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OBM Hepatology and Gastroenterology

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Original Research

Prevalence of Chronic Constipation and Irritable Bowel Syndrome, and their Overlap, among Female Undergraduate Students in Japan

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Academic Editor: Tatsuo Kanda

OBM Hepatology and Gastroenterology
2020, volume 4, issue 2
doi:10.21926/obm.hg.2002048

Received: April 10, 2020
Accepted: May 18, 2020
Published: May 19, 2020

Abstract

Chronic constipation and irritable bowel syndrome (IBS) are two of the most common functional gastrointestinal disorders, both of which negatively affect the quality of life of the patients. Since people may have co-existing symptoms of multiple disorders, chronic constipation and IBS with predominant constipation cannot be clearly distinguished. In this cross-sectional study, data were obtained from self-administered questionnaires to assess the prevalence of chronic constipation and IBS, and their overlap, among female undergraduate students in Japan. We also assessed the participants' mental status, physical activity, lifestyle, and dietary intake, each of which can influence chronic constipation and IBS. These parameters were assessed using a

Japanese version of the hospital anxiety and depression scale, and an established semi-quantitative questionnaire available for clinical investigation (FFQg).Among the 131 participants, 9.2% had chronic constipation and 18.0% had IBS, while 2 (1.7%) participants had both constipation and IBS. Increased body mass index and higher dietary intake of protein (energy ratio), fat (energy ratio), cholesterol, animal protein (ratio), animal fat (ratio), and meat and eggs, and decreased carbohydrate energy ratio and vegetable fat ratio, were associated with chronic constipation. A state of anxiety tended to be associated with IBS, but in contrast to the results for chronic constipation, the dietary intake of the nutrients and types of food examined were not associated with IBS, except for the "snacks food group". The results suggest that overlap between chronic constipation and IBS was not common, and that these two disorders had different clinical characteristics and backgrounds.

Keywords
Chronic constipation; irritable bowel syndrome; young women; lifestyle; food intake

1. Introduction

Chronic constipation and irritable bowel syndrome (IBS) are two of the most common functional gastrointestinal disorders worldwide, and both negatively affect the quality of life of the patients [1, 2]. The reported prevalence of constipation and IBS in several countries ranges from 0.7% to 79% and 10% to 20%, respectively, although it may vary depending on the diagnostic criteria used [2–5]. Although chronic constipation is more common in older people [4], it can also occur in younger people, among which, the prevalence is higher in females than in males. Based on an internet survey of 5155 participants, Tamura *et al.* reported that females in their twenties had the lowest mean frequency of defecations per week, and the frequency of hard stools in females increased significantly with younger age [6]. IBS is also more common in females than males and typically occurs during younger adulthood [1, 7].

The task force at the American College of Gastroenterology suggested that constipation was a symptom-based disorder, defined as unsatisfactory defecation characterized by infrequent stools, difficulty in stool passage, or both, while IBS was defined as abdominal discomfort associated with altered bowel habits [1]. The Rome IV criteria for functional constipation have stated that individuals with chronic constipation did not fulfill the criteria for IBS, with abdominal pain being a major determinant [8, 9]. However, it is difficult to clearly distinguish between chronic constipation and co-existing IBS with constipation because of the considerable overlap between these entities and a significant tendency for patients to fluctuate across these diagnoses over time [1, 10]. In Japan, the "Evidence-based clinical practice guidelines for chronic constipation, 2017" [11] have defined chronic constipation in accordance with the Rome IV criteria for functional constipation [8], but unlike the Rome IV criteria, the criteria of "loose stools are rarely present without the use of laxatives" and "insufficient criteria for IBS" are excluded [11].

In the present study, we aimed to investigate the prevalence of chronic constipation and IBS, and their overlap, among female undergraduate students in Japan. Also, we further assessed their

mental status, physical activity, lifestyle, and dietary intake, each of which could influence chronic constipation and IBS.

2. Subjects and Methods

This study was performed according to the principles of the Declaration of Helsinki. The study protocol was approved by the Ethical Committee of the University of Nagasaki (Approval No. 369).

2.1 Study Participants

The sample size for this study was calculated based on estimated chronic constipation or IBS prevalence of 10%, a confidence level of 95%, and a confidence interval of 0.10. The expected minimum sample size for these outcomes was 139. In the present study, 710 female students from the Faculty of Nursing and Nutrition, Faculty of Global and Media Studies, and Faculty of Information Systems, University of Nagasaki, Japan, were invited to enroll, among which 131 students (99 from the Faculty of Nursing and Nutrition, 13 from the Faculty of Global and Media Studies, and 19 from the Faculty of Information Systems) agreed to participate between April and July 2019. The rate of participation in the study was 18.5%.

2.2 Study Design

This cross-sectional study was conducted from April to July 2019. The participants completed self-administered questionnaires that included 95 questions regarding personal data, such as affiliation, age, height and body weight, defecation status (including frequency of bowel movements and stool texture), constipation and IBS-related symptoms, lifestyle, food habits, anxiety and depressive states, and status of physical activity. An established semi-quantitative questionnaire available for clinical investigation (a food frequency questionnaire based on food groups, i.e., FFQg ver. 5; Kenpaku-sha, Tokyo, Japan) was used to obtain a detailed assessment of food intake and the physical activity level (PAL) [12]. The body mass index (BMI) was calculated as the body weight (kg) divided by height (m) squared.

The questionnaires were filled out anonymously, and the submission of questionnaire answers was considered to be the consent for participation in the study.

2.3 Definition of Chronic Constipation

According to the "Evidence-based clinical practice guidelines for chronic constipation, 2017" published by the Japanese Society of Gastroenterology [11], a diagnosis of chronic constipation was made if the participant had experienced at least two of the following conditions: 1) straining during more than one-fourth (25%) of the defecations; 2) lumpy or hard stools (Bristol stool form scale 1 or 2 [13, 14] in more than one-fourth (25%) of the defecations; 3) a sensation of incomplete evacuation in more than one-fourth (25%) of the defecations; 4) a sensation of anorectal obstruction/blockage in more than one-fourth (25%) of the defecations; 5) performance of manual maneuvers (digital evacuation or support of the pelvic floor) to facilitate more than one-fourth (25%) of the defecations; and 6) fewer than three spontaneous bowel movements per week. The above criteria must have been fulfilled during the last three months, with symptom

onset occurring at least six months prior to diagnosis. The Rome IV criteria for functional constipation [8] were used, except for the criteria of "loose stools are rarely present without the use of laxatives" and "insufficient criteria for IBS", which were excluded in the Japanese criteria for chronic constipation [11]. As the preliminary investigation revealed that the word "straining" was unfamiliar to our study participants (only 2 out of 10 female undergraduate students knew the meaning of "straining"), the word was replaced with "defecation difficulty". Also, because "digital evacuation or support of the pelvic floor" was expected to be unfamiliar and rarely tried by our study participants, this criterion was excluded from the questionnaire, and the participants were asked to freely describe the manual maneuvers utilized to facilitate defecation.

2.4 Definition of IBS

According to the Rome IV criteria [8], the diagnosis of IBS was made if the participant had been experiencing recurrent abdominal pain that occurred on an average of at least one day per week during the past three months, which was associated with at least two of the following conditions: 1) defecation; 2) a change in the frequency of stools; and 3) a change in stool form (appearance). The above criteria must have been fulfilled for the last three months, with symptom onset occurring at least six months prior to diagnosis. Participants diagnosed with IBS were further classified into the following four subtypes based on the stool form on days with at least one abdominal bowel movement: 1) IBS with predominant constipation (IBS-C), defined as Bristol stool form types 1 or 2 in ≥25% and Bristol stool form type 6 or 7 in <25% of the bowel movements; 2) IBS with predominant diarrhea (IBS-D), defined as Bristol stool form type 6 or 7 in ≥25% and Bristol stool form types 1 or 2 in <25% of the bowel movements; 3) IBS with mixed bowel habits (IBS-M), defined as Bristol stool form types 1 or 2 in ≥25% and Bristol stool form types 6 or 7 in ≥25% of the bowel movements; and 4) unclassified IBS (IBS-U), defined as insufficient abnormalities in stool consistency to meet the criteria for the above IBS subtypes.

2.5 Psychological Assessment

The Japanese version of the Hospital Anxiety and Depression Scale (HADS), a scale that has been proven to be a reliable and valid screening method for the assessment of emotional disorders in women [15], was employed to evaluate the symptoms of anxiety and depression. The HADS is a self-administered questionnaire that consists of 14 items: seven items for anxiety (HADS-A) and seven items for depression (HADS-D), which are scored from 0 to 3. A total score of >10 was considered to represent a positive result (definite), while a score of 8 to 10 was considered to represent a probable result and a score of <8 was considered to represent a negative result for either condition [16].

2.6 Physical Activity Level

The PAL, calculated as the total energy expenditure divided by the basal metabolic rate, was estimated using a computer software program (FFQg ver. 5; Kenpaku-sha). For individuals aged between 18 and 29, a PAL of ≥1.4 to <1.6 was designated as level I, a PAL of 1.6 to 1.9 was designated as level II, and a PAL of >1.9 to ≤2.2 was designated as level III [17].

2.7 Frequency of Food Intake

Data regarding the portion sizes and consumption frequencies of 18 food groups within one week were collected using the commercially available semi-quantitative questionnaire FFQg ver. 5 (Kenpaku-sha). Using these data, the determined amounts of each nutrient and food group were estimated according to the 2015 edition of the Standard Tables of Food Composition in Japan [18], using a computer software program. The following nutrients were estimated: total energy; water; protein; total lipids; carbohydrates; ash; sodium; potassium; calcium; magnesium; phosphate; iron; zinc; copper; manganese; iodine; selenium; chromium; molybdenum; retinol; β-carotene; β-carotene equivalent; activity equivalent amount of retinol; vitamin D; α-tocopherol; vitamin K; vitamins B1, B2, B6, and B12; niacin; niacin equivalent; folic acid; pantothenic acid; biotin; vitamin C; saturated fatty acids; mono-unsaturated fatty acids; polyunsaturated fatty acids; cholesterol; water-soluble fiber; water-insoluble fiber; total fiber; salt; alcohol; total fatty acids; and n-3 and n-6 polyunsaturated fatty acids. The estimated foods were categorized into the following groups: cereals (rice, noodles, etc.); potatoes and starches; green-yellow vegetables; light-colored and other vegetables; mushrooms; seaweeds; beans; fish/shellfish; meats; eggs; milk/dairy products; fruits; snacks; beverages; sugar/sweets; nuts; oils/fats; and seasonings/spices.

2.8 Statistical Analysis

The data were expressed as the mean ± standard deviation (SD). Differences between groups were tested for statistical significance using the Student's *t*-test, chi-square test, or Fisher's exact test. A multivariate analysis, using logistic regression, was performed for variables that were observed to be significantly different in the univariate analyses. Correlations were examined using a linear regression analysis with coefficients of correlation. All the data analyses were performed using the statistical program SPSS ver. 25 (IBM Co., Armonk, NY, USA), on a computer with a Windows operating system. A p-value < 0.05 was considered to be statistically significant.

3. Results

3.1 Overall Characteristics of the 131 Participants

The age of the participants ranged from 18 to 22 years, with a mean (±SD) age of 19.5 ±1.3 years. Of the 131 female undergraduate students, 55 were in the first year, 20 were in the second year, 17 were in the third year, and 39 were in the fourth year of study at the university. The mean (±SD) height, body weight, and BMI were 157.1 ±5.1cm, 51.2 ±6.2 kg, and 20.7 ±2.0 kg/m^2, respectively. Of the 123 participants with known parameters, 18 (14.6%) participants were classified as underweight (BMI <18.5), 103 (83.7%) participants were classified in the normal range (BMI ≥18.5 and <25), and two (1.6%) participants were classified as pre-obese (BMI ≥25 and <30), according to the "Guidelines for the management of obesity disease, 2016" for Japan [19].

Of the 131 participants, 54 (41.2%) responded that they had felt constipated within the last three months due to a low frequency of bowel movements (50 participants; 92.6%); symptoms such as a sensation of incomplete evacuation, defecation difficulty, abdominal pain, and/or abdominal bloating (31 participants; 57.4%); a hard or lumpy stool texture (26 participants; 48.1%); and a small defecation volume (11 participants; 20.4%). Of the 130 participants for whom data for

the diagnosis of chronic constipation according to the "Evidence-based clinical practice guidelines for chronic constipation 2017" [11] were available, 12 (9.2%) participants were diagnosed with chronic constipation. Of the 122 participants for whom data for the diagnosis of IBS according to the Rome IV criteria [8] were available, 22 (18.0%) participants were diagnosed with IBS. Of these, six (27.2%) were diagnosed with IBS-C, one (4.5%) was diagnosed with IBS-D, 14 (63.6%) were diagnosed with IBS-U, and the remaining one (4.5%) participant could not be classified into any type of IBS due to insufficient data. Of the 32 participants with chronic constipation and/or IBS, 10 (31.3%) were diagnosed exclusively with chronic constipation, 20 (62.5%) were diagnosed exclusively with IBS, and the remaining two (6.3%) were diagnosed with both chronic constipation and IBS (Figure 1).

Of the 130 participants with available data for a psychological assessment using the HADS, 49 (37.7%) were classified as exhibiting a definite state of anxiety, and 53 (40.8%) were classified as exhibiting a probable state of anxiety. In addition, 20 (15.4%) participants were classified as exhibiting a definite state of depression, and 82 (63.1%) were classified as exhibiting a probable state of depression.

Regarding physical activity, the mean (±SD) PAL was 1.86 ±0.46. Of the 99 participants with available data, 35 (35.4%) were classified as having a PAL level of I, 23 (23.2%) were classified as having a PAL level of II, and 41 (41.4%) were classified as having a PAL level of III.

Of the 122 participants for whom data were available, the mean (±SD) intakes of total energy, carbohydrates, calcium, iron, and total fiber per day were 1684 ±460 kcal, 217.8 ±62.3 g, 423 ±168 mg, 6.1 ±2.4 mg, and 10.7 ±4.5 g, respectively, which were lower than the estimated energy requirement, estimated average requirement, recommended dietary allowance, or tentative dietary goals for preventing lifestyle-related diseases, as stated in the 2015 version of the Dietary Reference Intakes for Japanese population [17]. In contrast, the mean (±SD) intakes of protein and salt were 58.3 ±20.1 g and 8.2 ±3.4 g, respectively, which were higher than the recommended dietary allowance or tentative dietary goals for preventing lifestyle-related diseases, while the mean (±SD) intake of total lipids was within the range of the reference [17].

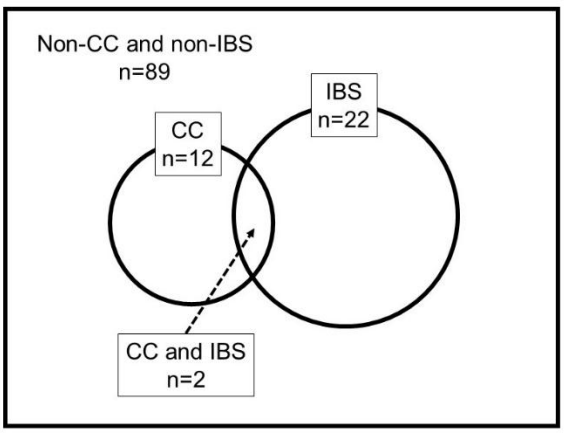

Figure 1 The overlap between chronic constipation and irritable bowel syndrome. The values represent the number of participants. CC, chronic constipation; IBS, irritable bowel syndrome.

3.2 Comparison of the Characteristics of the Participants with Chronic Constipation or Non-Chronic Constipation

Table 1 presents the comparisons of various parameters between the 12 participants with chronic constipation and 118 participants with non-chronic constipation. There were no significant differences between the two groups in terms of age, year of study at the university, height, and body weight. However, participants with chronic constipation had a significantly higher BMI than those with non-chronic constipation. The psychological status (anxiety and depressive status) and physical activity were similar between participants with chronic constipation and those with non-chronic constipation. Also, there were no significant differences between the two groups in terms of the number of sleeping hours per day; frequency of skipping breakfast, lunch, or dinner; dieting experience; daily scheduled time of defecation; change in appetite during stress or tiredness; the amount of coffee consumed per day; and the frequency of food chewing per bite. A regular or occasional alcohol drinking habit was more common in participants with chronic constipation, compared to those with non-chronic constipation. The intakes of total energy, protein, total lipids, and carbohydrates were not significantly different between the two groups, while the cholesterol consumption, protein-energy ratio, fat energy ratio, animal protein ratio, and animal fat ratio were significantly higher in participants with chronic constipation than in those with non-chronic constipation. In contrast, the carbohydrate energy ratio and vegetable fat ratio were significantly lower in the chronic constipation group than in the non-chronic constipation group. More meats and eggs were consumed in the chronic constipation group than in the non-chronic constipation group.

The variables that were varied significantly between chronic constipation and non-chronic constipation groups were selected for the analysis of logistic regression. Consequently, no variable was observed to be an independent predictor of chronic constipation.

Table 1 Comparison of the main characteristics of the participants with chronic constipation and non-chronic constipation.

Characteristics	**Chronic constipation (n = 12)**	**Non-chronic constipation (n = 118)**	***p***
Age (years)	20.2 ± 1.4	19.4 ± 1.3	0.062
Year of study (year)			
First/Second/Third/Fourth	3/1/1/7	51/19/16/32	0.167
Height (cm)	156.5 ± 6.3	157.2 ± 5.0	0.653
Body weight (kg)	54.0 ± 5.5	50.9 ± 6.2	0.118
BMI (kg/m^2)	21.9 ± 1.9	20.6 ± 2.0	0.036
Aware of own ideal body weight			
Yes/No	10/2	83/35	0.342
Anxiety state			
Definite/Probable/Negative	7/3/2	41/50/26	0.276
Depressive state			
Definite/Probable/Negative	2/8/2	18/74/25	0.933

PAL	1.8 ± 0.5	1.9 ± 0.5	0.772
PAL level			
I/II/III	1/2/2	19/20/21	0.419
Sleeping hours per day	6.0 ± 0.8	6.2 ± 0.9	0.536
Frequency of skipping breakfast (days/week)			
7/4 to 6/1 to 3/0	0/2/2/8	3/12/30/73	0.774
Frequency of skipping lunch (days/week)			
7/4 to 6/1 to 3/0	0/0/0/12	0/0/16/102	0.173
Frequency of skipping dinner (days/week)			
7/4 to 6/1 to 3/0	0/0/1/11	0/2/22/93	0.757
Dieting experience			
Yes/No	7/5	62/56	0.702
Fixed daily scheduled time for defecation			
Almost always/Usually/Not fixed	0/3/9	9/47/62	0.280
Change in appetite when feeling stressed or tired			
Increase/Unchanged/Decrease	6/1/1	44/20/16	0.549
Alcohol drinking habit			
Habitual or occasional/Never	7/5	29/87	0.014
Cigarette smoking habit			
Habitual/Never	0/12	0/118	-
Coffee consumption (cups/day)			
≥5/3 to 4/1 to 2/0	0/0/3/9	2/1/32/83	0.949
Amount of chewing per one bite (times)			
>20/10 to 20/<10/Unknown	1/10/1/0	14/69/12/23	0.308
Intakes of main nutrients and food groups per day as determined by FFQg			
Nutrients			
Total energy (kcal)[†]	1718 ± 552	1673 ± 466	0.753
Protein (g)[†]	67.6 ± 23.1	57.4 ± 19.5	0.092
Total lipids (g)[†]	67.4 ± 20.8	61.0 ± 23.6	0.374
Carbohydrates (g)[†]	200.4 ± 76.5	218.0 ± 63.9	0.377
Calcium (mg)[†]	454.8 ± 216.2	417.5 ± 164.7	0.473
Iron (mg)[†]	6.5 ± 2.7	6.1 ± 2.3	0.549
Cholesterol (mg)[†]	403.6 ± 123.9	293.5 ± 112.3	0.002
Total fiber (g)[†]	10.1 ± 5.2	10.8 ± 4.5	0.602
Salt (g)[†]	8.3 ± 3.6	8.1 ± 3.5	0.907
Protein energy ratio (%)[†]	15.9 ± 3.1	13.6 ± 2.7	0.008
Fat energy ratio (%)[†]	35.9 ± 6.0	31.2 ± 5.7	0.015
Carbohydrate energy ratio (%)[†]	48.2 ± 8.3	54.2 ± 8.2	0.018
Animal protein ratio (%)[†]	64.8 ± 10.0	52.5 ± 11.8	0.001
Animal fat ratio (%)[†]	5.5 ± 1.2	4.4 ± 1.2	0.003
Vegetable fat ratio (%)[†]	4.2 ± 1.1	5.2 ± 1.3	0.006
Food groups			

Cereals (g)[†]	303.9 ± 162.2	354.3 ± 128.3	0.211
Green-yellow vegetables (g)[†]	78.3 ± 63.6	66.3 ± 48.2	0.433
Beans (g)[†]	52.5 ± 47.4	48.5 ± 46.8	0.781
Fish/shellfish (g)[†]	38.6 ± 55.0	29.3 ± 26.5	0.317
Meats (g)[†]	137.6 ± 70.3	93.3 ± 56.0	0.012
Eggs (g)[†]	48.8 ± 21.3	34.5 ± 21.7	0.032
Milk/dairy products (g)[†]	135.6 ± 79.2	113.8 ± 86.4	0.404
Snacks (g)[†]	67.4 ± 30.9	63.9 ± 49.4	0.808
Seasonings/spices (g)[†]	32.5 ± 22.2	32.9 ± 33.2	0.970

Data are expressed as the mean ±SD, or the number of participants.

[†]According to the 2015 edition of the Standard Tables of Food Composition in Japan [18].

SD, standard deviation; BMI, body mass index; PAL, physical activity level; FFQg, a food frequency questionnaire based on food groups ver. 5 (Kenpaku-sha, Tokyo, Japan).

3.3 Comparison of the Characteristics of Participants with or without IBS

Table 2 presents the comparisons of main subject characteristics between the 22 participants with IBS and 100 participants without IBS. There were no significant differences between the IBS and non-IBS participants in terms of age, year of study at the university, height, body weight, and BMI. Furthermore, the psychological status (anxiety and depressive status); physical activity, number of sleeping hours per day; frequency of skipping breakfast, lunch, or dinner; dieting experience; daily scheduled time for defecation; and alcohol drinking habits were similar between the IBS and non-IBS participants. Participants reporting a decreased appetite under stress or fatigue, and those who chewed their food for >20 times per bite, were significantly more common in the IBS group, than in the non-IBS group. Also, it was more common for non-IBS participants to consume less than three cups of coffee per day. There were no significant differences between the IBS and non-IBS participants in terms of the dietary intake of any of the nutrients and food groups studied, except for snacks, which were consumed more in the non-IBS participants than in the IBS participants.

The variables that were observed to vary significantly between the IBS and non-IBS groups were selected for analysis of logistic regression. Consequently, no variable was observed to be an independent predictor of IBS.

Table 2 Comparison of the main characteristics of the IBS and non-IBS participants.

Characteristics	**IBS** (n = 22)	**Non-IBS** (n = 100)	***p***
Age (years)	19.4 ± 1.3	19.6 ± 1.3	0.509
Year of study (year)			
First/Second/Third/Fourth	10/5/1/6	39/14/15/32	0.440
Height (cm)	157.0 ± 5.5	157.0 ± 5.1	0.947
Body weight (kg)	51.1 ± 4.4	51.2 ± 6.6	0.946
BMI (kg/m^2)	20.9 ± 2.2	20.7 ± 2.0	0.644

Aware of own ideal body weight			
Yes/No	16/6	71/29	0.871
Anxiety state			
Definite/Probable/Negative	12/8/2	35/42/23	0.163
Depressive state			
Definite/Probable/Negative	3/11/8	13/68/19	0.186
PAL	1.8 ± 0.5	1.9 ± 0.5	0.383
PAL level			
I/II/III	5/3/3	15/18/17	0.419
Sleeping hours per day	6.3 ± 0.9	6.2 ± 1.0	0.623
Frequency of skipping breakfast (days/week)			
7/4 to 6/1 to 3/0	0/1/5/16	3/12/26/59	0.526
Frequency of skipping lunch (days/week)			
7/4 to 6/1 to 3/0	0/0/4/18	0/0/11/89	0.353
Frequency of skipping dinner (days/week)			
7/4 to 6/1 to 3/0	0/0/3/18	0/1/18/81	0.174
Dieting experience			
Yes/No	11/11	51/49	0.932
Fixed daily scheduled time for defecation			
Almost always/Usually/Not fixed	1/7/14	8/39/53	0.634
Change in appetite when feeling stressed or tired			
Increase/Unchanged/Decrease	6/4/7	41/16/10	0.044
Alcohol drinking habit			
Habitual or occasional/Never	5/17	30/69	0.478
Cigarette smoking habit			
Habitual/Never	0/22	0/100	-
Coffee consumption (cups/day)			
≥5/3 to 4/1 to 2/0	1/0/1/20	1/1/32/66	0.042
Amount of chewing per one bite (times)			
>20/10 to 20/<10/Unknown	6/8/3/5	9/67/9/15	0.034
Intakes of main nutrients and food groups per day as determined by FFQg			
Nutrients			
Total energy (kcal)[†]	1564 ± 325	1712 ± 494	0.205
Protein (g)[†]	54.7 ± 15.8	60.0 ± 20.6	0.281
Total lipids (g)[†]	55.2 ± 13.4	63.5 ± 24.8	0.152
Carbohydrates (g)[†]	201.6 ± 52.5	219.9 ± 67.5	0.256
Calcium (mg)[†]	410.2 ± 188.0	426.1 ± 164.4	0.701
Iron (mg)[†]	5.8 ± 2.5	6.2 ± 2.3	0.474
Cholesterol (mg)[†]	270.3 ± 95.5	315.3 ± 121.5	0.122
Total fiber (g)[†]	10.6 ± 5.5	10.8 ± 4.3	0.874
Salt (g)[†]	8.8 ± 3.0	8.0 ± 3.4	0.384
Protein energy ratio (%)[†]	14.0 ± 2.9	13.9 ± 2.8	0.884

Fat energy ratio (%)[†]	32.1 ± 6.1	32.0 ± 5.9	0.947
Carbohydrate energy ratio (%)[†]	53.8 ± 8.2	53.4 ± 8.5	0.812
Animal protein ratio (%)[†]	54.7 ± 12.3	54.4 ± 11.9	0.909
Animal fat ratio (%)[†]	4.8 ± 1.3	4.5 ± 1.2	0.383
Vegetable fat ratio (%)[†]	4.9 ± 1.2	5.1 ± 1.3	0.586
Food groups			
Cereals (g)[†]	323.6 ± 137.1	.4 ± 132.3	0.334
Green-yellow vegetables (g)[†]	67.9 ± 69.4	68.0 ± 46.0	0.992
Beans (g)[†]	46.5 ± 53.2	48.6 ± 43.4	0.870
Fish/shellfish (g)[†]	23.8 ± 19.2	33.4 ± 32.1	0.200
Meats (g)[†]	94.4 ± 52.8	100.5 ± 60.8	0.681
Eggs (g)[†]	30.7 ± 21.6	37.0 ± 22.2	0.249
Milk/dairy products (g)[†]	120.6 ± 112.8	117.8 ± 80.8	0.894
Snacks (g)[†]	42.4 ± 27.3	68.4 ± 50.6	0.028
Seasonings/spices (g)[†]	35.1 ± 19.8	32.4 ± 34.0	0.643

Data are expressed as the mean ±SD, or the number of participants.

[†]According to the 2015 edition of Standard Tables of Food Composition in Japan [18]

SD, standard deviation; IBS, irritable bowel syndrome; BMI, body mass index; PAL, physical activity level; FFQg, a food frequency questionnaire based on food groups ver. 5 (Kenpaku-sha, Tokyo, Japan).

3.4 Characteristics of the Two Participants with Co-Existing Chronic Constipation and IBS

Table 3 presents the answers to the questionnaire by the two participants with both chronic constipation and IBS. These participants had lumpy or hard stools, defecation difficulty, fewer than three spontaneous bowel movements per week, and recurrent abdominal pain related to defecation, that was associated with a change in stool form. Also, both had probable or definite states of anxiety and depression, had skipped breakfast 1 to 3 times per week, and had an irregular daily time of defecation. According to the results from FFQg, their intakes of total energy, iron, and total fiber were lower than the estimated energy requirement, estimated average requirement, recommended dietary allowance, or tentative dietary goals for preventing lifestyle-related diseases, stated in the 2015 version of the Dietary Reference Intakes for Japanese population [17]. Moreover, the two participants had lower intakes of carbohydrates and green-yellow vegetables, a high intake of cholesterol, and a high protein energy ratio, compared to the average values of the total 131 participants in this study. However, the intakes of the other nutrients and food groups differed between these two participants.

Table 3 Questionnaire responses from the two participants with both chronic constipation and IBS.

Characteristics	**Participant-1**	**Participant-2**
Age (years)	20	22
Year of study (year)	Second	Fourth
BMI (kg/m^2)	21.5	26.0
Symptoms of chronic constipation [11]		
Lumpy or hard stools	Yes	Yes
Sensation of incomplete evacuation	No	Yes
Defecation difficulty	Yes	Yes
Fewer than three bowel movements per week	Yes	Yes
Recurrent abdominal pain [8]		
Related to defecation	Yes	Yes
Associated with a change in stool frequency	No	No
Associated with a change in stool form	Yes	Yes
Aware of own ideal body weight	Yes	Yes
Anxiety state	Probable	Definite
Depressive state	Definite	Probable
PAL level	Not known	
Sleeping hours per day	6.0	8.0
Impaired quality of sleep (halfway awakening)	No	No
Frequency of skipping breakfast (days/week)	1 to 3	1 to 3
Frequency of skipping lunch (days/week)	0	0
Frequency of skipping dinner (days/week)	0	0
Dieting experience	No	Yes
Fixed daily scheduled time for defecation	Not fixed	Not fixed
Change in appetite when feeling stressed or tired	Not answered	Increase
Alcohol drinking habit	Never	Occasionally
Cigarette smoking habit	Never	Never
Coffee consumption (cups/day)	0	0
Amount of chewing per one bite (times)	>20	10 to 20
Intakes of main nutrients and food groups per day as determined by FFQg		
Nutrients		
Total energy (kcal)†	1670	1382
Protein (g)†	62.2	53.1
Total lipids (g)†	68.5	42.6
Carbohydrates (g)†	195.2	179.3
Calcium (mg)†	510	187
Iron (mg)†	6.9	3.2
Cholesterol (mg)†	357	336
Total fiber (g)†	10.3	3.0
Salt (g)†	6.1	8.7

Protein energy ratio (%)[†]	14.9	15.4
Fat energy ratio (%)[†]	36.9	27.7
Carbohydrate energy ratio (%)[†]	48.2	56.9
Animal protein ratio (%)[†]	53.7	71.9
Animal fat ratio (%)[†]	4.4	7.8
Vegetable fat ratio (%)[†]	5.3	1.9
Food groups		
Cereals (g)[†]	249	351
Green-yellow vegetables (g)[†]	43	14
Beans (g)[†]	120	0
Fish/shellfish (g)[†]	29	23
Meats (g)[†]	86	149
Eggs (g)[†]	43	36
Milk/dairy products (g)[†]	179	58
Snacks (g)[†]	93	47
Seasonings/spices (g)[†]	19	53

[†]According to the 2015 edition of Standard Tables of Food Composition in Japan [18]

IBS, irritable bowel syndrome; BMI, body mass index; PAL, physical activity level, FFQg, a food frequency questionnaire based on food groups ver. 5 (Kenpaku-sha, Tokyo, Japan).

4. Discussion

Constipation is a symptom-based disorder with a largely subjective definition. The frequency of bowel movements is usually considered to be a key point for the diagnosis of chronic constipation, although it is neither sufficient nor necessary for the diagnosis [2]. Although patients with constipation have been reported to be more concerned with the ease of passage and stool consistency rather than the frequency of bowel movements [20], the most common reason behind the feeling of constipation in our participants was a low frequency of bowel movements, followed by symptoms such as a sensation of incomplete evacuation, defecation difficulty, abdominal pain and/or abdominal bloating, a hard or lumpy stool texture, and a small defecation volume. Tamura *et al.* also reported that participants with self-recognized constipation considered "few bowel movements" to be the most important factor, followed by "difficulty in defecation", "hard stools", and "inability to defecate without medication" [6].

Apart from age and gender, mental status (depression) and modifiable lifestyle factors, such as a higher BMI, skipping meals (breakfast or lunch), an irregular daily time of defecation, dieting experience, lower frequency of chewing per bite, lower physical activity, and fewer hours of sleep per day have been associated with constipation [11]. Moreover, constipation has also been reported to be associated with the consumption of certain foods: among young Japanese women, it is positively associated with the consumption of confectionery, bread, and Japanese and Chinese tea, and is inversely correlated with the consumption of rice, pulses, and coffee [21, 22]. Our results were at least partly consistent with the above findings, as our participants with chronic constipation had a significantly higher BMI and higher dietary intakes of protein (energy ratio), fat (energy ratio), cholesterol, animal protein (ratio), animal fat (ratio), meats and eggs. Conversely,

the carbohydrate energy ratio and vegetable fat ratio were significantly lower in the participants with chronic constipation than in the participants without chronic constipation, in this study.

The pathogenesis of IBS also appears to be multifactorial as it is affected by heredity and genetics, the dietary/intestinal microbiota, and disturbances of the neuroendocrine system of the gut [23, 24]. Also, IBS-C patients show a higher prevalence of psychological disorders, such as depression and anxiety [2]. Kosako *et al.* reported that female IBS-C patients (aged 20 to 49 years) with abdominal pain, according to the Rome IV criteria, had more anxiety [25]. A definite state of anxiety, as assessed using the HADS-A, was more common in our participants with IBS (12 of 22 participants; 54.5%) than in those without IBS (35 of 100 participants; 35.0%), although the difference was not statistically significant. Psychological stress can result in intestinal symptoms by inducing changes in intestinal functions that are mediated by the autonomic nervous system, hypothalamic-pituitary-adrenal axis, and/or immune system [26, 27]. In this context, participants that reported a decreased appetite due to stress or fatigue were significantly more common in the IBS group than in the non-IBS group, in this study.

IBS has also been reported to be positively associated with the dietary intake of canned foods, processed meats, beef, milk, pulses, cereals or grain bread/pasta, cafeteria products, fruit compotes, and herbal teas [28], and negatively associated with the dietary intake of fish, fruit, milk, and green-yellow vegetables [29]. However, in contrast to the results for chronic constipation, there were no significant differences in the consumption of any of the nutrients and food groups studied between the participants with and without IBS, except for snacks, which were consumed in higher quantities by the participants without IBS than those with IBS. The participants with IBS may have avoided snacks because snacks were considered to trigger IBS.

In this study, 18.0% (22/122) of the participants were diagnosed with IBS, according to the Rome IV criteria [8]. Seven years ago (June-July, 2012), we conducted a similar study on female students from the same university and reported that the prevalence of IBS according to the Rome III criteria was 12.0% (28/234) [5]. Regarding the diagnostic criteria of IBS, the term “discomfort”, which was included in the Rome III criteria, was eliminated from the Rome IV criteria. The definition of “discomfort” is subjective and has different meanings in different languages. Therefore, only “abdominal pain” has now been included in the Rome IV criteria, which is related to bowel movements rather than just improving with bowel movements [9]. Regardless of the change in the diagnostic criteria, the prevalence of IBS appeared to have increased during the last seven years. Although the reasons for this are unclear, the prevalence of IBS-C was higher (25.0% to 27.2%) among our participants.

Lock III *et al.* analyzed a total of 643 participants and reported that 17% had constipation, 12% had IBS, and 6.5% had both constipation and IBS [30]. In this study, 9.2% (12/130) of the participants had chronic constipation, 18.0% (22/122) of the participants had IBS, and only two participants (2/121; 1.7%) had both chronic constipation and IBS. It was noted that the characteristics of nutritional status, mental status, physical activity, lifestyle, and dietary intakes of these two participants were markedly different. Although both participants had similar anxiety and depressive states, occasionally skipped breakfast, and had an irregular daily time of defecation, their dietary intakes of several nutrients and food groups were not consistent. These results suggest that the overlap between chronic constipation and IBS is not highly common and that these two disorders have different clinical characteristics and backgrounds. According to the Rome III criteria, functional constipation and IBS should be theoretically separated mainly by the

presence of abdominal pain or discomfort relieved by defecation, and these two disorders should be mutually exclusive [2]. However, people may have symptoms of multiple disorders at the same time [30], and IBS-C patients may have more constipation-associated symptoms than patients with functional constipation [31]. Therefore, the Rome IV criteria consider that functional constipation and IBS-C exist as a continuum rather than as isolated disorders [9]. Patients with chronic constipation and IBS-C share several similar gastrointestinal complaints and psychosocial characteristics [32]. However, gastrointestinal and psychological presentations of these two diseases have been reported to differ slightly from each other, as IBS-C patients had more severe bloating, heartburn, and depression, while patients with chronic constipation had worse sleep quality [32]. Moreover, Siah *et al.* recently reported that differential responses of these diseases to treatment provided the strongest evidence that they may be different disorders, rather than components of a single disease [33].

There were limitations worth noting in the present study. First, our study population was relatively small, although the calculated sample size was reasonable. The main reason for the small study size was the low rate of participation in the study (18.5%), which may have possibly led to the selection bias. In the present study, surveys were conducted by conventional techniques that have recently become more difficult to execute due to enhanced protection of personal privacy. In contrast, an internet-based (online questionnaire) survey can provide significant amounts of data without requiring individuals to identify themselves. However, this methodology cannot guarantee that a survey was actually completed by the participant, and also cannot exclude the possibility that the participants may provide answers indifferently [6]. Second, the word “straining” was replaced with “defecation difficulty” in our questionnaire. In addition, because “digital evacuation or support of the pelvic floor” was expected to be unfamiliar and rarely tried by our study participants, this criterion was excluded from the questionnaire, and the participants were asked to freely describe the manual maneuvers utilized to facilitate defecation. These changes to the questionnaire may have affected the results obtained for the prevalence of chronic constipation and its association with mental status, physical activity, lifestyle, and dietary intake. Third, this study was a cross-sectional one, which could reveal only associations between the studied elements and not causality. Fourth, the participants in the present study included only female undergraduate students in a rural area of the southwestern part of Japan, and may thus not be representative of the general population of young Japanese women.

5. Conclusions

This study found that the prevalence of chronic constipation and IBS was 9.2% and 18.0%, respectively, and only two (1.7%) participants had both constipation and IBS. A higher BMI and dietary intake of certain nutrients and food groups were associated with chronic constipation. However, in contrast to the results for chronic constipation, the dietary intakes of nearly all the nutrients or food groups studied were not associated with IBS. These results suggest that the overlap between chronic constipation and IBS was not highly common and that these two disorders had different clinical characteristics and backgrounds. As our results were obtained only from a small sample of young females, further investigation with larger sample size, including other age groups and genders, is needed to confirm our present findings.

Acknowledgments

The authors thank Professor Hitoshi Morita, Department of Global and Media Studies, Professor Toru Hiraoka, Department of Information Systems, Professors Tetsuya Nagano and Ayako Komatsu, Department of Information Security, for their assistance in this survey.

Author Contributions

K. Omagari created the study design, adjusted results and drafted the article. R.K., Y.K., M.S. and A.T. recruited the participants and analyzed the data. A.K. and M.I. interpreted the data. K.K., A.K. and K. Otsuka provided critical advice and approved the final version of the manuscript to be published. All authors have read and approved the final manuscript.

Funding

This research was not funded by any specific project grant.

Competing Interests

The authors declare no conflicts of interest (COI) in preparing this article.

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