity-related health disorders and/or visceral fat accumulation (visceral fat area ≥100 cm^2). According to national data, 31.7% of Japanese adult males and 21.0% of Japanese females have a BMI of ≥25 kg/m^2, with the prevalence among males particularly increasing over the past decade.[4] Consequently, obesity has emerged as a significant public health and social issue in Japan.

Weight reduction has been shown to improve various health disorders associated with obesity.[5] Specifically, a 3% reduction in weight has been demonstrated to improve multiple obesity-related clinical parameters, whereas a 5% reduction in weight has been linked to a reduced risk of cardiovascular diseases.[6] Aligning with these findings, the Japanese guidelines recommend a minimum weight loss of 3% for individuals diagnosed with obesity disease.[2] Among various weight loss approaches, previous studies have indicated that in addition to diet and exercise therapy, incorporating behavioural therapy can further enhance weight loss outcomes and support weight maintenance.[7–9] Importantly, obese individuals often exhibit irregular habitual patterns in eating behaviours that they may not fully recognize, which can contribute to weight gain. Therefore, identifying and addressing these behavioural issues is a key aspect of effective intervention.

The Dietary Behaviour Questionnaire from JASSO (JASSO-DBQ), which was developed by Yoshimatsu et al. in the 1990s, consists of 55 questions derived from the actual words and impressions of obese patients.[2] Moreover, the scores obtained from each question are categorised into seven key domains, such as dietary content, meal regularity, and emotional eating; additionally, these domains are subsequently visualised in a diagram, which objectively highlights specific eating behaviour patterns associated with obesity.[2] Therefore, this questionnaire serves as a valuable tool not only for health care professionals involved in weight management interventions but also for obese subjects themselves to promote self-awareness of unhealthy eating behaviours in daily life and support cognitive behavioural therapy.[10]

In addition to obesity levels, various factors such as sex, life stage, and social background are assumed to influence eating behaviours.[11–13] Notably, the National Health and Nutrition Survey in Japan reported that female sex, older age, and higher household income were associated with higher diet quality scores, characterised by greater vegetable intake and better adherence to dietary guidelines.[11] Furthermore, a recent cross-sectional online survey identified significant sex differences in eating-related attitudes and behaviours, including dietary restraint, susceptibility to hunger, disinhibition in overeating, and familiarity with low-calorie foods, which were higher in females.[12] Despite these findings, few studies have comprehensively investigated the associations of these factors with eating behaviours across a wide range of domains, particularly in contemporary Japanese society. In this study, we analysed a large-scale online research database using the JASSO-DBQ to examine differences in eating behaviours according to age, sex, and obesity level.

2 | MATERIALS AND METHODS

2.1 | Study population and sampling procedure

This study utilized data from an anonymous online survey conducted by Cross Marketing Co., Ltd. (Tokyo, Japan) between August 25 and August 29, 2023, including individuals who had preregistered as members of the company's survey panel. Before the study, the target sample size was set at 20 000 respondents from the general public in Japan aged 20–69 years. To better reflect the actual population structure in Japan, the proportions of male and female respondents were separately adjusted to match the distribution in 10-year age increments and across five geographic blocks—(1) Hokkaido/Tokoku, (2) Kanto, (3) Chubu, (4) Kinki, and (5) Chugoku/Shikoku/Kyushu/Okinawa—based on the 2020 Japanese census.[14]

Respondents who worked in or had family members employed in one of the following six occupational categories were excluded before completing the survey and were not included in the final cohort of 20 000 participants, as their professional backgrounds may have influenced their responses due to prior knowledge of the research methodologies: (1) manufacturing (pharmaceuticals, medical products, or cosmetics), (2) wholesale or retail (pharmaceuticals, or medical products, or cosmetics), (3) distribution (department stores, supermarkets, convenience stores, or drugstores, among other distribution sites), (4) media-related industries (television, radio, newspapers, or magazines), (5) consulting or think tanks, or (6) market research companies, advertising agencies, or sales promotion companies.

Of the 20 000 respondents who completed the web-based questionnaire survey, 2234 individuals (786 males and 1448 females) with missing height or body weight data were excluded, thereby resulting in 17 766 respondents included in the final analysis.

2.2 | Data collection and BMI classification

Clinical information, including sex, age, height, and body weight, was obtained via self-reported responses to the questionnaire. BMI was calculated based on self-reported height and body weight measurements and classified into the following four categories: underweight (<18.5 kg/m^2), normal weight (18.5 to <25 kg/m^2), overweight

(25 to <30 kg/m^2, which is the threshold of obesity defined by the JASSO guidelines), and obese (≥30 kg/m^2). Besides, based on the JASSO criteria, subjects with a BMI of 25 to <35 kg/m^2 were classified as 'obesity', and those with a BMI ≥35 kg/m^2 were classified as 'high-degree obesity'.

2.3 | Assessment of eating behaviours

Obesity-related eating behaviours were assessed using the JASSO-DBQ. This questionnaire consists of 55 questions, which are categorized into the following seven major domains of eating behaviour: (1) Perception Regarding Constitution and Body Mass (e.g., 'Do you think it is easier for you to gain weight than others?'), (2) Eating Motives (e.g., 'If food smells and looks good, do you eat more than usual?'), (3) Eating as a Diversion (e.g., 'Do you have the desire to eat when you are irritated?'), (4) Sense of Hunger and Fullness (e.g., 'Do you get irritated when you feel hungry?'), (5) Way of Eating (e.g., 'Do you eat fast?'), (6) Dietary Content (e.g., 'Do you like fatty food?'), and (7) Regularity of Dietary Habits (e.g., 'Is your dinner time too late at night?'). All of the question items were rated on a four-point scale (1. Never, 2. Sometimes, 3. Frequently, and 4. Always), and the questionnaire typically required ∼5 min to complete. To minimize order effects, the sequence of the 55 questions was randomized for each participant.

Because the number of questions used to calculate certain domains differed between males and females, the scores for each eating behaviour domain and the total score were expressed as a percentage of the maximum score.

2.4 | Statistical analysis

All of the values are presented as means ± standard deviations (SDs) and medians (interquartile ranges [IQRs]) or the number of subjects (%). Because age, body weight, BMI values, and eating behaviour scores were not normally distributed, the Wilcoxon rank-sum test was used to compare continuous variables, and the chi-square test was used for categorical variables. The Steel test was used to compare eating behaviour domain scores and total scores across age groups, with the 20s being used as the reference group. Differences in eating behaviour domain scores across BMI categories were examined using the Wilcoxon rank-sum test or the Steel–Dwass test for multiple comparisons. The correlations between BMI and scores for each eating behaviour domain were analysed using Spearman rank correlation coefficient. Additionally, to calculate the age-adjusted correlation between BMI and eating behaviour scores, multiple regression analysis was performed, with log-transformed BMI as the dependent variable and log-transformed eating behaviour scores and log-transformed age as explanatory variables.

For all of the statistical analyses, two-sided tests were conducted, and p values <0.05 were considered to be statistically significant. All of the analyses were performed using JMP Pro 17 (SAS Institute Japan).

3 | RESULTS

3.1 | Characteristics of the study subjects

Table 1 summarizes the characteristics of the 17 766 subjects included in the final analysis. Briefly, the analysed population comprised 9238 males (52.0%) and 8528 females (48.0%). The mean age was 46.5 ± 13.3 years for males and 46.6 ± 13.4 years for females, with the age distribution in 10-year increments being generally consistent with that of the 2020 Japanese census.[14] The mean BMI was significantly higher in males (23.1 ± 3.8 kg/m^2) than in females (20.7 ± 3.5 kg/m^2; $p < 0.001$). With respect to BMI categories, 663 males (3.7%) and 2098 females (11.8%) were classified as underweight, 6215 males (35.0%) and 5541 females (31.2%) as normal weight, 1904 (10.7%) males and 704 females (4.0%) as overweight, and 456 males (2.6%) and 185 females (1.0%) as obese. The distribution of BMI categories significantly differed between the sexes ($p < 0.001$). Notably, the proportion of underweight individuals was higher among females, whereas the proportion of overweight or obese individuals was higher among males.

3.2 | Sex and age differences in eating behaviours among normal-weight subjects

To examine eating behaviours among individuals with a healthy body weight, we first analysed the eating behaviour scores of subjects with normal weight (BMI 18.5 to <25 kg/m^2) according to sex and age. As shown in Table 2, the mean age was significantly higher in females, whereas the mean BMI was significantly higher in males. With respect to eating behaviour, male subjects scored significantly higher in the 'Way of Eating' and 'Dietary Content' domains, whereas female subjects exhibited significantly higher scores in all other domains, as well as in the total score.

Afterwards, we examined differences in eating behaviour domains across age groups among subjects with normal weights, stratified by sex. For both sexes, scores across all eating behaviour domains were significantly lower in males in their 40s, 50s, and 60s (Figure 1), and in females in their 50s and 60s (Figure 2), compared with those in their 20s. Additionally, significant declines from earlier age groups were observed in 'Eating as a Diversion' (Figure 1C) among males, and 'Sense of Hunger and Fullness' (Figure 2D), 'Way of Eating' (Figure 2E), 'Dietary Content' (Figure 2F), and 'Regularity of Dietary Habits' (Figure 2G) among females. These results indicate that eating behaviour scores in normal-weight subjects generally decline with age.

3.3 | Comparison of eating behaviour scores between the normal weight, overweight, and obese subjects

Because the JASSO-DBQ was originally designed to assess the eating behaviour of obese individuals rather than underweight individuals,[2]

TABLE 1 Characteristics of the study subjects.

	Total (n = 17 776)	Males (n = 9238, 52.0%)	Females (n = 8528, 48.0%)	p value
Age (years)	46.6 ± 13.3 (48 [36–58])	46.5 ± 13.3 (47 [36–58])	46.6 ± 13.4 (48 [36–58])	0.391
Body weight (kg)	59.9 ± 13.5 (58.0 [50.0–68.0])	67.5 ± 12.0 (65.7 [60.0–74.0])	51.6 ± 9.5 (50.0 [45.4–56.0])	<0.001
BMI (kg/m^2)	22.0 ± 3.9 (21.4 [19.4–24.0])	23.1 ± 3.8 (22.6 [20.7–25.0])	20.7 ± 3.5 (20.1 [18.5–22.2])	<0.001
Age categories, n (%)				<0.001
20s (20–29 years)	2672 (15.0%)	1406 (7.9%)	1266 (7.1%)	
30s (30–39 years)	3151 (17.7%)	1655 (9.4%)	1486 (8.4%)	
40s (40–49 years)	4222 (23.8%)	2229 (12.6%)	1993 (11.2%)	
50s (50–59 years)	3923 (22.1%)	2047 (11.5%)	1876 (10.6%)	
60s (60–69 years)	3798 (21.4%)	1891 (10.6%)	1907 (10.7%)	
BMI categories, n (%)				<0.001
Underweight (BMI <18.5)	2761 (15.5%)	663 (3.7%)	2098 (11.8%)	
Normal weight (BMI 18.5 to < 25)	11 756 (66.2%)	6215 (35.0%)	5541 (31.2%)	
Overweight (BMI 25 to < 30)	2608 (14.7%)	1904 (10.7%)	704 (4.0%)	
Obese (BMI ≥30)	641 (3.6%)	456 (2.6%)	185 (1.0%)	

Note: The data are presented as the means (±SDs) (the medians [IQRs]) or as the number of subjects (%). BMI, body mass index. The p values were calculated to compare males and females (Wilcoxon rank-sum test for continuous variables and chi-square test for categorical variables).

TABLE 2 Comparison of the eating behaviour scores of normal-weight subjects by sex.

	Males (n = 6215)	Females (n = 5541)	p value
Age (years)	46.2 ± 13.4 (47 [36–58])	46.7 ± 13.4 (48 [36–58])	0.021
Body weight (kg)	63.9 ± 6.7 (64.0 [59.0–68.0])	51.9 ± 5.3 (51.0 [48.0–55.0])	<0.001
BMI (kg/m^2)	21.9 ± 1.7 (21.9 [20.5–23.3])	20.9 ± 1.7 (20.5 [19.5–22.1])	<0.001
Eating behaviour scores (%)			
Perception regarding constitution and body mass	45.8 ± 15.6 (42.9 [32.1–57.1])	51.9 ± 16.6 (50.0 [37.5–62.5])	<0.001
Eating motives	43.9 ± 15.0 (40.0 [32.5–52.5])	46.7 ± 15.2 (44.4 [36.1–55.6])	<0.001
Eating as a diversion	39.6 ± 16.5 (31.3 [25.0–50.0])	45.5 ± 18.4 (43.8 [31.3–56.3])	<0.001
Sense of hunger and fullness	43.6 ± 15.8 (43.8 [31.3–50.0])	44.4 ± 15.3 (41.7 [33.3–54.2])	<0.001
Way of eating	46.5 ± 17.7 (45.0 [30.0–60.0])	45.5 ± 18.2 (40.0 [30.0–55.0])	<0.001
Dietary content	48.8 ± 15.5 (47.2 [36.1–58.3])	47.3 ± 14.8 (46.4 [35.7–57.1])	<0.001
Regularity of dietary habits	44.7 ± 14.4 (43.8 [34.4–53.1])	46.8 ± 14.8 (43.8 [34.4–56.3])	<0.001
Total score	45.1 ± 13.4 (43.1 [35.1–52.7])	47.0 ± 13.2 (45.0 [37.2–55.0])	<0.001

Note: The data are presented as the means (±SDs) (the medians [IQRs]) or as the number of subjects (%). The scores for each eating behaviour domain and the total score were expressed as a percentage of the maximum score. BMI, body mass index. The p values were calculated to compare males and females (Wilcoxon rank-sum test).

we compared the scores for the eating behaviour domains among subjects in the normal-weight, overweight, and obese categories (excluding underweight subjects), stratified by sex (Figure 3 and Table S1). Among both males and females, overweight and obese subjects exhibited significantly higher scores across all of the eating behaviour domains than did normal-weight subjects (p < 0.001). Furthermore, obese male subjects scored significantly higher than overweight subjects in all of the domains (Figure 3A and Table S1). Similarly, among females, scores for the 'Perception Regarding Constitution and Body Mass', 'Dietary Content', and 'Regularity of Dietary Habits' domains were significantly higher in obese subjects than in overweight subjects, and this increasing trend with increasing obesity levels was also observed across the other domains (Figure 3B and Table S1). Within the category of obesity, JASSO specifically defines a BMI of 35 kg/m^2 or higher as high-degree obesity, a threshold at which more intensive intervention is recommended.[11] Among males with high-degree obesity, scores for all eating behaviour domains were significantly higher than in those with obesity (BMI 25 to <35 kg/m^2) (Figure S1 and Table S2). Although the number of female respondents with BMI ≥35 kg/m^2 was limited (n = 52), scores for 'Perception Regarding Constitution and Body Mass' and 'Dietary Content' were also significantly higher in this group (Figure S1 and Table S2).

We then examined age-related changes in eating behaviour scores across BMI categories, stratified by sex. Changes in the total

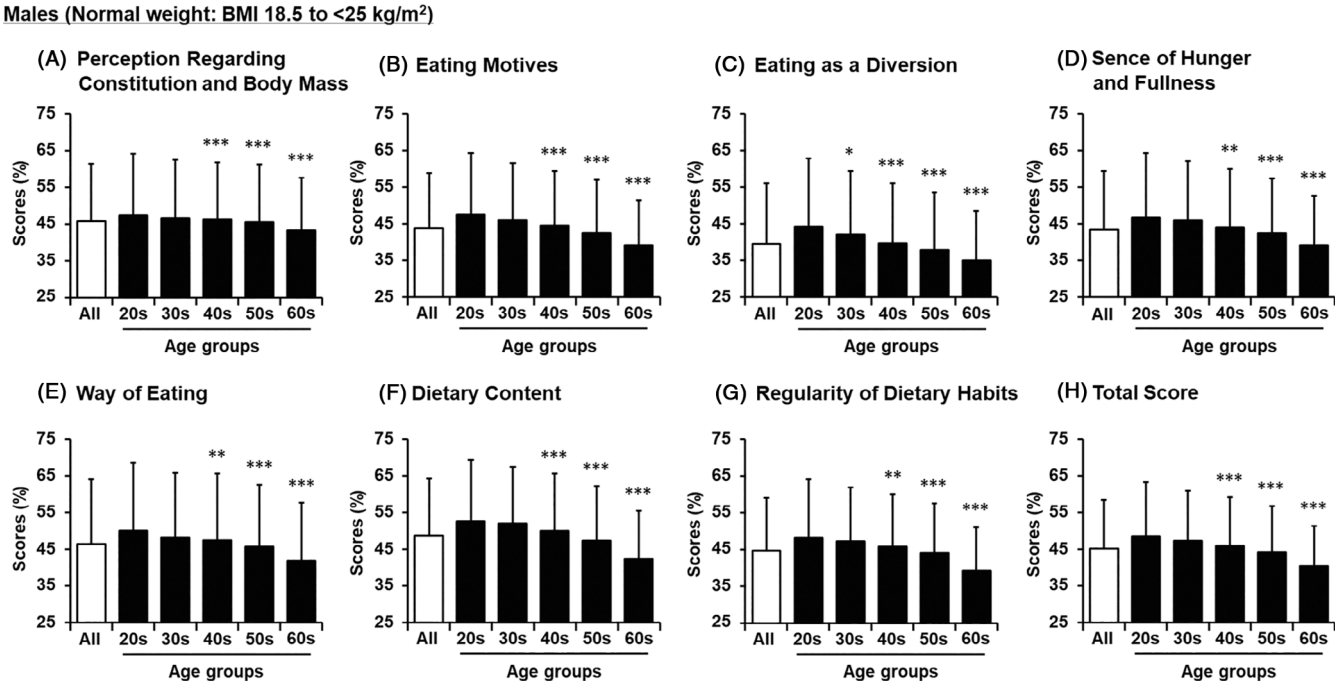

FIGURE 1 Age-stratified comparison of scores for the eating behaviour domains in male subjects with normal weight. (A–H) The scores for each eating behaviour domain for each 10-year age group (black bars) and all male subjects (white bars). The scores for each eating behaviour domain and the total score are expressed as a percentage of the maximum score. The data represent the means (%) ± SDs. $^{*}p < 0.05$, $^{**}p < 0.01$, and $^{***}p < 0.001$ vs. scores for the 20s (Steel test).

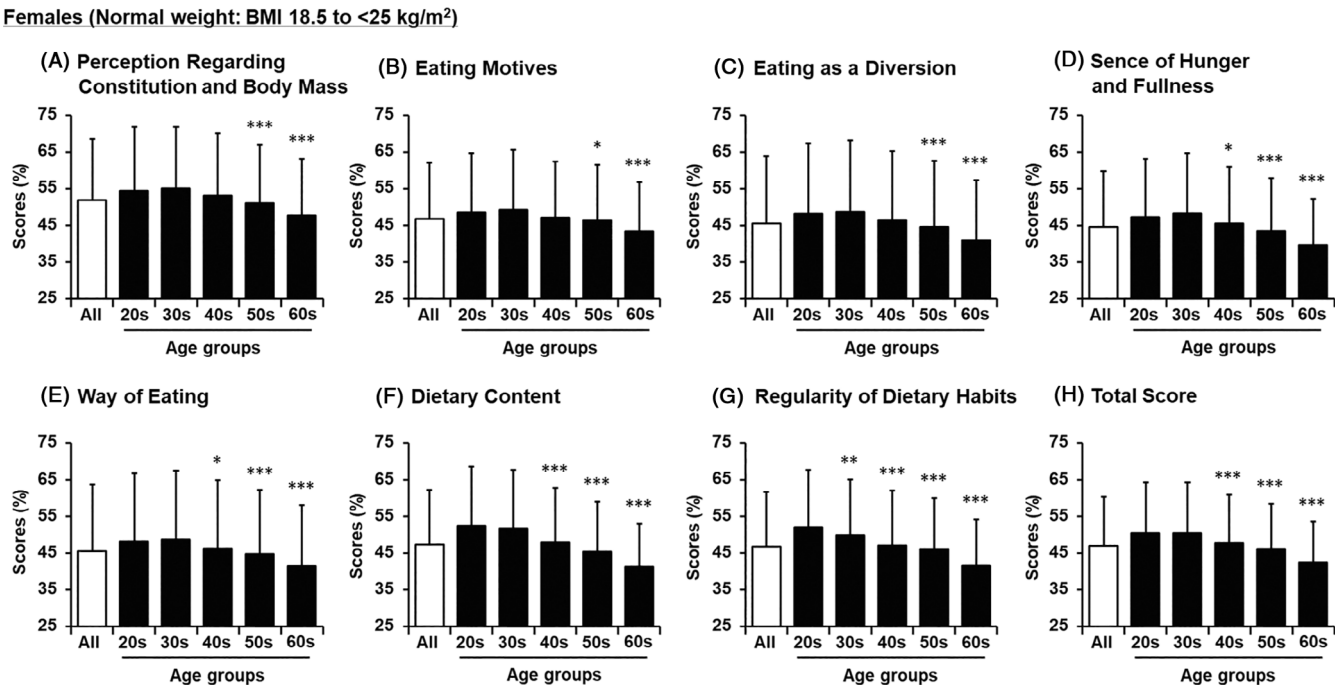

FIGURE 2 Age-stratified comparison of scores for the eating behaviour domains in female subjects with normal weight. (A–H) The scores for each eating behaviour domain for each 10-year age group (black bars) and all female subjects (white bars). The scores for each eating behaviour domain and the total score are expressed as a percentage of the maximum score. The data represent the means (%) ± SDs. $^{*}p < 0.05$, $^{**}p < 0.01$, and $^{***}p < 0.001$ vs. scores for the 20s (Steel test).

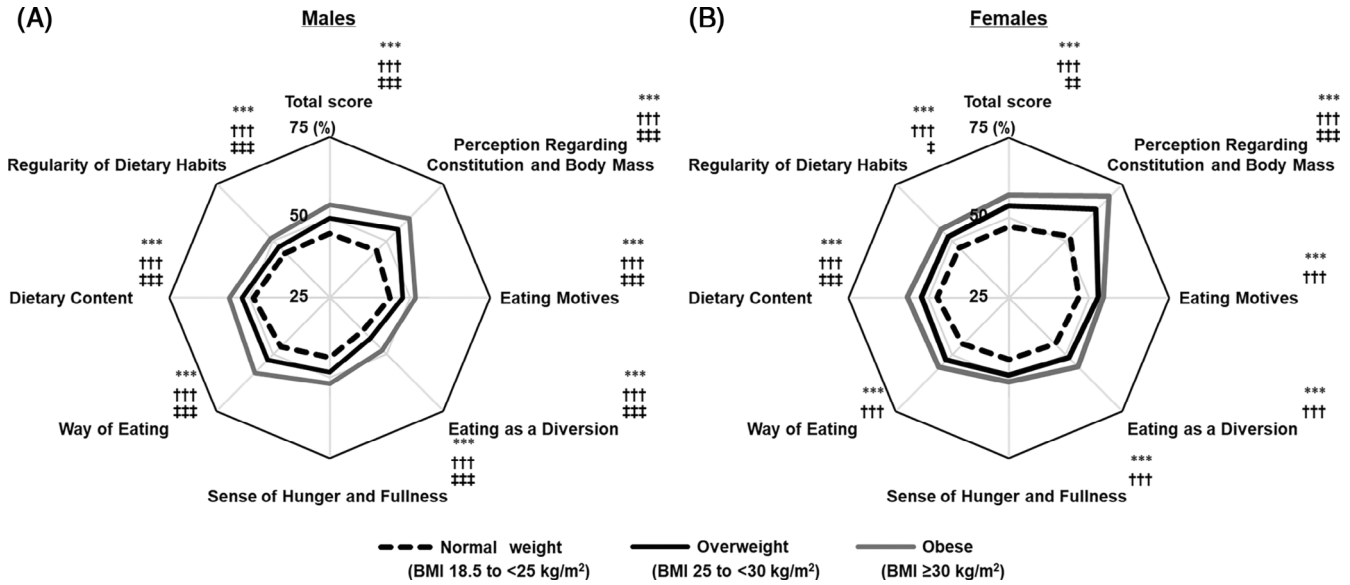

FIGURE 3 Eating behaviour diagrams by obesity level in males and females. (A, B) Mean scores for each behaviour domain in the normal-weight, overweight, and obese subjects are separately displayed for males (A) and females (B). Among both males and females, overweight and obese subjects exhibited significantly higher scores in all of the eating behaviour domains than those with normal weights. Additionally, obese subjects scored significantly higher than overweight subjects across all of the domains in males and in 'Perception Regarding Constitution and Body Mass', 'Dietary Content', and 'Regularity of Dietary Habits' in females. The scores for each eating behaviour domain and the total score are expressed as a percentage of the maximum score. $^{***}p < 0.001$ for normal weight vs. overweight; $^{\dagger\dagger\dagger}p < 0.001$ for normal weight vs. obese; $^{\ddagger}p < 0.05$, $^{\ddagger\ddagger}p < 0.01$, and $^{\ddagger\ddagger\ddagger}p < 0.001$ for overweight vs. obese (Steel–Dwass test).

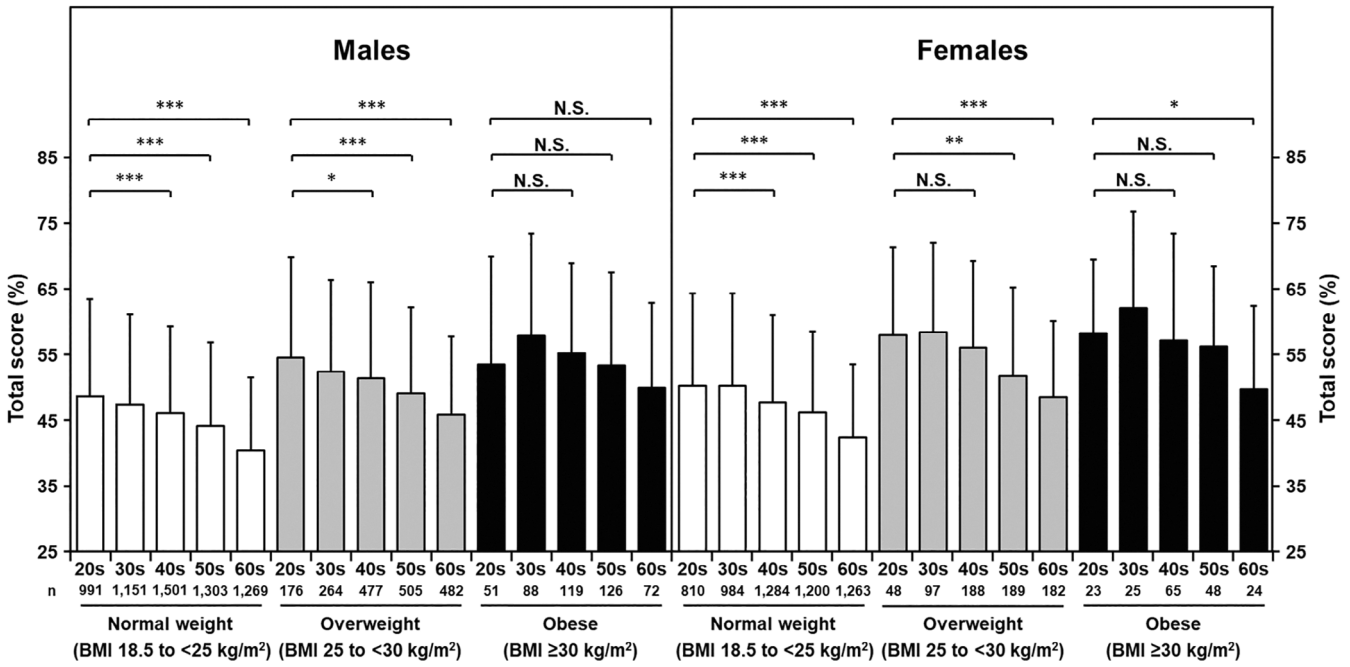

FIGURE 4 Age-stratified comparison of the total eating behaviour scores across BMI categories in males and females. The total eating behaviour scores for each 10-year age group are shown for the normal-weight (white bars), overweight (grey bars), and obese (black bars) subjects for males (left) and females (right). The total scores are expressed as a percentage of the maximum score. The scores for the normal-weight subjects are identical to those in Figures 1H and 2H; the scores for the overweight subjects are identical to those in Figures S2H and S4H; and the scores for the obese subjects are identical to those in Figures S3H and S5H. The data represent the means (%) ± SDs. $^{*}p < 0.05$, $^{**}p < 0.01$, and $^{***}p < 0.001$ vs. scores for the 20s. N.S., not significant (Steel test).

TABLE 3 Correlations between scores for each eating behaviour domain and BMI.

	Unadjusted		Age-adjusted	
Males	***ρ***	***p* value**	***stdβ***	***p* value**
Perception regarding constitution and body mass	0.385	<0.001	0.372	<0.001
Eating motives	0.174	<0.001	0.199	<0.001
Eating as a diversion	0.147	<0.001	0.180	<0.001
Sense of hunger and fullness	0.187	<0.001	0.208	<0.001
Way of eating	0.205	<0.001	0.230	<0.001
Dietary content	0.143	<0.001	0.183	<0.001
Regularity of dietary habits	0.142	<0.001	0.170	<0.001
Total score	0.237	<0.001	0.261	<0.001
	Unadjusted		**Age-adjusted**	
Females	***ρ***	***p* value**	***stdβ***	***p* value**
Perception regarding constitution and body mass	0.339	<0.001	0.352	<0.001
Eating motives	0.166	<0.001	0.182	<0.001
Eating as a diversion	0.144	<0.001	0.166	<0.001
Sense of hunger and fullness	0.153	<0.001	0.178	<0.001
Way of eating	0.161	<0.001	0.184	<0.001
Dietary content	0.157	<0.001	0.202	<0.001
Regularity of dietary habits	0.131	<0.001	0.170	<0.001
Total score	0.220	<0.001	0.254	<0.001

Note: The associations between body mass index (BMI) and scores for each eating behaviour domain in males and females were examined using Spearman rank correlation coefficient (ρ). Age-adjusted standardized regression coefficients (stdβ) were calculated using log-transformed BMI and log-transformed eating behaviour scores, with log-transformed age included as a covariate.

scores (Figure 4) and scores for each domain (Figures S2–S5) were also analysed for overweight and obese subjects. Although the total scores declined significantly with age in normal-weight individuals of both sexes, such declines were less pronounced in overweight and obese subjects (Figure 4). Notably, no significant age-related changes were observed in obese males (Figure 4, left), whereas in obese females, a significant decrease was observed only in those in their 60s compared with those in their 20s (Figure 4, right).

Finally, we examined the correlations between BMI and scores for each eating behaviour domain and the total score among subjects with a BMI of 18.5 kg/m^2 or higher (Table 3). For both males and females, scores for all of the eating behaviour domains were significantly positively correlated with BMI ($p < 0.001$), and these relationships remained significant after adjusting for age ($p < 0.001$). Notably, the 'Perception Regarding Constitution and Body Mass' domain exhibited the strongest correlation with BMI (std $\beta = 0.372$ in males and 0.352 in females).

4 | DISCUSSION

The present study, based on a nationwide large-scale analysis using the JASSO-DBQ, provided a comprehensive overview of eating behaviour characteristics in Japan. First, our findings revealed significant differences in eating behaviours by age and sex among a large population of normal-weight individuals. Despite having a lower BMI within the normal-weight subgroup, females scored higher than males in more eating behaviour domains. One possible explanation for these sex differences is the variation in how scores for each eating behaviour domain were calculated for males and females, as the JASSO-DBQ includes both sex-common and sex-specific questions. For example, in assessing the 'Dietary Content' domain, the question 'Do you have a strong preference for sweets?' is included only for males, whereas 'Do you like noodle dishes?' is included only for females. It is reasonable to assume that these sex-specific questions contributed to the observed differences in eating behaviour scores between the sexes. However, a reanalysis of the scores using only questions common to both sexes did not change the results (data not shown). Previous studies using the Dutch Eating Behaviour Questionnaire (DEBQ)[15,16] and the Adult Eating Behaviour Questionnaire (AEBQ)[17–19] have also reported sex-related differences in eating behaviours, suggesting that such difference are inherent and that dietary habits should be evaluated separately for males and females, regardless of the assessment method used, including the JASSO-DBQ.

Importantly, this study revealed age-related changes in eating behaviours, in which scores for all of the domains significantly decreased with age in both sexes. Regarding differences in eating behaviours between adults and elderly individuals, a study of 2231 Japanese individuals using the AEBQ reported that subjects aged 60–80 years demonstrated significantly lower scores for hunger, food

responsiveness, emotional overeating, and enjoyment of food than those aged 19–39 years or 40–59 years.[19] One possible explanation for these changes involves differences in meal timing and frequency, as reflected in the 'Regularity of Dietary Habits'. A previous survey reported that individuals in their 20s and 30s were more likely than older individuals to skip breakfast or not eat three meals a day at regular times.[20] Additionally, food preferences, which can affect 'Dietary Content', have also been reported to change with age. Both Japanese males and females tend to decrease their intake of poultry and red meat while increasing their consumption of seafood with increasing age.[21] Another potential factor associated with lower eating behaviour scores in older age groups is the decline in basal[22] and total[23] energy expenditure with aging, which has also been observed in Japanese individuals.[24] As such, to maintain a normal BMI, energy intake should decrease with age in parallel with reductions in energy expenditure. Interestingly, the age-related decline in eating behaviour scores was less evident in overweight and obese subjects (Figure 4). In particular, among obese males, no significant age-related changes were observed in scores for any of the domains except for 'Regularity of Dietary Habits' (Figures 4 and S3). Furthermore, the total scores of overweight subjects in their 50s and obese subjects in their 60s were not significantly different from those of normal-weight subjects in their 20s in either gender. These findings suggest that, in individuals with obesity, eating behaviour patterns that are established in early adulthood may persist and remain unchanged with age, thus potentially contributing to sustained weight gain or the development of obesity later in life due to excessive energy intake that exceeds age-related declines in metabolic demand. Importantly, several comorbidities, common in older adults, such as heart failure,[25] chronic kidney disease,[26] and sarcopenia,[27] are known to negatively impact appetite and nutritional intake, which may in part contribute to age-related declines in eating behaviour. However, our study did not collect detailed information on coexisting chronic diseases; therefore, clarifying how these conditions influence changes in eating behaviour among the aging population remains an important topic for future research.

Using the JASSO-DBQ, we previously demonstrated that patients with type 2 diabetes who had visceral fat accumulation (VFA) (mean BMI: 28.5 ± 5.4 kg/m^2) showed significantly higher scores in the 'Perception Regarding Constitution and Body Mass' domain in both males and females compared with 22 patients without VFA (mean BMI: 21.3 ± 2.3 kg/m^2). In particular, male patients with VFA exhibited significantly higher scores in the 'Eating Motives', 'Dietary Content', and 'Regularity of Dietary Habits', along with a trend toward higher scores in other domains.[28] Although the presence of diabetes or VFA was not assessed in the present study, both overweight and obese individuals of both sexes exhibited significantly higher scores in all of the eating behaviour domains compared with those with normal weights. These findings provide strong evidence of substantial differences in eating behaviours between normal-weight and overweight or obese individuals in such a large cohort; therefore, the JASSO-DBQ remains a valuable tool for evaluating the characteristics of eating behaviours in obese individuals even in modern Japan, where lifestyles have significantly changed since the questionnaire was first developed. Furthermore, this study revealed that male subjects with a BMI ≥30 kg/m^2 demonstrated higher eating behaviour scores across all of the domains than those with a BMI of 25 to <30 kg/m^2. Although no statistically significant differences were observed between overweight and obese females in several eating behaviour domains, this may be attributed to the small sample size of obese females ($n = 185$), which could have limited the statistical power. Such differences in eating behaviours between overweight and obese individuals are considered to be important, as obese individuals are associated with significantly greater metabolic risks and disease burdens compared with overweight individuals. A meta-analysis reported that the risk of all-cause mortality increased with the degree of obesity, with hazard ratios of 1.11 for overweight individuals and 1.44 for those with grade 1 obesity (BMI 30 to <35 kg/m^2) compared with those with a normal BMI.[29] Additionally, in Japanese males, the incidence of coronary heart disease has been reported to be 1.8 times higher in obese individuals with a reference BMI of 23 to <25 kg/m^2, whereas no increased incidence was observed in those individuals classified as overweight.[30] Moreover, our results also demonstrated that, even within Japanese criteria for obesity (BMI ≥25 kg/m^2), individuals with a BMI ≥35 kg/m^2 exhibited distinctly different eating behaviour patterns across a wide range of domains (Figure S1), indicating the clinical significance of high-degree obesity and underscoring the need for more intensive behavioural interventions in this group. Taken together, more pronounced eating behaviour characteristics in obese individuals, even compared with overweight individuals, may contribute to an increased risk of developing obesity-related diseases, with the JASSO-DBQ serving as a useful tool for supporting targeted interventions against these habitual patterns.

Among subjects with normal-weight, overweight, and obese, eating behaviour scores were significantly positively correlated with BMI across all of the domains in both sexes, even after adjusting for age. In particular, 'Perception Regarding Constitution and Body Mass' demonstrated the strongest correlation with BMI, followed by 'Way of Eating' in males and 'Dietary Content' in females, according to their stdβ values (Table 3). Notably, the 'Perception Regarding Constitution and Body Mass' domain, which includes questions such as 'Do you feel like you are not losing weight despite not eating much?' and 'Do you gain weight even from drinking water?', showed relatively high predictive ability for distinguishing normal weight from obese individuals in both sexes (area under the curve [AUC] = 0.741 for males and 0.774 for females), with optimal cut-off scores of 53.6% for males (sensitivity 71.1%, specificity 67.4%) and 62.5% for females (sensitivity 73.5%, specificity 69.9%). Although this domain is based on the assumption that obese individuals may have misperceptions about their body weight, high scores may also reflect actual physiological difficulties in managing weight, particularly in cases of severe obesity. Genetic predispositions, endocrine disorders, hypothalamic dysfunction, and certain medications can contribute to secondary causes of obesity.[31] Furthermore, individuals with a high polygenic risk score (PRS), which is calculated via a weighting approach incorporating obesity-related SNPs, have been reported to be associated with

obesity since childhood.[32] Given this context, obese individuals with such genetic backgrounds may demonstrate elevated eating behaviour scores, including 'Perception Regarding Constitution and Body Mass', from an early age. Therefore, it may be important to recognize that not all obese individuals have incorrect perceptions of their weight gain tendencies. For the 'Way of Eating' and 'Dietary Content' domains, we have previously reported that 6 months of treatment with the glucagon-like peptide-1 receptor agonist liraglutide significantly improved eating behaviours in obese patients with type 2 diabetes, with reductions in these two domains being particularly correlated with the degree of weight loss.[33] Additionally, it is well known that obese individuals tend to chew food inadequately and eat quickly, which can increase the risk of metabolic syndrome.[34] Previous studies of Japanese university students have revealed that a fast rate of eating was associated with weight gain,[35] even among those who reported only occasionally eating at a fast rate.[10] Thus, in addition to modifying dietary content, behavioural interventions aimed at slowing eating speed, such as increasing the number of chews per bite,[36] may be particularly effective for weight management in obese individuals.

The present study has several limitations. First, selection bias may have occurred because the study subjects were recruited from a web-based survey panel. Second, information bias due to potentially inaccurate self-reported values for height, body weight, and eating behaviour scores cannot be ruled out. Third, eating behaviours may also be influenced by social factors such as income and education,[13] as well as health-related factors, including comorbidities (e.g., diabetes and mental disorders) and the use of appetite-affecting medications, none of which were examined in this study. Fourth, consideration should be given to the validation of the JASSO-DBQ for unsupervised, web-based self-administration. In Japan, the questionnaire has been widely adopted in various formats, including freely accessible web-based platforms for individual self-assessment of eating behaviour. Additionally, tablet-based assessments are routinely completed by patients themselves without professional guidance in clinical settings, where its clinical utility is well established. However, further direct evaluation, such as assessment of response integrity and test–retest reliability, is needed to confirm that the psychometric properties of the JASSO-DBQ are maintained in fully unsupervised, large-scale online settings.

In conclusion, this large-scale analysis of the JASSO-DBQ targeting the Japanese general population revealed significant differences in eating behaviours according to sex and age, as well as obesity levels. Notably, both overweight and obese individuals exhibited more specific eating behaviours across a wide range of dietary habits. These findings should provide important evidence for establishing more effective strategies for the treatment of obesity disease.

AUTHOR CONTRIBUTIONS

Design: Yuya Fujishima and Hitoshi Nishizawa. Data collection: Kohei Fujii, Yuya Fujishima, and Yu Kimura. Data analysis: Kohei Fujii, Yuya Fujishima, Yu Kimura, Tomoyuki Hara, Hirofumi Nagao, Yoshinari Obata, Shiro Fukuda, and Naoko Nagai. Manuscript writing: Kohei Fujii, Yuya Fujishima, Hitoshi Nishizawa, Tetsuya Kakuma, and Iichiro Shimomura. All the authors have read and approved the final manuscript.

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CONFLICT OF INTEREST STATEMENT

All authors declare that they have no competing interests.

PEER REVIEW

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study were provided by Kobayashi Pharmaceutical Co., Ltd. and are not publicly available. However, the data are available from the corresponding author upon reasonable request and with permission from Kobayashi Pharmaceutical Co., Ltd.

ETHICS STATEMENT

This study was conducted in accordance with the Declaration of Helsinki and approved by the Human Ethics Committee of Osaka University (no. 24163).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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