**Name of Journal:** *World Journal of Clinical Cases*

**Manuscript NO:** 61384

**Manuscript Type:** ORIGINAL ARTICLE

***Observational Study***

**Differences in dietary habits of people with *vs* without irritable bowel syndrome and its association with symptom and psychological status: A pilot study**

Meng Q *et al*. IBS and dietary habits

Qiao Meng, Geng Qin, Shu-Kun Yao, Guo-Hui Fan, Fen Dong, Chang Tan

**Qiao Meng, Shu-Kun Yao, Chang Tan,** Graduate School, Peking University China-Japan Friendship School of Clinical Medicine, Beijing 100029, China

**Geng Qin, Shu-Kun Yao,** Department of Gastroenterology, China-Japan Friendship Hospital, Beijing 100029, China

**Guo-Hui Fan, Fen Dong,** Institute of Clinical Medical Sciences, China-Japan Friendship Hospital, Beijing 100029, China

**Author contributions:** Meng Q and Tan C performed the study, analyzed the data and drafted the manuscript; Dong F and Fan GH gave guidance to data processing; Qin G contributed to project design and supervised the investigation progress; Yao SK designed the study, revised the manuscript, and supervised the study performance.

**Supported by** the National Key Technology Support Program during “12th Five-Year Plan” period of China, No. 2014BAI08B00; and the Leap-forward Development Program for Beijing Biopharmaceutical Industry (G20), No. Z171100001717008.

**Corresponding author: Shu-Kun Yao, MD, PhD, Professor,** Graduate School, Peking University China-Japan Friendship School of Clinical Medicine, No. 2 Yinghua East Road, Chaoyang District, Beijing 100029, China. shukunyao@126.com

**Received:** December 5, 2020

**Revised:** December 28, 2020

**Accepted:** February 19, 2021

**Published online:**

**Abstract**

BACKGROUND

Previous studies have demonstrated that dietary factors were involved in irritable bowel syndrome (IBS), but the role of diet was evaluated mostly based on food frequency questionnaire. Whether food categories, quantity per time and intake frequency were different between IBS patients and non-IBS individuals has not been clearly clarified.

AIM

To explore differences in dietary habits of people with *vs* without IBS and its correlation with symptom and psychological status.

METHODS

Of 220 questionnaires were distributed in a community population and the Rome IV criteria was applied to diagnose IBS. The dietary questionnaire used in this study was multidimensional from food categories, quantity per time and intake frequency, in contrast to “yes or no” classification used in previous studies. IBS symptom severity scale (IBS-SSS), IBS quality of life, visceral sensitivity index, hospital anxiety and depression score (HADS) and gastrointestinal symptom rating scale of participants were also collected. Rank sum test was used to compare the quantity per time and intake frequency between IBS patients and non-IBS participants. The correlation between psychological factors and diet was evaluated by Spearman correlation analysis. Logistic regression analysis was used to assess the possible dietary risk factors for IBS.

RESULTS

In total, 203 valid questionnaires were collected (response rate 92.3%). Twenty-five participants met the Rome IV criteria for IBS, including 15 (60.0%) women and 10 (40.0%) men. Compared with the non-IBS group, the quantity per time and intake frequency of soybean and its products, spicy food and dry-fried nuts were statistically significant in IBS participants (all *P* < 0.05). They were positively associated with IBS-SSS, HADS anxiety and depression score (all *P* < 0.05). Besides, seafood, soft drinks, vegetables and fruits differed only in quantity per time. The intake frequency of egg, barbecue and coarse grain were statistically significant in IBS patients (all *P* < 0.05). We also found that the frequency of soybean and its products (≥ 7 *t*/wk, odds ratio 11.613, 95% confidence interval 2.145-62.855, *P* = 0.004) was an independent risk factor for IBS.

CONCLUSION

Both quantity per time and intake frequency, especially soybean, differ between IBS patients and non-IBS participants. Dietary habits might play potential roles in the pathophysiology of IBS.

**Key Words:** Irritable bowel syndrome; Dietary habits; Quantity per time; Intake frequency; Symptom severity; Psychosocial status

Meng Q, Qin G, Yao SK, Fan GH, Dong F, Tan C. Differences in dietary habits of people with vs without irritable bowel syndrome and its association with symptom and psychological status: A pilot study. *World J Clin Cases* 2021; In press

**Core Tip:** This study investigated the dietary habits between irritable bowel syndrome (IBS) patients and non-IBS participants based on a multidimensional questionnaire. We also found that quantity per time and intake frequency of some foods were positively associated with symptom and psychological status, especially soybean. The intake frequency of soybean and its products was an independent risk factor for IBS.

**INTRODUCTION**

Irritable bowel syndrome (IBS) is one of the most common functional bowel disorders characterized by abdominal pain and accompanied by changes in defecation habits and fecal traits, of which diarrhea-predominant irritable bowel syndrome (IBS-D) accounts for the majority of cases[1,2]. According to the published literatures, the prevalence of IBS varies from 0.2% to 29.2%[2], and this variation might be related to research subjects, investigation methods and diagnostic criteria[3,4]. Recurrent symptoms led to a significant decline in the quality of life of patients, which was associated with substantial costs to patients, healthcare systems and society. Effective interventions could alleviate the symptoms and improve the quality of life in IBS patients[5].

The etiology and pathogenesis of IBS have not been fully elucidated but is considered to be the result of multiple factors, such as visceral hypersensitivity, intestinal mucosal inflammation and increased intestinal permeability[6]. Many studies have found that an inappropriate diet could induce or aggravate IBS symptoms, such as spicy food, fruit, soybeans, dairy products, onion and meat[7,8]. Recent studies suggested that the fermented oligosaccharide, disaccharide, monosaccharide and polyol (FODMAP) diet and a gluten-rich diet played important roles in the pathogenesis of IBS[9,10]. The effectiveness of low FODMAP diet and gluten-free diet (GFD) in alleviating IBS symptoms have been confirmed in many researches of the Western countries[11-16].

It has been known that dietary pattern, as a factor of nutrition, was different between the Eastern and Western countries. An Asian diet was characterized by high-carbohydrate, high-fiber, low-fat and low-meat protein. A traditional Asian diet usually included rice and vegetables, which were the main sources of carbohydrates and fibers. Vegetable oil was a common source of fat, while fish, egg, poultry and pork were the major protein sources. This was different from a modern Western diet, which was rich in animal fat and protein, but low in carbohydrates and fibers[17]. It is of great significance to fully understand the dietary habits in Chinese population, for guiding the choice of diet therapy.

There has been no high-quality evidence to support the effectiveness of "elimination diet" in patients with IBS in China. In clinical practice, we found that the pathogenicity of diet might also be associated with quantity per time. However, the majority of studies using the food frequency questionnaire (FFQ)[18-21] might not fully reflect the diet habits of IBS patients. Differing from FFQ[22] , although commonly used, we supposed that the effect of diet was similar to the dose-response and time-response relationship of drugs. Consequently, we designed and used a multidimensional dietary questionnaire. The innovative questionnaire involved three dimensions, including food categories, intake frequency and quantity per time, rather than simply classifying responses as “yes or no” as noted in previous studies. Based on this innovative questionnaire, we surveyed the diet of residents in a Northern city including IBS patients and non-IBS participants. We evaluated and analyzed the dietary habits between IBS patients and non-IBS participants objectively and semi-quantitatively according to the questionnaire. It helped to understand the dietary habits of IBS patients comprehensively, and to provide evidence for dietary guidance.

The main aim of this study was to compare dietary habits between IBS patients and non-IBS participants from food categories, quantity per time and intake frequency in Chinese population. The secondary purpose was to explore the correlation between symptom, psychological status and diet.

**MATERIALS AND METHODS**

***Study setting***

From May 2020 to July 2020, a cross-sectional survey was conducted among the permanent residents selected by simple random sampling in Hongsheng community in Gaomi city, Shandong Province, China. To some extent, they were representative of city residents in northern China. Finally, 220 residents were included in this study. The study was performed filling in the questionnaires face to face. All participants were fully informed of the study and provided written informed consent. The study protocol was approved by the Ethics Committee of China-Japan Friendship Hospital (No. 2015-33), and the study was performed in accordance with the Declaration of Helsinki.

***Study population***

The inclusion criteria for participants were as follows: (1) Participants older than 18 years old, regardless of gender; and (2) There were no abnormalities during colonoscopy within half a year. Participants with the following conditions were excluded: (1) Presence of warning symptoms, such as hematochezia, positive fecal occult blood test, anemia, abdominal mass, ascites, fever, weight loss, family history of colorectal cancer; (2) Family history of cancer; (3) Chronic diseases, such as diabetes mellitus, hypertension, chronic kidney disease, chronic hepatitis, liver cirrhosis, inflammatory bowel disease and autoimmune diseases; (4) Abdominal and pelvic surgery; and (5) Pregnant or lactating women.

***Criteria for IBS patients***

The newest diagnostic criteria,Rome IV, was established in 2016[23]. Recurrent abdominal pain occurred at a frequency of at least one day/week, associated with two or more of the following criteria: (1) Related to defecation; (2) Associated with a change in frequency of stool; or (3) Associated with a change in form (appearance) of stool. The criteria fulfilled for the last 3 mo with symptom onset ≥ 6 mo before diagnosis. There were no morphological changes and biochemical abnormalities that could explain the symptoms.

***Sociodemographic characteristics***

Detailed baseline information, including age, gender, body mass index, level of education, drinking and smoking was obtained for each participant.

***Dietary assessment***

The dietary habits of 220 participants three to six months before investigation were assessed. The diet questionnaire was conducted by a trained researcher at the beginning of the study to interview each participant directly, and the mean time required to answer dietary questionnaire was approximately 15 min. Two hundred and three questionnaires were collected, of which 135 were valid (IBS patients 25, non-IBS participants 110).

There was no consensus among the studies whether it was necessary to set the option "quantity per time" in the questionnaire. Researchers from the university of California believed that the option "quantity per time" could increase the validity of the FFQ[24], while scholars from the Institute of Cancer Epidemiology in Copenhagen thought that it has little effect on the validity of the FFQ[25]. In order to reflect the dietary habits of the participants in detail, we revised the FFQ according to the Chinese eating habits, and average quantity per time was included in the questionnaire. So, the diet questionnaire in this study included three elements: food categories, quantity per time and intake frequency.

Food list included six food categories: (1) Animal protein; (2) Vegetable protein; (3) Spicy food, barbecue and dry-fried nuts; (4) Soft drinks; (5) Staple food, and (6) Vegetables and fruits. The pictures of each food in 25 g were presented to all participants for semi-quantitative estimation. We asked participants to describe how many portions they ate each time, and counted the quantity per time. Product labels were used as appropriate. For soft drinks, soybean milk and eggs, we took the bottles or numbers as the unit. The intake frequency (time/week) was divided into three groups：≤ 1 *t*/wk, 2-6 *t*/wk and ≥ 7 *t*/wk, rather than "seldom, sometimes, always" mentioned by FFQ[26]. The detailed dietary questionnaire was provided in Supplementary Table 1. The questionnaire focused not only on intake frequency, but also on quantity per time.  Compared with FFQ, the dietary questionnaire revealed the eating habits with a wider range, while the validity of the questionnaire should be confirmed in a larger sample.

***Questionnaires***

**Chinese version of Rome IV questionnaire:** The diagnostic questionnaire used in this study is the Rome IV diagnostic questionnaire for adults[27].

**IBS symptom severity scale questionnaire:** This scale[28] was used to assess the severity of IBS symptoms. The scale included five items (abdominal pain degree, abdominal pain frequency, abdominal distension, stool characteristics and quality of life). The score of each item was between 0 and 100, and the total score of the five items was added.

**IBS-specific quality of life questionnaire:** This scale[29] was used to evaluate the quality of life of IBS patients and included 34 items. The higher the score, the better the quality of life of patients.

**Gastrointestinal symptom rating scale questionnaire:** The gastrointestinal symptoms were evaluated using a standardized gastrointestinal symptom rating scale (GSRS)[30], and the common gastrointestinal symptoms were quantified. The specific items included heartburn, acid regurgitation, upper abdominal tightness, nausea and vomiting, bowel sounds, belching, increased frequency of defecation, feeling of urgency and incomplete defecation. The score for each item was 0 to 3, and the total score was 0 to 30.

**Visceral sensitivity index questionnaire:** The scale was a self-rating scale for assessing visceral sensitivity and anxiety related to gastrointestinal symptoms. The scale consisted of 15 items. Each item was scored 1 to 5, and the scale had a total score of 0 to 75. The higher the score, the higher the visceral sensitivity and the more serious the anxiety.

**Hospital anxiety and depression scale questionnaire:** Standardized hospital anxiety and depression scale (HADS)[31] was used to assess the psychological state. The scale included 14 items (7 items for anxiety and 7 items for depression), and each item was scored from 0 to 3 points. The HADS anxiety score and depression score were obtained by adding the individual item scores, separately.

***Statistical analysis***

SPSS version 26.0 (SPSS Inc., Chicago, IL, United States) was used for statistical analysis. The quantitative data were represented by median (Q1, Q3) and the qualitative data were expressed as number (percentage). Wilcoxon rank sum test was used for the comparison between groups. Spearman correlation analysis was used to evaluate the correlation analysis. Logistic regression analysis was used to assess the possible risk factors for IBS. *P* < 0.05 was defined as statistically significant. Statistical charts were generated using Graph Prism version 8.0 (GraphPad Software Inc., La Jolla, CA, United States).

**RESULTS**

***Basic characteristics***

The questionnaire was completed by 203 of the 220 participants (response rate 92.3%), including 122 (60.1%) women and 81 (39.9%) men. According to the Rome IV questionnaire, 25 participants were diagnosed IBS, and 60.0% were women. The number of IBS with predominant constipation, IBS-D, IBS with mixed bowel habits and IBS unclassified were 5 (20%), 7 (28%), 9 (36%) and 4 (16%), respectively. Sociodemographic and clinical characteristics between IBS patients and non-IBS participants were presented in Table 1.

***Dietary habits***

Sixty-eight questionnaires were incomplete of 203. Only 135 (61.4%) dietary questionnaires were valid, including 25 IBS patients and 110 non-IBS participants. The dietary results were provided in the form of quantity per time (Figure 1 and 2) and intake frequency (Figure 3 and 4). The dietary factors of the two groups were evaluated comprehensively. We found that patients with IBS consumed more soybean and its products, spicy food and dry-fried nuts in terms of quantity per time and intake frequency. Besides, seafood, soft drinks, vegetables and fruits differed only in quantity per time. The intake frequency of egg, barbecue and coarse grain were statistically different. Results with significant differences were shown in Table 2 and a more detailed analysis of dietary factors was provided in Supplementary Table 2.

***Symptom severity and psychological factors***

We found that visceral sensitivity index [median (Q1, Q3), 64.0 (53.0, 68.5) *vs* 29.0 (17.5, 38.25), *P* < 0.001]、HADS anxiety score [7.0 (3.5, 10.0) *vs* 3.0 (1.0, 6.0), *P* < 0.001]、HADS depression score [5.0 (2.5, 8.0) *vs* 3.0 (1.0, 6.0), *P* = 0.026] and GSRS [4.0 (3.0, 6.5) *vs* 3.0 (1.0, 5.0), *P* = 0.007] were significantly increased in IBS patients compared with the non-IBS group. See Table 2 for relevant statistical data.

***The association between dietary factors and clinical score, psychological score.***

After the univariate analysis, we found that the quantity per time and intake frequency of soybean and its products, spicy food and dry-fried nuts were statistically significant. They were positively associated with IBS symptom severity scale (IBS-SSS), HADS anxiety score and HADS depression score. See details in Table 3.

***Risk factors for IBS***

Combined with previous literatures, we finally entered the frequency of soybean and its products, spicy food and dry-fried nuts into multivariable logistic regression analysis. This study found that the frequency of soybean and its products (≥ 7 *t*/wk, odds ratio 11.613, 95% confidence interval 2.145-62.855, *P* = 0.004) was an independent risk factor for IBS. The results were shown in Table 4.

**DISCUSSION**

IBS is a common functional bowel disorder that is the result of multiple factors. In plenty of researches, the role of diet in the occurrence and development of IBS has been widely concerned. Diet could cause IBS symptoms by several mechanisms, such as a direct effect of food, changing gut microbiota and immune activation[32]. An elimination diet, such as low-FODMAP diet or GFD diet, represented an effective intervention for relieving gastrointestinal symptoms in patients with IBS[33].

As we all know, food categories differed largely between the eastern and western diet[17]. Moreover, the mostly used dietary questionnaires, especially FFQ, only evaluated the intake frequency of some foods[19,21]. Thus, these diet questionnaires were not entirely suitable to evaluate the dietary habits of Asian population, especially the Chinese. We constructed a new dietary questionnaire according to the eating habits of the Chinese, and “quantity per time” was included for analysis. It is the first study using a multidimensional questionnaire to investigate the dietary habits systematically and comprehensively between IBS patients and non-IBS participants in a community-based study. The formulation of the questionnaire has been completed in clinical practice before this study, and the reliability and validity test will be performed in the future.

To our delight, we found some clinically instructive findings. In our study, the consumption of soybean and its products, egg and seafood were significantly increased in patients with IBS. Such differences have been confirmed in previous studies[34,35]. Protein could be fermented to produce sulfur-containing and nitrogen-containing gases. A large amount of gas accumulated in enteric cavity and led to high intraluminal pressure, which then induced abdominal pain, abdominal discomfort and other symptoms[36,37]. In addition, metabolic products of protein fermentation, such as short-chain fatty acids, phenolic and indolic compounds, exerted harm in the intestinal tract depending on the imbalance among the rate of production, absorption and excretion[38]. Food allergy, characterized by an activation of IgE-mediated antibodies to a food protein, was still controversial in the pathogenesis of IBS[39]. Zuo *et al*[40]reported that serum IgG antibody increased in IBS patients compared with health controls. However, no significant correlation was observed between symptom severity and elevated serum food antigen-specific IgG antibodies. Soybeans were rich in proteins and carbohydrates, which might participate in the pathogenesis of IBS through accumulated gaseous products and toxic metabolites of fermentation. In the multivariate analysis, the intake frequency of soybean and its products (≥ 7 *t*/wk) was an independent risk factor for IBS. This also provided theoretical support to eliminate soybean and its products from diet structure in IBS patients.

At the same time, we also found that spicy foods differed between two groups. Everyone knows that spicy foods contain capsaicin. Previous controlled studies have found that patients with functional dyspepsia and IBS were highly sensitive to capsaicin or capsaicin containing foods[41,42]. Capsaicin could act on transient receptor potential vanilloid-1 (TRPV-1) and mediate visceral hypersensitivity[43,44]. A multicenter study involving Korean and Japanese populations found that, regardless of TRPV-1 genotype and *Helicobacter pylori* infection status, upper gastrointestinal symptoms were more common in patients who ate more spicy foods[45]. Contrary to expectations, long-term intake of capsaicin agonists or chilli could desensitize and improve symptoms. Compared with placebo, red pepper improved the dyspeptic symptoms effectively, which the desensitization of gastric nociceptive C-fibers was attributed to capsaicin[46]. This study found that IBS patients consumed more spicy foods from quantity per time and intake frequency. Further studies are needed to confirm whether the correlation between capsaicin and functional gastrointestinal disorders (FGIDs) symptoms is related to duration time, single dose and intake frequency.

In recent years, the effect of nuts has been widely concerned by scholars worldwide. Nuts were rich in antioxidants, particularly vitamin E and polyphenols, which played antioxidant properties by mediating DNA repairment, preventing lipid peroxidation and regulating signal pathway[47]. However, some scholars also have found that foods could cause a variety of diseases after dry-fried or high-temperature processed. Oh *et al*[48]revealed that the allergen activity of raw, dry-fried and boiled walnuts differed, and the walnut allergen activity was reduced by thermal processing methods. Several studies have revealed nutrient-sensing mechanisms existed in the gastrointestinal tract and resulted in the transmission of neuronal signals to the brain, particularly satiety[49]. The taste of food was changed during high-temperature processing, which might be related with reduced gut-brain satiety signal. In addition, a large number of harmful substances were formed during high-temperature cooking, which could mediate tissue damage and cause mucosal low-grade inflammation[50-52]. Other studies have shown that some food additives, such as artificial sweeteners, emulsifiers and food colorants, could mediate inflammation and induce intestinal flora imbalance[53-55]. Our study found that the intake frequency and quantity per time of dry-fried nuts in IBS patients were higher than that of non-IBS participants. We speculated that dry-fried or high-temperature processed food might aggravate symptoms by changing food allergen activity, re-setting of satiety signal and inducing gut inflammation by food additives or harmful substances. It is necessary to further explore the detailed mechanisms *in vitro* and animal experiments.

The study also found that IBS patients ate coarse grain more frequently. In fact, there are two types of dietary fiber in these foods: soluble dietary fiber and insoluble dietary fiber. The role of dietary fiber in IBS remained to be determined. A meta- analysis of 22 studies found that soluble fiber improved assessment of symptoms, as well as the abdominal pain score. However, no improvement was observed in insoluble fiber group[56]. Another study has shown that there was no definitive recommendation supporting the use of fiber for children with IBS[57]. Further prospective studies are needed to confirm the association or dose-response trend for different types of dietary fiber separately with risk of IBS.

In addition, soft drinks, vegetables and fruits differed only in quantity per time between IBS patients and non-IBS participants. The soft drinks contained reducing sugars, which were poorly digested and absorbed. A large amount of reducing sugars accumulated in the enteric lumen and formed osmotic activity[33]. Whether vegetables were protective or harmful, it may be related to vegetable varieties. It is generally accepted that onion, garlic and chives could induce IBS symptoms[58]. We found that IBS patients ate more vegetables and fruits at a time, and no positive results were found in the intake frequency. Therefore, we speculated that a single high-dose intake may lead to a sharp increase in intraluminal osmotic activity and liquid secretion, inducing symptoms. The results might be limited by the sample size. Further studies are still needed to clarify whether differences in the intake frequency of vegetables and fruits existed between IBS patients and health controls.

Unfortunately, no statistical differences were found in meat and processed meat between two groups. The results were not in line with that in previous studies[21]. To our surprise, a study from Bangladesh found that less intake of meat was an important associated factor for IBS. These differences might be attributed to different eating habits among populations[36]. It is necessary to refine the scale and enlarge the sample size to confirm whether differences existed in meat and processed meat between IBS patients and non-IBS participants.

In our study, IBS patients had visceral hypersensitivity, which was consistent with the results of previous studies[6,59]. The mechanisms of visceral hypersensitivity in IBS patients were mainly related to visceral afferent nerve sensitization, increased excitability of neurons in the dorsal horn of spinal cord and central sensory abnormalities. The visceral hypersensitivity was also characterized by the high response to dining. That is to say, dining could induce visceral hypersensitive symptoms, such as abdominal pain, abdominal distension, abdominal discomfort, *etc*[60]. Previous studies have reported that IBS may overlap with other FGIDs[61,62], thus making the illness more complicated to diagnose for clinicians. This might help explain that IBS patients had a higher score of GSRS questionnaire in our study. It is generally believed that psychological disorders might be closely related to IBS. As findings in our study, the anxiety and depression scores of IBS patients were significantly increased according to HADS questionnaire. Psychological abnormalities could change autonomic nervous function, which led to gastrointestinal dysfunction and affected visceral sensation. In addition, due to visceral hypersensitivity and other reasons, the information captured by visceral receptors was amplified in the process of uploading to central nervous system (CNS), thus affecting the state of the CNS and changing the emotional response[63,64].

This study found that soybeans, spicy foods and dry-fried nuts were positively correlated with symptoms and psychological scores. The correlations between symptom severity, psychological state and diet were different among studies. Bennet*et al*[65] reported that the low FODMAP diet lasting 4 wk significantly reduced IBS-SSS by ≥ 50, and had significant impact on fecal bacteria[65]. A study on pregnant women showed that low intake of soybeans was significantly associated with generalized anxiety disorder[66]. Compared with a healthy dietary pattern, Western dietary pattern was characterized by a higher consumption of meat and eggs, which increased the risk of current and subsequent depression[67]. In our opinion, the damage caused by a low-dose intake or low intake frequency of some food could be quickly repaired. However, high-dose intake per time, high intake frequency and long-term intake could lead to cumulative effects, exceeding the repairing ability of tissues, causing damage and inducing symptoms. Long-term dietary habits undoubtedly had effects on intestinal ecosystem. The products of intestinal flora might stimulate the enteric nervous system and vagal afferents, and promote the activation of the hypothalamic-pituitary-adrenal axis[68]. Further studies are needed to confirm our deduction.

To date, most studies have confirmed that the frequency of some food were independent risk factors for IBS, which used the FFQ. However, there was no difference in the food frequency in IBS patients compared with non-IBS patients sometimes. This study objectively reflected the eating habits of residents in a Chinese community. It is significant for guiding IBS patients to have a reasonable diet. The results also confirmed that the quantity per time of specific food might differed between IBS patients and non-IBS participants. Physicians should not make decisions simply depending on intake frequency, but on the basis of multidimensional questionnaire.

Our research also has some limitations. First, there were differences only in intake frequency or quantity per time in some foods, which may be limited by the sample size and need more detailed classification. Larger sample size studies are performed to confirm our results in the future. In addition, the diet questionnaire relied on memory rather than the use of diet diary, which could result in recall bias. Third, the reliability and validity test of the dietary questionnaire are needed in the subsequent experiments with sufficient samples. Last but not the least, the role of food ingredients and cooking methods has not been deeply studied. This required further exploration in the subsequent experiments. Further studies should refine scale, expand the sample size and adopt a prospective study design to delve into the role of diet in IBS.

**CONCLUSION**

In conclusion, this study evaluated dietary differences between IBS patients and non-IBS participants from multiple perspectives, including food categories, intake frequency and quantity per time. The intake frequency and quantity per time of soybean and its products, spicy foods and dry-fried nuts were positively associated with clinical and psychological status. The intake frequency of soybean was a risk factor for IBS. These data suggested that some foods played a potential role in the occurrence and development of IBS.

**ARTICLE HIGHLIGHTS**

***Research background***

Previous studies have demonstrated that dietary factors could induce or aggravate irritable bowel syndrome (IBS) symptoms, which was evaluated mostly based on food frequency questionnaire. This study investigated the dietary habits between IBS patients and non-IBS participants from food categories, quantity per time and intake frequency.

***Research motivation***

Our study was to explore the dietary differences between IBS patients and non-IBS participants from dietary categories, intake frequency and quantity each time. These differences might be helpful for dietary guidance in the treatment of IBS.

***Research objectives***

To explore differences in dietary habits of people with *vs* without IBS and its correlation with symptom and psychological status.

***Research methods***

The participants were evaluated by the questionnaires (dietary questionnaire, IBS symptom severity scale (IBS-SSS), IBS quality of life, visceral sensitivity index, hospital anxiety and depression score (HADS) and Gastrointestinal symptom rating scale) to obtain clinical and psychological characteristics. These parameters were analyzed by SPSS version 26.0.

***Research results***

In this study, patients with IBS consumed more soybean and its products, spicy food and dry-fried nuts in terms of quantity per time and intake frequency. They were positively associated with IBS-SSS, HADS anxiety score and HADS depression score. Besides, seafood, soft drinks, vegetables and fruits differed only in quantity per time. The intake frequency of egg, barbecue and coarse grain were statistically different. We also found that the intake frequency of soybean and its products (≥ 7 *t*/wk) was an independent risk factor for IBS.

***Research conclusions***

In conclusion, the dietary habits differed between IBS patients and non-IBS participants. The intake frequency and quantity per time of soybean and its products, spicy foods and dry-fried nuts were positively associated with clinical and psychological status, and the intake frequency of soybean was a risk factor for IBS. These results suggested that some foods played a potential role in the occurrence and development of IBS.

***Research perspectives***

We preliminarily explored the dietary differences between the two groups. However, some limitations existed in this study. Further studies should refine scale, expand the sample size and adopt a prospective study design to delve into the role of diet in IBS in the future.

**ACKNOWLEDGEMENTS**

We thank Ms. Sun YJ, Ms. Qiao JY for collecting questionnaires and Dr. Zhouge YJ, Dr. Yin TF, Dr. Zhao DY for amending the manuscript.

**REFERENCES**

1 **Barbara G**, Feinle-Bisset C, Ghoshal UC, Quigley EM, Santos J, Vanner S, Vergnolle N, Zoetendal EG. The Intestinal Microenvironment and Functional Gastrointestinal Disorders. *Gastroenterology* 2016; **150**: 1305-1318.e8 [PMID: 27144620 DOI: 10.1053/j.gastro.2016.02.028]

2 **Oka P**, Parr H, Barberio B, Black CJ, Savarino EV, Ford AC. Global prevalence of irritable bowel syndrome according to Rome III or IV criteria: a systematic review and meta-analysis. *Lancet Gastroenterol Hepatol* 2020; **5**: 908-917 [PMID: 32702295 DOI: 10.1016/S2468-1253(20)30217-X]

3 **Sperber AD**, Bangdiwala SI, Drossman DA, Ghoshal UC, Simren M, Tack J, Whitehead WE, Dumitrascu DL, Fang X, Fukudo S, Kellow J, Okeke E, Quigley EMM, Schmulson M, Whorwell P, Archampong T, Adibi P, Andresen V, Benninga MA, Bonaz B, Bor S, Fernandez LB, Choi SC, Corazziari ES, Francisconi C, Hani A, Lazebnik L, Lee YY, Mulak A, Rahman MM, Santos J, Setshedi M, Syam AF, Vanner S, Wong RK, Lopez-Colombo A, Costa V, Dickman R, Kanazawa M, Keshteli AH, Khatun R, Maleki I, Poitras P, Pratap N, Stefanyuk O, Thomson S, Zeevenhooven J, Palsson OS. Worldwide Prevalence and Burden of Functional Gastrointestinal Disorders, Results of Rome Foundation Global Study. *Gastroenterology* 2021; **160**: 99-114.e3 [PMID: 32294476 DOI: 10.1053/j.gastro.2020.04.014]

4 **Palsson OS**, Whitehead W, Törnblom H, Sperber AD, Simren M. Prevalence of Rome IV Functional Bowel Disorders Among Adults in the United States, Canada, and the United Kingdom. *Gastroenterology* 2020; **158**: 1262-1273.e3 [PMID: 31917991 DOI: 10.1053/j.gastro.2019.12.021]

5 **Canavan C**, West J, Card T. Review article: the economic impact of the irritable bowel syndrome. *Aliment Pharmacol Ther* 2014; **40**: 1023-1034 [PMID: 25199904 DOI: 10.1111/apt.12938]

6 **Gwee KA**, Gonlachanvit S, Ghoshal UC, Chua ASB, Miwa H, Wu J, Bak YT, Lee OY, Lu CL, Park H, Chen M, Syam AF, Abraham P, Sollano J, Chang CS, Suzuki H, Fang X, Fukudo S, Choi MG, Hou X, Hongo M. Second Asian Consensus on Irritable Bowel Syndrome. *J Neurogastroenterol Motil* 2019; **25**: 343-362 [PMID: 31327218 DOI: 10.5056/jnm19041]

7 **Ligaarden SC**, Lydersen S, Farup PG. Diet in subjects with irritable bowel syndrome: a cross-sectional study in the general population. *BMC Gastroenterol* 2012; **12**: 61 [PMID: 22676475 DOI: 10.1186/1471-230X-12-61]

8 **Saito YA**, Locke GR 3rd, Weaver AL, Zinsmeister AR, Talley NJ. Diet and functional gastrointestinal disorders: a population-based case-control study. *Am J Gastroenterol* 2005; **100**: 2743-2748 [PMID: 16393229 DOI: 10.1111/j.1572-0241.2005.00288.x]

9 **Rej A**, Aziz I, Tornblom H, Sanders DS, Simrén M. The role of diet in irritable bowel syndrome: implications for dietary advice. *J Intern Med* 2019; **286**: 490-502 [PMID: 31468640 DOI: 10.1111/joim.12966]

10 **Patcharatrakul T**, Juntrapirat A, Lakananurak N, Gonlachanvit S. Effect of Structural Individual Low-FODMAP Dietary Advice vs. Brief Advice on a Commonly Recommended Diet on IBS Symptoms and Intestinal Gas Production. *Nutrients* 2019; **11**: 2856 [PMID: 31766497 DOI: 10.3390/nu11122856]

11 **Wilson B**, Rossi M, Kanno T, Parkes GC, Anderson S, Mason AJ, Irving PM, Lomer MC, Whelan K. β-Galactooligosaccharide in Conjunction With Low FODMAP Diet Improves Irritable Bowel Syndrome Symptoms but Reduces Fecal Bifidobacteria. *Am J Gastroenterol* 2020; **115**: 906-915 [PMID: 32433273 DOI: 10.14309/ajg.0000000000000641]

12 **Cox SR**, Lindsay JO, Fromentin S, Stagg AJ, McCarthy NE, Galleron N, Ibraim SB, Roume H, Levenez F, Pons N, Maziers N, Lomer MC, Ehrlich SD, Irving PM, Whelan K. Effects of Low FODMAP Diet on Symptoms, Fecal Microbiome, and Markers of Inflammation in Patients With Quiescent Inflammatory Bowel Disease in a Randomized Trial. *Gastroenterology* 2020; **158**: 176-188.e7 [PMID: 31586453 DOI: 10.1053/j.gastro.2019.09.024]

13 **Zahedi MJ**, Behrouz V, Azimi M. Low fermentable oligo-di-mono-saccharides and polyols diet *vs* general dietary advice in patients with diarrhea-predominant irritable bowel syndrome: A randomized controlled trial. *J Gastroenterol Hepatol* 2018; **33**: 1192-1199 [PMID: 29159993 DOI: 10.1111/jgh.14051]

14 **Calasso M**, Francavilla R, Cristofori F, De Angelis M, Gobbetti M. New Protocol for Production of Reduced-Gluten Wheat Bread and Pasta and Clinical Effect in Patients with Irritable Bowel Syndrome: A randomised, Double-Blind, Cross-Over Study. *Nutrients* 2018; **10**: 1873 [PMID: 30513824 DOI: 10.3390/nu10121873]

15 **Shahbazkhani B**, Sadeghi A, Malekzadeh R, Khatavi F, Etemadi M, Kalantri E, Rostami-Nejad M, Rostami K. Non-Celiac Gluten Sensitivity Has Narrowed the Spectrum of Irritable Bowel Syndrome: A Double-Blind Randomized Placebo-Controlled Trial. *Nutrients* 2015; **7**: 4542-4554 [PMID: 26056920 DOI: 10.3390/nu7064542]

16 **Vazquez-Roque MI**, Camilleri M, Smyrk T, Murray JA, Marietta E, O'Neill J, Carlson P, Lamsam J, Janzow D, Eckert D, Burton D, Zinsmeister AR. A controlled trial of gluten-free diet in patients with irritable bowel syndrome-diarrhea: effects on bowel frequency and intestinal function. *Gastroenterology* 2013; **144**: 903-911.e3 [PMID: 23357715 DOI: 10.1053/j.gastro.2013.01.049]

17 **Suhana N**, Sutyarso, Moeloek N, Soeradi O, Sri Sukmaniah S, Supriatna J. The effects of feeding an Asian or Western diet on sperm numbers, sperm quality and serum hormone levels in cynomolgus monkeys (Macaca fascicularis) injected with testosterone enanthate (TE) plus depot medroxyprogesterone acetate (DMPA). *Int J Androl* 1999; **22**: 102-112 [PMID: 10194642 DOI: 10.1046/j.1365-2605.1999.00156.x]

18 **Elmaliklis IN**, Liveri A, Ntelis B, Paraskeva K, Goulis I, Koutelidakis AE. Increased Functional Foods' Consumption and Mediterranean Diet Adherence May Have a Protective Effect in the Appearance of Gastrointestinal Diseases: A Case⁻Control Study. *Medicines (Basel)* 2019; **6**: 50 [PMID: 30970582 DOI: 10.3390/medicines6020050]

19 **Mazzawi T**, Hausken T, Gundersen D, El-Salhy M. Effects of dietary guidance on the symptoms, quality of life and habitual dietary intake of patients with irritable bowel syndrome. *Mol Med Rep* 2013; **8**: 845-852 [PMID: 23820783 DOI: 10.3892/mmr.2013.1565]

20 **Khayyatzadeh SS**, Esmaillzadeh A, Saneei P, Keshteli AH, Adibi P. Dietary patterns and prevalence of irritable bowel syndrome in Iranian adults. *Neurogastroenterol Motil* 2016; **28**: 1921-1933 [PMID: 27324285 DOI: 10.1111/nmo.12895]

21 **Tigchelaar EF**, Mujagic Z, Zhernakova A, Hesselink MAM, Meijboom S, Perenboom CWM, Masclee AAM, Wijmenga C, Feskens EJM, Jonkers DMAE. Habitual diet and diet quality in Irritable Bowel Syndrome: A case-control study. *Neurogastroenterol Motil* 2017; **29** [PMID: 28714091 DOI: 10.1111/nmo.13151]

22 **Salari-Moghaddam A**, Keshteli AH, Esmaillzadeh A, Adibi P. Adherence to the pro-inflammatory diet in relation to prevalence of irritable bowel syndrome. *Nutr J* 2019; **18**: 72 [PMID: 31711479 DOI: 10.1186/s12937-019-0487-6]

23 **Mearin F**, Lacy BE, Chang L, Chey WD, Lembo AJ, Simren M, Spiller R. Bowel Disorders. *Gastroenterology* 2016; **150**: 1393-1407.e5 [PMID: 27144627 DOI: 10.1053/j.gastro.2016.02.031]

24 **Block G**, Thompson FE, Hartman AM, Larkin FA, Guire KE. Comparison of two dietary questionnaires validated against multiple dietary records collected during a 1-year period. *J Am Diet Assoc* 1992; **92**: 686-693 [PMID: 1607564]

25 **Tjonneland A**, Haraldsdóttir J, Overvad K, Stripp C, Ewertz M, Jensen OM. Influence of individually estimated portion size data on the validity of a semiquantitative food frequency questionnaire. *Int J Epidemiol* 1992; **21**: 770-777 [PMID: 1521982 DOI: 10.1093/ije/21.4.770]

26 **Brantsæter AL**, Torjusen H, Meltzer HM, Papadopoulou E, Hoppin JA, Alexander J, Lieblein G, Roos G, Holten JM, Swartz J, Haugen M. Organic Food Consumption during Pregnancy and Hypospadias and Cryptorchidism at Birth: The Norwegian Mother and Child Cohort Study (MoBa). *Environ Health Perspect* 2016; **124**: 357-364 [PMID: 26307850 DOI: 10.1289/ehp.1409518]

27 **Palsson OS**, Whitehead WE, van Tilburg MA, Chang L, Chey W, Crowell MD, Keefer L, Lembo AJ, Parkman HP, Rao SS, Sperber A, Spiegel B, Tack J, Vanner S, Walker LS, Whorwell P, Yang Y. Rome IV Diagnostic Questionnaires and Tables for Investigators and Clinicians. *Gastroenterology* 2016; **150**: 1481-1491 [PMID: 27144634 DOI: 10.1053/j.gastro.2016.02.014]

28 **Francis CY**, Morris J, Whorwell PJ. The irritable bowel severity scoring system: a simple method of monitoring irritable bowel syndrome and its progress. *Aliment Pharmacol Ther* 1997; **11**: 395-402 [PMID: 9146781 DOI: 10.1046/j.1365-2036.1997.142318000.x]

29 **Drossman DA**, Patrick DL, Whitehead WE, Toner BB, Diamant NE, Hu Y, Jia H, Bangdiwala SI. Further validation of the IBS-QOL: a disease-specific quality-of-life questionnaire. *Am J Gastroenterol* 2000; **95**: 999-1007 [PMID: 10763950 DOI: 10.1111/j.1572-0241.2000.01941.x]

30 **Svedlund J**, Sjödin I, Dotevall G. GSRS--a clinical rating scale for gastrointestinal symptoms in patients with irritable bowel syndrome and peptic ulcer disease. *Dig Dis Sci* 1988; **33**: 129-134 [PMID: 3123181 DOI: 10.1007/bf01535722]

31 **Bjelland I**, Dahl AA, Haug TT, Neckelmann D. The validity of the Hospital Anxiety and Depression Scale. An updated literature review. *J Psychosom Res* 2002; **52**: 69-77 [PMID: 11832252 DOI: 10.1016/s0022-3999(01)00296-3]

32 **Moayyedi P**, Simrén M, Bercik P. Evidence-based and mechanistic insights into exclusion diets for IBS. *Nat Rev Gastroenterol Hepatol* 2020; **17**: 406-413 [PMID: 32123377 DOI: 10.1038/s41575-020-0270-3]

33 **Gibson PR**, Varney J, Malakar S, Muir JG. Food components and irritable bowel syndrome. *Gastroenterology* 2015; **148**: 1158-74.e4 [PMID: 25680668 DOI: 10.1053/j.gastro.2015.02.005]

34 **Böhn L**, Störsrud S, Törnblom H, Bengtsson U, Simrén M. Self-reported food-related gastrointestinal symptoms in IBS are common and associated with more severe symptoms and reduced quality of life. *Am J Gastroenterol* 2013; **108**: 634-641 [PMID: 23644955 DOI: 10.1038/ajg.2013.105]

35 **Friedman G**. Diet and the irritable bowel syndrome. *Gastroenterol Clin North Am* 1991; **20**: 313-324 [PMID: 2066155 DOI: 10.1097/01.mog.0000208462.92136.02]

36 **Saha M**, Parveen I, Uddoula MS, Alam MJ, Afsar NS, Debnath BC, Ali SE. Irritable Bowel Syndrome: Prevalence and Dietary Factors in the Sylhet District of Bangladesh. *Mymensingh Med J* 2018; **27**: 82-88 [PMID: 29459596]

37 **Linlawan S**, Patcharatrakul T, Somlaw N, Gonlachanvit S. Effect of Rice, Wheat, and Mung Bean Ingestion on Intestinal Gas Production and Postprandial Gastrointestinal Symptoms in Non-Constipation Irritable Bowel Syndrome Patients. *Nutrients* 2019; **11**:2061 [PMID: 31484315 DOI: 10.3390/nu11092061]

38 **Yao CK**, Muir JG, Gibson PR. Review article: insights into colonic protein fermentation, its modulation and potential health implications. *Aliment Pharmacol Ther* 2016; **43**: 181-196 [PMID: 26527169 DOI: 10.1111/apt.13456]

39 **Crowe SE**. Food Allergy Vs Food Intolerance in Patients With Irritable Bowel Syndrome. *Gastroenterol Hepatol (N Y)* 2019; **15**: 38-40 [PMID: 30899207]

40 **Zuo XL**, Li YQ, Li WJ, Guo YT, Lu XF, Li JM, Desmond PV. Alterations of food antigen-specific serum immunoglobulins G and E antibodies in patients with irritable bowel syndrome and functional dyspepsia. *Clin Exp Allergy* 2007; **37**: 823-830 [PMID: 17517095 DOI: 10.1111/j.1365-2222.2007.02727.x]

41 **Gonlachanvit S**, Mahayosnond A, Kullavanijaya P. Effects of chili on postprandial gastrointestinal symptoms in diarrhoea predominant irritable bowel syndrome: evidence for capsaicin-sensitive visceral nociception hypersensitivity. *Neurogastroenterol Motil* 2009; **21**: 23-32 [PMID: 18647268 DOI: 10.1111/j.1365-2982.2008.01167.x]

42 **Hammer J**, Führer M, Pipal L, Matiasek J. Hypersensitivity for capsaicin in patients with functional dyspepsia. *Neurogastroenterol Motil* 2008; **20**: 125-133 [PMID: 17931342 DOI: 10.1111/j.1365-2982.2007.00997.x]

43 **Perna E**, Aguilera-Lizarraga J, Florens MV, Jain P, Theofanous SA, Hanning N, De Man JG, Berg M, De Winter B, Alpizar YA, Talavera K, Vanden Berghe P, Wouters M, Boeckxstaens G. Effect of resolvins on sensitisation of TRPV1 and visceral hypersensitivity in IBS. *Gut* 2020 epub ahead of print [PMID: 33023902 DOI: 10.1136/gutjnl-2020-321530]

44 **Akbar A**, Yiangou Y, Facer P, Walters JR, Anand P, Ghosh S. Increased capsaicin receptor TRPV1-expressing sensory fibres in irritable bowel syndrome and their correlation with abdominal pain. *Gut* 2008; **57**: 923-929 [PMID: 18252749 DOI: 10.1136/gut.2007.138982]

45 **Lee SY**, Masaoka T, Han HS, Matsuzaki J, Hong MJ, Fukuhara S, Choi HS, Suzuki H. A prospective study on symptom generation according to spicy food intake and TRPV1 genotypes in functional dyspepsia patients. *Neurogastroenterol Motil* 2016; **28**: 1401-1408 [PMID: 27094759 DOI: 10.1111/nmo.12841]

46 **Bortolotti M**, Coccia G, Grossi G, Miglioli M. The treatment of functional dyspepsia with red pepper. *Aliment Pharmacol Ther* 2002; **16**: 1075-1082 [PMID: 12030948 DOI: 10.1046/j.1365-2036.2002.01280.x]

47 **Lorenzon Dos Santos J**, Quadros AS, Weschenfelder C, Garofallo SB, Marcadenti A. Oxidative Stress Biomarkers, Nut-Related Antioxidants, and Cardiovascular Disease. *Nutrients* 2020; **12**: 682 [PMID: 32138220 DOI: 10.3390/nu12030682]

48 **Oh JW**. Is There Any Necessity to Prescribe Consumption of Walnuts Cooked by Different Processing Techniques to Patients With Walnut Allergy? *Allergy Asthma Immunol Res* 2018; **10**: 287-289 [PMID: 29949828 DOI: 10.4168/aair.2018.10.4.287]

49 **Raka F**, Farr S, Kelly J, Stoianov A, Adeli K. Metabolic control *via* nutrient-sensing mechanisms: role of taste receptors and the gut-brain neuroendocrine axis. *Am J Physiol Endocrinol Metab* 2019; **317**: E559-E572 [PMID: 31310579 DOI: 10.1152/ajpendo.00036.2019]

50 **Mittal M**, Siddiqui MR, Tran K, Reddy SP, Malik AB. Reactive oxygen species in inflammation and tissue injury. *Antioxid Redox Signal* 2014; **20**: 1126-1167 [PMID: 23991888 DOI: 10.1089/ars.2012.5149]

51 **Han W**, Lu X, Jia X, Zhou T, Guo C. Soluble mediators released from PI-IBS patients' colon induced alteration of mast cell: involvement of reactive oxygen species. *Dig Dis Sci* 2012; **57**: 311-319 [PMID: 21901252 DOI: 10.1007/s10620-011-1897-2]

52 **Turesky RJ**. Mechanistic Evidence for Red Meat and Processed Meat Intake and Cancer Risk: A Follow-up on the International Agency for Research on Cancer Evaluation of 2015. *Chimia (Aarau)* 2018; **72**: 718-724 [PMID: 30376922 DOI: 10.2533/chimia.2018.718]

53 **Raposa B**, Pónusz R, Gerencsér G, Budán F, Gyöngyi Z, Tibold A, Hegyi D, Kiss I, Koller Á, Varjas T. Food additives: Sodium benzoate, potassium sorbate, azorubine, and tartrazine modify the expression of NFκB, GADD45α, and MAPK8 genes. *Physiol Int* 2016; **103**: 334-343 [PMID: 28229641 DOI: 10.1556/2060.103.2016.3.6]

54 **Holder MK**, Chassaing B. Impact of food additives on the gut-brain axis. *Physiol Behav* 2018; **192**: 173-176 [PMID: 29454065 DOI: 10.1016/j.physbeh.2018.02.025]

55 **Rinninella E**, Cintoni M, Raoul P, Gasbarrini A, Mele MC. Food Additives, Gut Microbiota, and Irritable Bowel Syndrome: A Hidden Track. *Int J Environ Res Public Health* 2020; **17**: 8816 [PMID: 33260947 DOI: 10.3390/ijerph17238816]

56 **Nagarajan N**, Morden A, Bischof D, King EA, Kosztowski M, Wick EC, Stein EM. The role of fiber supplementation in the treatment of irritable bowel syndrome: a systematic review and meta-analysis. *Eur J Gastroenterol Hepatol* 2015; **27**: 1002-1010 [PMID: 26148247 DOI: 10.1097/MEG.0000000000000425]

57 **Axelrod CH**, Saps M. The Role of Fiber in the Treatment of Functional Gastrointestinal Disorders in Children. *Nutrients* 2018; **10**: 1650 [PMID: 30400292 DOI: 10.3390/nu10111650]

58 **Bardisi BM**, Halawani AKH, Halawani HKH, Alharbi AH, Turkostany NS, Alrehaili TS, Radin AA, Alkhuzea NM. Efficiency of diet change in irritable bowel syndrome. *J Family Med Prim Care* 2018; **7**: 946-951 [PMID: 30598938 DOI: 10.4103/jfmpc.jfmpc\_173\_18]

59 **Pisipati S**, Connor BA, Riddle MS. Updates on the epidemiology, pathogenesis, diagnosis, and management of postinfectious irritable bowel syndrome. *Curr Opin Infect Dis* 2020; **33**: 411-418 [PMID: 32833689 DOI: 10.1097/QCO.0000000000000666]

60 **Arsiè E**, Coletta M, Cesana BM, Basilisco G. Symptom-association probability between meal ingestion and abdominal pain in patients with irritable bowel syndrome. Does somatization play a role? *Neurogastroenterol Motil* 2015; **27**: 416-422 [PMID: 25581334 DOI: 10.1111/nmo.12510]

61 **Wang A**, Liao X, Xiong L, Peng S, Xiao Y, Liu S, Hu P, Chen M. The clinical overlap between functional dyspepsia and irritable bowel syndrome based on Rome III criteria. *BMC Gastroenterol* 2008; **8**: 43 [PMID: 18808723 DOI: 10.1186/1471-230X-8-43]

62 **Lee SY**, Lee KJ, Kim SJ, Cho SW. Prevalence and risk factors for overlaps between gastroesophageal reflux disease, dyspepsia, and irritable bowel syndrome: a population-based study. *Digestion* 2009; **79**: 196-201 [PMID: 19342860 DOI: 10.1159/000211715]

63 **Van Oudenhove L**, Demyttenaere K, Tack J, Aziz Q. Central nervous system involvement in functional gastrointestinal disorders. *Best Pract Res Clin Gastroenterol* 2004; **18**: 663-680 [PMID: 15324706 DOI: 10.1016/j.bpg.2004.04.010]

64 **Mayer EA**, Naliboff BD, Craig AD. Neuroimaging of the brain-gut axis: from basic understanding to treatment of functional GI disorders. *Gastroenterology* 2006; **131**: 1925-1942 [PMID: 17188960 DOI: 10.1053/j.gastro.2006.10.026]

65 **Bennet SMP**, Böhn L, Störsrud S, Liljebo T, Collin L, Lindfors P, Törnblom H, Öhman L, Simrén M. Multivariate modelling of faecal bacterial profiles of patients with IBS predicts responsiveness to a diet low in FODMAPs. *Gut* 2018; **67**: 872-881 [PMID: 28416515 DOI: 10.1136/gutjnl-2016-313128]

66 **Paskulin JTA**, Drehmer M, Olinto MT, Hoffmann JF, Pinheiro AP, Schmidt MI, Nunes MA. Association between dietary patterns and mental disorders in pregnant women in Southern Brazil. *Braz J Psychiatry* 2017; **39**: 208-215 [PMID: 28355346 DOI: 10.1590/1516-4446-2016-2016]

67 **Tsai HJ**. Dietary patterns and depressive symptoms in a Taiwanese population aged 53 years and over: Results from the Taiwan Longitudinal Study of Aging. *Geriatr Gerontol Int* 2016; **16**: 1289-1295 [PMID: 26463836 DOI: 10.1111/ggi.12641]

68 **Makris AP**, Karianaki M, Tsamis KI, Paschou SA. The role of the gut-brain axis in depression: endocrine, neural, and immune pathways. *Hormones (Athens)* 2020 epub ahead of print [PMID: 32827123 DOI: 10.1007/s42000-020-00236-4]

**Footnotes**

**Institutional review board statement:** This study was approved by the Ethics Committee of China-Japan Friendship Hospital (No. 2015-33).

**Informed consent statement:** All study participants provided written informed consent prior to study enrollment.

**Conflict-of-interest statement:** All authors report no conflicts of interest.

**Data sharing statement:** No additional data are available.

**STROBE statement:** The authors have read the STROBE Statement-checklist of items, and the manuscript was prepared and revised according to the STROBE Statement-checklist of items.

**Open-Access:** This article is an open-access article that was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution NonCommercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: http://creativecommons.org/Licenses/by-nc/4.0/

**Manuscript source:** Unsolicited manuscript

**Peer-review started:** December 5, 2020

**First decision:** December 24, 2020

**Article in press:**

**Specialty type:** Gastroenterology and hepatology

**Country/Territory of origin:** China

**Peer-review report’s scientific quality classification**

Grade A (Excellent): 0

Grade B (Very good): B

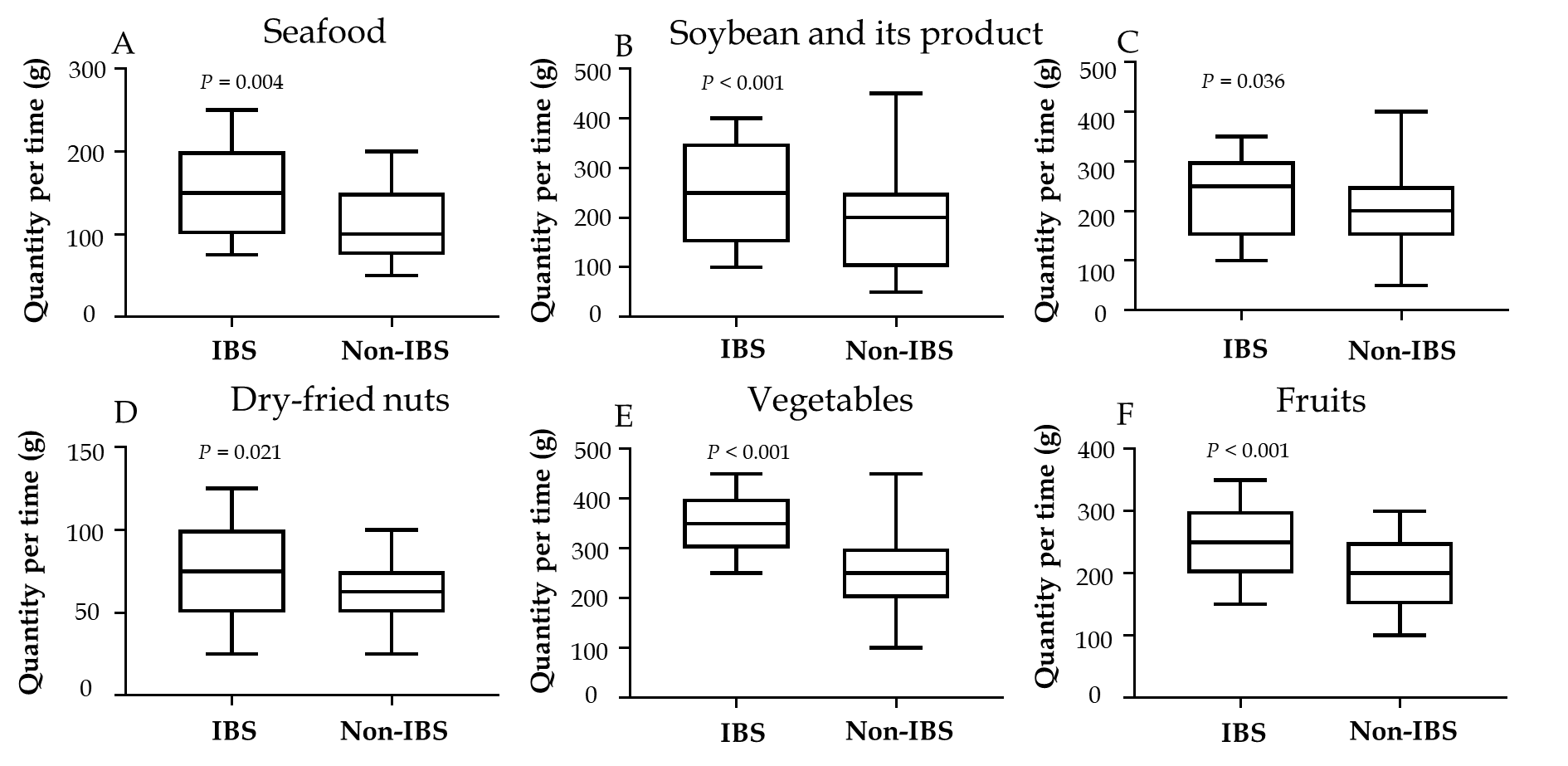
Grade C (Good): 0

Grade D (Fair): D

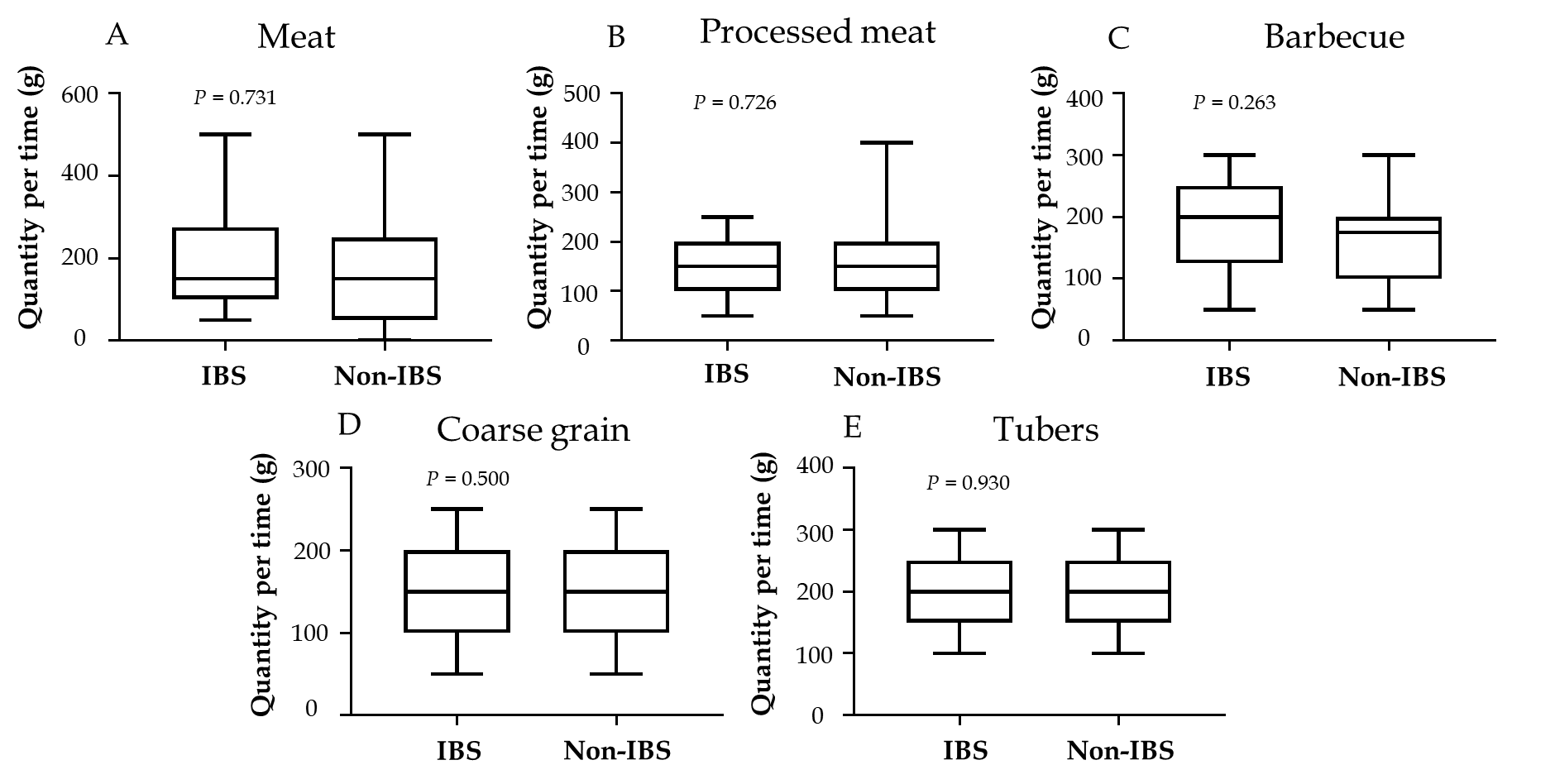
Grade E (Poor): 0

**P-Reviewer:** Esteban-Zubero E, Iovino P **S-Editor:** Liu M **L-Editor: P-Editor:**

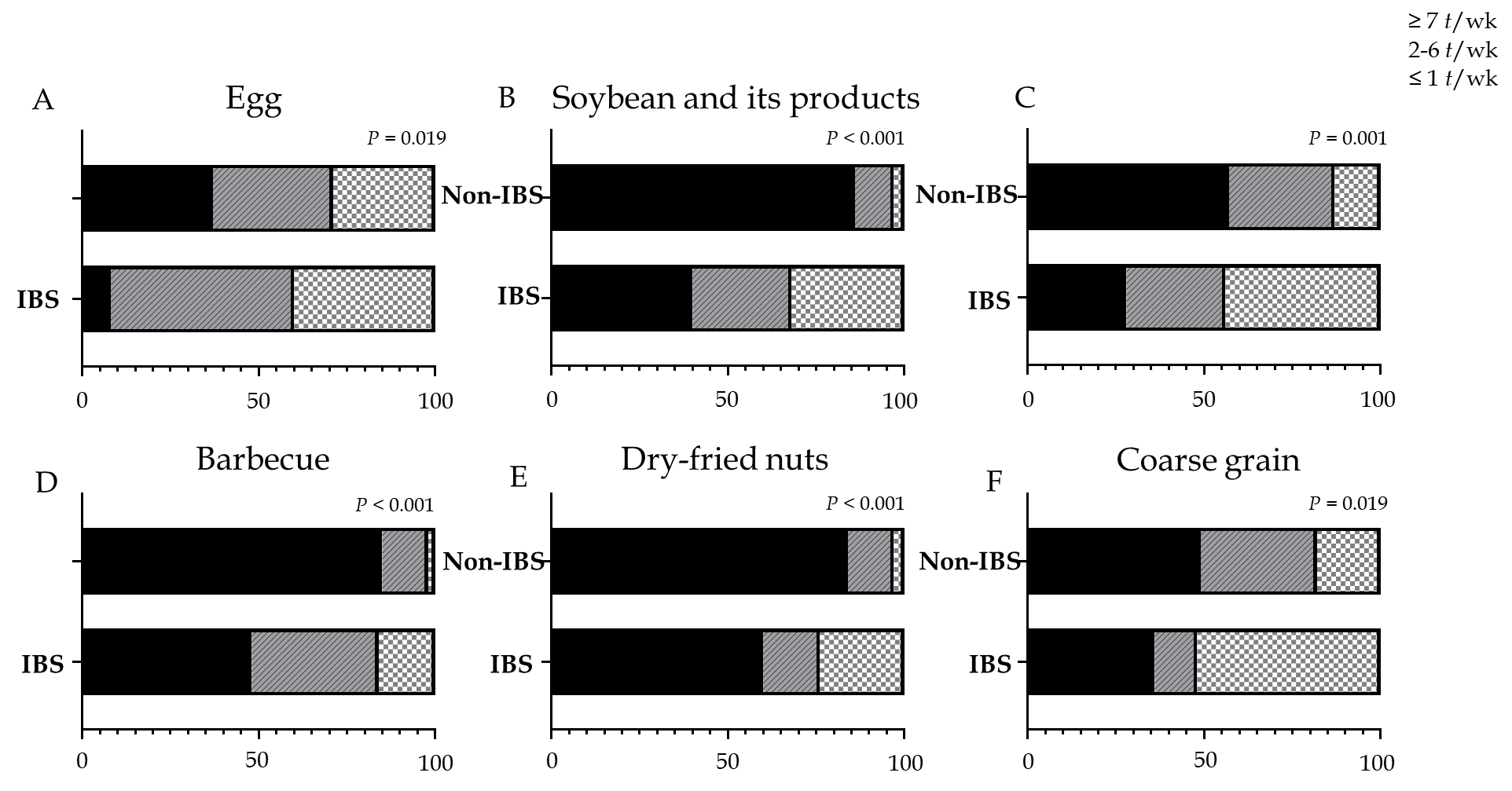
**Figure Legends**



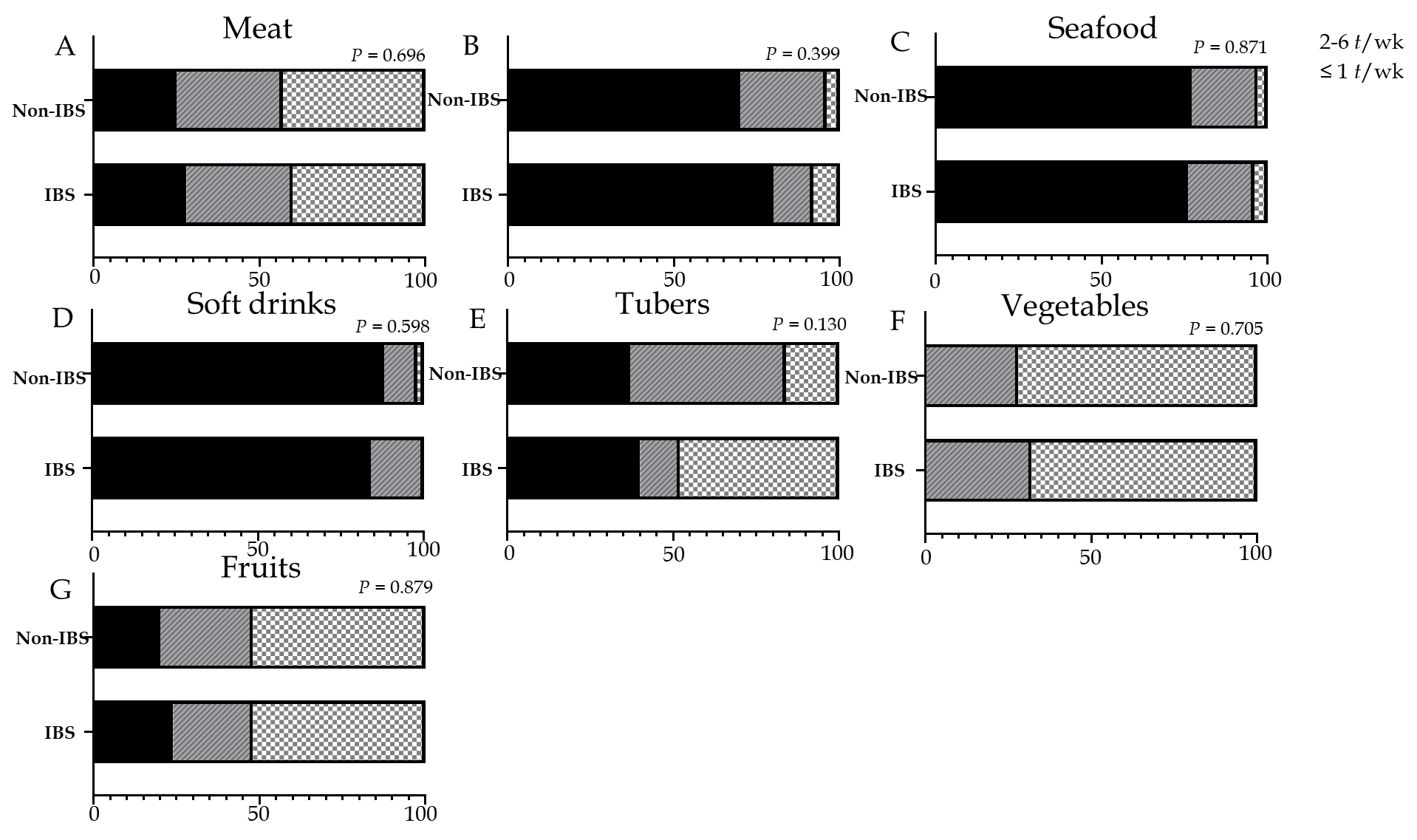
**Figure 1 Comparison of quantity per time between irritable bowel syndrome patients and non-irritable bowel syndrome participants.** A: Seafood; B: Soybean and its products; C: Spicy food; D: Dry-fried nuts; E: Vegetables; F: Fruits. All *P* < 0.05 *vs* controls. IBS: Irritable bowel syndrome.



**Figure 2 Comparison of quantity per time between irritable bowel syndrome patients and non-irritable bowel syndrome participants.** A: Meat; B: Processed meat; C: Barbecue; D: Coarse grain; E: Tubers. All *P* > 0.05 *vs* controls. IBS: Irritable bowel syndrome.



**Figure 3 Comparison of intake frequency between irritable bowel syndrome patients and non-irritable bowel syndrome participants.** A: Egg; B: Soybean and its products; C: Spicy food; D: Barbecue; E: Dry-fried nuts; F: Coarse grain. All *P* < 0.05 *vs* controls. IBS: Irritable bowel syndrome.



**Figure 4 Comparison of intake frequency between irritable bowel syndrome patients and non-irritable bowel syndrome participants.** A: Meat; B: Processed meat; C: Seafood; D: Soft drinks; E: Tubers; F: Vegetables; G: Fruits. All *P* > 0.05 *vs* controls. IBS: Irritable bowel syndrome.

**Table 1 Sociodemographic characteristics, *n* (%)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **IBS patients (*n* = 25)** | **Non-IBS participants (*n* = 178)** | ***P* value** |
| Age in yr | 36.0 (29.5, 43.0) | 32.0 (28.0, 38.0) | 0.215 |
| Gender, male : female | 10 : 15 | 71 : 107 | 0.991 |
| Body mass index in kg/m2a | 22.31 (21.22, 23.40)a | 23.50 (21.3, 26.2) | 0.033 |
| Level of educationa  junior middle school  senior middle school  undergraduate  master degree or above | 2 (8.0)  5 (20.0)  10 (40.0)  8 (32) | 5 (2.8)  46 (25.8)  110 (61.8)  17 (9.6) | 0.007 |
| Drinking  Yes  No | 8 (32.0)  17 (68.0) | 64 (36.0)  114 (64.0) | 0.699 |
| Smoking  Yes  No | 6 (24.0)  19 (76.0) | 48 (27.0)  130 (73.0) | 0.753 |
| Predominant bowel pattern  Diarrhea  Constipation  Mixed  Unclassified | 7 (28)  5 (20)  9 (36)  4 (16) | N/A  N/A  N/A  N/A | N/A |

The data are presented as the median (Q1, Q3) or number (percentage). a*P* < 0.05 *vs* controls. IBS: Irritable bowel syndrome; N/A: Not applicable.

**Table 2 Dietary habits, clinical characteristics and psychological states of irritable bowel syndrome patients and non-irritable bowel syndrome participants, *n* (%)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **IBS patients** | **Non-IBS participants** | ***P* value** |
| Dietary habits | *n* = 25 | *n* = 110 |  |
| Quantity per time (g for solid food and mL for liquid food) | | | |
| Seafood | 150 (100, 200) | 100(75, 150) | 0.004 |
| Soybean and its products | 250 (150, 350) | 200 (100, 250) | < 0.001 |
| Spicy food | 250 (150, 300) | 200 (150, 250) | 0.036 |
| Dry-fried nuts | 75 (50, 100) | 62.5 (50, 75) | 0.021 |
| Soft drinks  0 mL  250 mL  500 mL | 5 (20.0)  9 (36.0)  11 (44.0) | 45 (40.9)  54 (49.1)  11 (10.0) | < 0.001 |
| Vegetables | 350 (300, 400) | 250 (200, 300) | < 0.001 |
| Fruits | 250 (200, 300) | 200 (150, 250) | < 0.001 |
| Intake frequency (times per wk) | | | |
| Egg  ≤ 1 *t*/wk  2–6 *t*/wk  ≥ 7 *t*/wk | 2 (8.0)  13 (52.0)  10 (40.0) | 41 (37.3)  38 (34.5)  31 (28.2) | 0.019 |
| Soybean and its products  ≤ 1 *t*/wk  2–6 *t*/wk  ≥ 7 *t*/wk | 10 (40.0)  7 (28.0)  8 (32.0) | 95 (86.4)  12 (10.9)  3 (2.7) | < 0.001 |
| Spicy food  ≤ 1 *t*/wk  2–6 *t*/wk  ≥ 7 *t*/wk | 7 (28.0)  7 (28.0)  11 (44.0) | 63 (57.3)  33 (30.0)  14 (12.7) | 0.001 |
| Barbecue  ≤ 1 *t*/wk  2–6 *t*/wk  ≥ 7 *t*/wk | 12 (48.0)  9 (36.0)  4 (16.0) | 93 (84.5)  14 (12.7)  3 (2.7) | < 0.001 |
| Dry-fried nuts  ≤ 1 *t*/wk  2–6 *t*/wk  ≥ 7 *t*/wk | 15 (60.0)  4 (16.0)  6 (24.0) | 102 (92.7)  7 (6.4)  1 (0.9) | < 0.001 |
| Coarse grain  ≤ 1 *t*/wk  2–6 *t*/wk  ≥ 7 *t*/wk | 9 (36.0)  3 (12.0)  13 (52.0) | 54 (49.1)  36 (32.7)  20 (18.2) | 0.019 |
| Clinical and psychological score | *n* = 25 | *n* = 178 |  |
| IBS-SSS | 150.0 (37.5, 187.5) | N/A | N/A |
| IBS-QOL | 46.0 (35.5, 74.5) | N/A | N/A |
| GSRS | 4.0 (3.0, 6.5) | 3.0 (1.0, 5.0) | 0.007 |
| VSI | 64.0 (53.0, 68.5) | 29.0 (17.5, 38.25) | < 0.001 |
| HADS anxiety score | 7.0 (3.5, 10.0) | 3.0 (1.0, 6.0) | < 0.001 |
| HADS depression score | 5.0 (2.5, 8.0) | 3.0 (1.0, 6.0) | 0.026 |

The data are presented as the median (Q1, Q3) or number (percentage). All *P* < 0.05 *vs* controls. IBS: Irritable bowel syndrome; IBS-SSS: IBS symptom severity scale; IBS-QOL: IBS-specific quality of life; VSI: Visceral sensitivity index; HADS: Hospital anxiety and depression scale; GSRS: Gastrointestinal symptom rating scale; N/A: Not applicable.**Table 3 The association between dietary factors and symptom scores/ psychological factors**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **IBS-SSS** | | **HADS(a)** | | **HADS(d)** | |
|  | ***r*** | ***P* value** | ***r*** | ***P* value** | ***r*** | ***P* value** |
| Quantity per time | | | | | | |
| Soybean and its products | 0.415 | 0.039 | 0.635 | 0.001 | 0.604 | 0.001 |
| Spicy food | 0.590 | 0.002 | 0.454 | 0.022 | 0.483 | 0.014 |
| Dry-fried nuts | 0.738 | < 0.001 | 0.608 | 0.001 | 0.616 | 0.001 |
| Intake frequency | | | | | | |
| Soybean and its products | 0.702 | < 0.001 | 0.422 | 0.036 | 0.566 | 0.003 |
| Spicy food | 0.691 | < 0.001 | 0.451 | 0.024 | 0.424 | 0.034 |
| Dry-fried nuts | 0.512 | 0.009 | 0.605 | 0.001 | 0.622 | 0.001 |

All *P* < 0.05. IBS-SSS: Irritable bowel syndrome - symptom severity scale; HADS: Hospital anxiety and depression scale; a: Anxiety; d: Depression.

**Table 4 Evaluation of dietary factors for IBS by logistic regression analysis**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Univariable** | | | | **Multivariable** | | | |
| **OR** | **95%CI** | | ***P* value** | **OR** | **95%CI** | | ***P* value** |
| **Lower** | **Upper** | **Lower** | **Upper** |
| Quantity per time | | | | | | | | |
| Soybean and its products | 1.009 | 1.004 | 1.014 | 0.001 |  |  |  |  |
| Spicy food | 1.006 | 1.000 | 1.013 | 0.040 |  |  |  |  |
| Dry-fried nuts | 1.032 | 1.010 | 1.054 | 0.004 |  |  |  |  |
| Intake frequency | | | | | | | | |
| Soybean and its products  ≤ 1 *t*/wk  2–6 *t*/wk  ≥ 7 *t*/wk | Ref  4.318  23.030 | 1.351  5.314 | 13.801  99.804 | < 0.001  /  0.014  < 0.001 | 2.433  11.613 | 0.625  2.145 | 9.473  62.855 | 0.015  0.200  0.004 |
| Spicy food  ≤ 1 *t*/wk  2–6 *t*/wk  ≥ 7 *t*/wk | Ref  1.909  7.071 | 0.617  2.329 | 5.905  21.470 | 0.002  /  0.262  0.001 |  |  |  | 0.184 |
| Dry-fried nuts  ≤ 1 *t*/wk  2–6 *t*/wk  ≥ 7 *t*/wk | Ref  3.886  40.800 | 1.015  4.588 | 14.880  362.841 | 0.001  /  0.048  0.001 |  |  |  | 0.078 |

CI: Confidence interval; OR: Odds ratio; Ref: reference.