The risk of irritable bowel syndrome in patients with metabolic syndrome—a population-based, 5-year follow-up cohort study

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Research Article

Keywords: Irritable bowel syndrome, metabolic syndrome, follow-up, cumulative incidence rate, risk factors

Posted Date: October 14th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-2156939/v1

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Abstract

Purpose

Few studies have reported the associations between metabolic syndrome (MetS) and irritable bowel syndrome (IBS). The purpose of this study was to investigate the incidence of IBS in patients with MetS during a 5-year follow-up period and to evaluate potential risk of IBS.

Methods

A retrospective cohort study was conducted, and 5104 subjects who underwent physical examination in the People's Hospital of Xinjiang Uygur Autonomous Region in October 2014 were randomly selected and divided into MetS group, pre-metabolic syndrome (Pre-MetS) group and healthy control (HC) group. The clinical data and the incidence of IBS were recorded and analyzed.

Results

In total, 663 subjects were diagnosed with IBS. The 5-year cumulative incidence rate of IBS was 20.7% and 16.6% for MetS and Pre-MetS group, respectively, which was significantly higher than that of HC group (7.1%, log-rank < .001). In the univariate analysis, the indicators associated with IBS were larger waist circumference, hypertriglyceridemia, animal food-predominant form, anxiety and depression. After stepwise adjustment for multiple factors, the hazard ratio of IBS were 2.665 (95%CI 1.992–3.565) and 3.372 (95%CI 2.177–5.223) for MetS and Pre-MetS group, respectively. In the MetS components, there may be predictive value for the development of IBS when waist circumference is 86.5 cm and triglyceride (TG) is 307.5 mg/dL.

Conclusions

The risk of IBS was significantly increased in both MetS and Pre-MetS patients during 5-year follow-up, suggesting that MetS status, especially larger waist circumference and higher TG, may be potential risk factors for IBS.

Introduction

Irritable bowel syndrome (IBS) is a common digestive system disease worldwide, with abdominal pain, abdominal distension, and abdominal discomfort with altered bowel habits as the main clinical manifestations [1]. IBS often affects the work and life of patients and has varying degrees of negative impact on their quality of life. Long-term treatment and absenteeism impose a huge economic and social burden on patients. Therefore, IBS is a clinical and social problem that deserves attention [2–4].
Metabolic syndrome (MetS) is a group of clinical syndromes in which obesity, dyslipidemia (hypertriglyceridemia, low high-density lipoprotein cholesterolemia), hyperglycemia (or diabetes), and hypertension accumulate and seriously affect the health of the body, and is a combination of a group of metabolically interrelated risk factors that directly promote the occurrence of atherosclerotic cardiovascular disease and also increase the risk of developing type 2 diabetes [5–7]. It has been shown that the prevalence of MetS is more than 35% in people over 18 years of age in the United States[8]. In Asia, the prevalence of MetS is also increasing with changes in lifestyle and dietary structure [9]. According to two cross-sectional surveys of nutrition and health in China [10], the prevalence of MetS in Chinese adults increased from 9.5–18.7% from 2002 to 2012, while this trend is still increasing [11].

The pathophysiological mechanism of IBS remains incompletely elucidated and is currently thought to be the result of a combination of factors [12]. However, few studies have been performed to confirm the relationship between MetS and IBS. In this study, we first assessed the impact of MetS on IBS incidence through a 5-year follow-up. Furthermore, to identify risk factors for IBS and to determine their relationship.

**Methods**

**Study subjects and design**

A retrospective study was conducted in which 5658 subjects who underwent physical examination in the People’s Hospital of Xinjiang Uygur Autonomous Region in October 2014 were randomly selected, of which 554 subjects were excluded due to: IBS diagnosed before the start of the study; those who did not complete the follow-up within 5 years; missing or incomplete clinical data and enteroscopic data; combined with other intestinal diseases, including inflammatory bowel disease, intestinal tuberculosis, Behcet’s disease, ischemic bowel disease, and radiation colitis; and combined with systemic malignancies, autoimmune diseases, cardiovascular and cerebrovascular diseases, and psychological diseases. Finally, 5104 subjects were enrolled. All subjects were resident non-mobile population and were able to complete physical examination and provide current medical history, past medical history, personal history and treatment history during follow-up time. They had complete physical examination, laboratory examination and enteroscopy data and could independently complete the questionnaire.

**Cohort**

According to the different MetS components, we divided 5014 subjects into MetS, pre-metabolic syndrome (Pre-MetS) and healthy control (HC) group, and the number of subjects in each group was 1251, 1443, and 2320, respectively (Fig. 1). Criteria for MetS diagnosis were in accordance with the Joint Interim Statement of the 2009 International Diabetes Federation Task Force on Epidemiology and Prevention [13]: (1) Abdominal obesity: waist circumference ≥ 90 cm in men or ≥ 80 cm in women; (2) triglycerides (TG) ≥ 150 mg/dL; (3) high density lipoprotein (HDL-C) < 40 mg/dL in man or < 50 mg/dL in
women; (4) blood pressure $\geq 130/85$ mmHg or has been confirmed as hypertension and treated; (5) fasting blood glucose (FG) $\geq 100$ mg/dL or have been diagnosed with diabetes and treated. MetS can be diagnosed with 3 or more items. Pre-MetS is an early state of MetS and has the potential risk of developing into MetS. It has 1 to 2 diagnostic criteria for MetS. Because people lipids tend to be distributed into the abdominal cavity and abdominal obesity is easily formed, even in people with BMI $< 25$ kg/m$^2$, a considerable number of people present with severe accumulation of intra-abdominal fat, so we did not use BMI as a diagnostic indicator of obesity.

Data Collection

Detailed data on 5-year follow-up of all subjects were obtained from the database of the Information Center of the People’s Hospital of Xinjiang Uygur Autonomous Region, which included: waist circumference, blood pressure, TG, HDL-C, FG, colonoscopy data, history of smoking, alcohol drinking, hypertension, diabetes and related treatment. Smoking was defined as having an average daily smoking of $\geq 1$ cigarette in the past 1 year. Alcohol drinking was defined as an average daily alcohol consumption of $\geq 20$ g in the past 1 year; Zung's self-rating anxiety/depression scale (SAS/SDS) was used to evaluate anxiety and depression. SAS criterion score $\geq 50$ was classified as anxious state, and SDS criterion score $\geq 53$ was classified as depressive state. A semi-quantitative food frequency questionnaire was used to ask all subjects to recall the frequency and intake of food in the past 1 year, which was asked and recorded by the trained investigators of the medical examination center. According to the dietary characteristics of the population, we divided the dietary pattern into three categories: animal food-based type (low carbohydrate, high fat, high protein), plant food-based type (high carbohydrate, low fat, low protein) and animal and plant food balance type (balanced carbohydrate, protein, fat intake).

Follow-up

Three groups of subjects were followed up by physical examination or reexamination in the outpatient department for 5 years. The cut-off date of follow-up was October 31, 2019. The endpoint event of follow-up was defined as the occurrence of IBS. The subjects were also divided into IBS and non-IBS groups according to whether the patients developed IBS, and the influencing factors causing IBS were analyzed. The diagnosis of IBS and IBS subtypes was based on Rome III criteria [14].

Statistical analysis

Statistical analysis was performed using SPSS 17 software (SPSS, Chicago, IL, USA). Continuous variables not following a normal distribution were presented as medians (interquartile range) and comparisons between groups were performed using the Mann-Whitney $U$-test. Categorical variables were presented as rates or percentages and chi-square tests were used for comparisons between groups. Kaplan-Meier method was used to analyze the cumulative incidence of IBS during 5-year follow-up in three groups. The COX proportional hazards model was used to analyze the correlation between MetS,
Pre-MetS and new-onset IBS. Receiving operating characteristics (ROC) curves were calculated for the area under the ROC curve (AUC), optimal cut-off value, sensitivity and specificity of each significant variable.

**Results**

During the follow-up period from October 2014 to October 2019, 663 (13.2%) of 5014 subjects developed IBS, the incidence cases of IBS among MetS, Pre-MetS and healthy controls group was 259, 239 and 165, respectively. Kaplan-Meier curves showed that within 5 years, the cumulative incidence rate (CIR) of IBS in MetS and Pre-MetS group was 20.7% and 16.6%, which was significantly higher than that in HC group (7.1%, log-rank < .001) (Fig. 2). Similarly, the incidence density (ID) of IBS was also significantly different among the three groups, with MetS and Pre-MetS group being higher than HC group (Table 1).

**Table 1**

Incidence of IBS in MetS, Pre-MetS and healthy controls followed for 5 years.

<table>
<thead>
<tr>
<th>Follow-up time</th>
<th>MetS group ($n = 1251$)</th>
<th>Pre-MetS group ($n = 1443$)</th>
<th>HC group ($n = 2320$)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBS</td>
<td>CIR</td>
<td>ID</td>
<td>IBS</td>
<td>CIR</td>
</tr>
<tr>
<td>Within 1 year</td>
<td>43</td>
<td>3.4</td>
<td>31.5</td>
<td>38</td>
</tr>
<tr>
<td>Within 2 years</td>
<td>98</td>
<td>7.8</td>
<td>36.2</td>
<td>84</td>
</tr>
<tr>
<td>Within 3 years</td>
<td>155</td>
<td>12.4</td>
<td>38.7</td>
<td>139</td>
</tr>
<tr>
<td>Within 4 years</td>
<td>207</td>
<td>16.5</td>
<td>39.1</td>
<td>190</td>
</tr>
<tr>
<td>Within 5 years</td>
<td>259</td>
<td>20.7</td>
<td>39.6</td>
<td>239</td>
</tr>
</tbody>
</table>

IBS: irritable bowel syndrome incident cases ($n$); CIR: cumulative incidence rate (%); ID: incidence density (per 1000 person-years).

The distribution of IBS subtypes in MetS, Pre-MetS and HC group was significantly different. IBD-D was most common in MetS and HC group, while IBD-C was most common in Pre-MetS group (Table 2).
Table 2  
Distribution of IBS subtypes in MetS, Pre-MetS and healthy controls.

<table>
<thead>
<tr>
<th></th>
<th>IBS</th>
<th>IBS-D</th>
<th>IBS-C</th>
<th>IBS-M</th>
<th>IBS-U</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MetS, n(%)</td>
<td>259</td>
<td>90(34.7%)</td>
<td>84(32.4%)</td>
<td>64(24.7%)</td>
<td>21(8.1%)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Pre-MetS, n(%)</td>
<td>239</td>
<td>75(31.4%)</td>
<td>81(33.9%)</td>
<td>70(29.3%)</td>
<td>13(5.4%)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>HC, n(%)</td>
<td>165</td>
<td>61(37.0%)</td>
<td>52(31.5%)</td>
<td>43(26.1%)</td>
<td>9(5.5%)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Total, n(%)</td>
<td>663</td>
<td>226(34.1%)</td>
<td>217(32.7%)</td>
<td>177(26.7%)</td>
<td>43(6.5%)</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

IBS-D: diarrhoeal irritable bowel syndrome; IBS-C: constipation irritable bowel syndrome; IBS-M: mixed irritable bowel syndrome; IBS-U: uncertain irritable bowel syndrome.

Baseline characteristics of IBS and non-IBS patients were analyzed by univariate analysis. Compared with non-IBS patients, those who developed IBS had larger waist circumference and higher TG. Among the dietary patterns, animal food-predominant type were predominant in IBS patients, while the three dietary patterns were more average in non-IBS patients. In addition, the number of patients with anxiety and depression at the 5-year follow-up was significantly higher in IBS patients than in non-IBS. Other factors such as age, sex, smoker, alcohol drinking, HDL-C, SBP, DBP, hypertension, FG, and diabetes mellitus were not significantly different between the two groups (Table 3).
Table 3
Clinical baseline characteristics between IBS and non-IBS patients at the time of the endpoint event.

<table>
<thead>
<tr>
<th></th>
<th>IBS group</th>
<th>Non-IBS group</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 663)</td>
<td>(n = 4351)</td>
<td></td>
</tr>
<tr>
<td>Age(years)</td>
<td>44(30–57)</td>
<td>44(31–57)</td>
<td>0.508</td>
</tr>
<tr>
<td>Female, (n(%))</td>
<td>363(54.8%)</td>
<td>2241(52.6%)</td>
<td>0.312</td>
</tr>
<tr>
<td>Dietary pattern</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animal food-predominant</td>
<td>280(42.2%)</td>
<td>1419(32.6%)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Vegetative food-predominant</td>
<td>167(25.2%)</td>
<td>1490(34.2%)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Animal and vegetative food balance</td>
<td>216(32.6%)</td>
<td>1442(33.1%)</td>
<td>0.774</td>
</tr>
<tr>
<td>Smoker, (n(%))</td>
<td>66(10%)</td>
<td>413(9.5%)</td>
<td>0.706</td>
</tr>
<tr>
<td>Alcohol drinking, (n(%))</td>
<td>21(3.2%)</td>
<td>94(2.2%)</td>
<td>0.107</td>
</tr>
<tr>
<td>Waist circumference(cm)</td>
<td>94(85–103)</td>
<td>78(70–88)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>TG(mg/dL)</td>
<td>333(146–387)</td>
<td>143(115–259)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>HDL-C(mg/dL)</td>
<td>54(40–63)</td>
<td>55(46–64)</td>
<td>0.001</td>
</tr>
<tr>
<td>SBP(mmHg)</td>
<td>121(116–126)</td>
<td>121(115–126)</td>
<td>0.610</td>
</tr>
<tr>
<td>DBP(mmHg)</td>
<td>73(69–79)</td>
<td>73(69–78)</td>
<td>0.503</td>
</tr>
<tr>
<td>Hypertension, (n(%))</td>
<td>58(8.7%)</td>
<td>360(8.2%)</td>
<td>0.681</td>
</tr>
<tr>
<td>FG(mmHg)</td>
<td>86(79–94)</td>
<td>86(78–94)</td>
<td>0.297</td>
</tr>
<tr>
<td>Diabetes mellitus, (n(%))</td>
<td>43(6.5%)</td>
<td>211(4.8%)</td>
<td>0.074</td>
</tr>
<tr>
<td>Anxiety, (n(%))</td>
<td>189(28.5%)</td>
<td>799(18.4%)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Depression, (n(%))</td>
<td>152(22.9%)</td>
<td>646(14.8%)</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

During the 5-year follow-up period, without adjustment for any factors (Model 1), the HR of IBS was 3.120 (95% CI 2.311–4.211) for MetS and 5.173 (95% CI 3.242–8.252) for Pre-MetS compared with HC group. After stepwise adjustment (Model 4), the HR for the occurrence of IBS were 2.665 (95% CI 1.992–3.565) and 3.372 (95% CI 2.177–5.223) for MetS and Pre-MetS, respectively. Among MetS components, only larger waist circumference and higher TG were associated with the risk of IBS, even after adjusting for multiple covariates \((p < .001)\) (Table 4).
Table 4
COX proportional hazards model analysis of Pre-MetS, MetS and MetS components on new-onset IBS.

<table>
<thead>
<tr>
<th></th>
<th>HR(95%CI)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 3</td>
<td>Model 4</td>
</tr>
<tr>
<td>HC</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>MetS</td>
<td>3.120(2.311–4.211)</td>
<td>2.667(1.992–3.571)</td>
<td>2.716(2.029–3.635)</td>
<td>2.665(1.992–3.565)</td>
</tr>
<tr>
<td>MetS components</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waist circumference</td>
<td>1.050(1.040–1.059)</td>
<td>1.036(1.028–1.054)</td>
<td>1.035(1.027–1.044)</td>
<td>1.036(1.027–1.044)</td>
</tr>
<tr>
<td>TG</td>
<td>1.006(1.005–1.007)</td>
<td>1.006(1.005–1.008)</td>
<td>1.006(1.005–1.008)</td>
<td>1.007(1.005–1.008)</td>
</tr>
<tr>
<td>HDL-C</td>
<td>0.993(0.997–0.999)</td>
<td>0.998(0.992–1.004)</td>
<td>0.998(0.992–1.004)</td>
<td>0.998(0.992–1.004)</td>
</tr>
<tr>
<td>SBP</td>
<td>1.001(0.990–1.012)</td>
<td>1.000(0.989–1.012)</td>
<td>1.000(0.989–1.011)</td>
<td>1.000(0.989–1.011)</td>
</tr>
<tr>
<td>DBP</td>
<td>1.000(0.998–1.013)</td>
<td>0.999(0.987–1.011)</td>
<td>0.999(0.987–1.012)</td>
<td>0.999(0.986–1.011)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>0.983(0.708–1.366)</td>
<td>1.016(0.735–1.405)</td>
<td>1.018(0.736–1.409)</td>
<td>1.036(0.750–1.432)</td>
</tr>
<tr>
<td>FG</td>
<td>1.004(0.999–1.008)</td>
<td>1.003(0.998–1.007)</td>
<td>1.003(0.998–1.007)</td>
<td>1.003(0.998–1.008)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>1.354(0.905–2.025)</td>
<td>1.350(0.916–1.989)</td>
<td>1.353(0.920–1.990)</td>
<td>1.353(0.919–1.992)</td>
</tr>
</tbody>
</table>

HR: hazard ratio; CI: confidence interval; Model 1: unadjusted; Model 2: adjusted for age and sex; Model 3: adjusted for age, sex, smoker, alcohol drinking and dietary pattern; Model 4: adjusted for age, sex, smoker, alcohol drinking, dietary pattern, anxiety and depression.

ROC curves were generated for waist circumference and TG, indicators of significance in the COX proportional hazards model. The AUC for waist circumference was 0.777, with a sensitivity of 71.2% and specificity of 72.6% when Cut-off value was 86.5 cm (Fig. 3a). The AUC for TG was 0.741, with a sensitivity of 59.0% and specificity of 83.6% when Cut-off value was 307.5 mg/dL (Fig. 3b).

**Discussion**
This was a population-based retrospective cohort study that investigated the association between MetS and IBS. At 5-year follow-up, both MetS and Pre-MetS had a significantly increased risk of IBS, and we found that MetS patients had a 3.120-times higher risk of developing IBS than HC, while Pre-MetS patients had an approximately 5.173-times higher risk of developing IBS than HC. Even after stepwise adjustment for multiple covariates, this trend remained unchanged, and patients with MetS, Pre-MetS had a 2.665- times and 3.372- times higher risk of IBS than HC, respectively.

Current studies on the association between MetS and IBS are very limited. In a Korean case-control study [15], the prevalence of MetS in IBS patients was about 32.5%, much higher than that of 12.7% in controls, and the risk of MetS in IBS patients remained increased after controlling for confounding factors, indicating that IBS may be a state of MetS patients. Prior to this, Japanese scholars have also reported that IBS is associated with a high prevalence of MetS, especially with a close relationship with elevated TG [16]. The above two studies unidirectionally indicated the relationship that IBS patients had a higher risk of MetS than the general population, but neither was prospective studies, and the sample size was small, and there is still a lack of relevant reports on the incidence of IBS in MetS patients.

In this study, we focused on the incidence of IBS in MetS and Pre-MetS patients during follow-up. During the second year of follow-up, the number of IBS cases began to rise, peaked in the third year, and leveled off afterwards. The CIR and ID of IBS in each year were higher for both MetS and Pre-MetS than for HC. Whereas MetS was again higher than Pre-MetS, although the HR of Pre-MetS was higher than that of MetS. The reason for this result may be that there are some protective factors in MetS components, and in addition, population characteristics, data bias, and experimental models can also affect the study results. Through COX proportional hazards model, we found that waist circumference and TG were closely related to the pathogenesis of IBS in MetS components, but there was no direct evidence to prove their mechanism of action. Recent studies have favored the important role of intestinal dysbacteriosis in metabolic diseases. Firstly, It has been reported that gut microbiota leads to obesity and triglyceride deposition in the body by inhibiting fasting-induced adipose factor (FIAL) gene expression induced by fasting in intestinal epithelial cells [17]. In addition, obese patients have a mild chronic inflammatory state, and inflammatory cell infiltration is found in the body adipose tissue, which may be related to the fact that the intestinal flora induces the body inflammatory cascade through bacterial translocation and activates innate immunity, thereby promoting the release of a large number of inflammatory factors [18]. And this mild chronic inflammation of the mucosa, particularly the activation of mast cells, may be a causative factor in IBS [19]. It has also been found that approximately one-fourth of IBS patients have clinical symptoms arising from gastrointestinal inflammation [20, 21]. Various bacterial infections promote the release of inflammatory cytokines from mast cells or other inflammatory cells in the intestinal mucosa, causing intestinal dysfunction to develop IBS. Furthermore, intestinal flora is involved in the progression of a variety of diseases through the gut-brain axis, including obesity and IBS, however whether there is an interaction between them remains to be further demonstrated in related studies. Finally, there is an imbalance in intestinal microecology in both MetS and IBS patients. Obese patients showed a decrease in the number of Firmicutes and a relative increase in Escherichia coli, Bacteroidetes, and Proteus after gastric volume reduction surgery [22]. Microbial dysregulation in IBS patients is mainly
characterized by elevated levels of anaerobic bacteria which includes streptococcus and Escherichia coli, and increased numbers of Firmicutes and Bacteroidetes as well [23]. Thus, MetS and IBS do have the same changes in the number and proportion of some flora, so the possibility of mutual influence cannot be excluded.

The role of dietary factors in the pathogenesis of IBS is currently controversial. Therefore, in this study, we analyzed the dietary structure of the subjects, and the results showed that the proportion of animal food-predominant type in IBS patients was higher than that in non-IBS patients, which was more obvious in IBS-D, considering that IBS subtypes may be related to dietary structure, but this difference was not statistically significant in multivariate analysis. Some studies have shown that symptoms in IBS patients are associated with a high-fat diet [24, 25]. Patients with IBS are characterized by visceral hypersensitivity and increased sensitivity to various responses and stimuli. Lipids have the strongest stimulating effect in the digestion and absorption of various nutrients. Stimulation of the duodenum, ileum, and colorectum by lipid loading can cause clinical symptoms such as abdominal distension, diarrhea, and abdominal pain in patients [26, 27], which can be relieved in IBS patients after changing their dietary structure [28]. Whether the stimulatory effect of lipids on the digestive tract is exaggerated remains to be further investigated [26]. High-protein diet, especially excessive intake of dairy products, is not conducive to controlling IBS symptoms. Studies have reported that some IBS patients develop lactose intolerance after eating dairy products [29], which may be associated with immune inflammatory responses and increased permeability of the intestinal mucosa. Thus, diet is closely related to symptoms in IBS patients.

Psycho-psychological factors also play an important role in IBS pathogenesis. In particular, anxiety and depression seriously affect the condition and quality of life of IBS patients [30]. In this study, all subjects were excluded from psycho-psychological disorders prior to enrollment. With follow-up, anxiety and depression developed gradually, especially in patients with MetS and Pre-MetS. The presence of anxiety and depression in MetS patients may be related to MetS components and negative emotions generated during treatment, and this state can alter the physiological function of the digestive tract and also directly lead to an increased risk of IBS development.

This study has some limitations. First, although gender was a confounding factor in this study, given the female predilection for IBS, male and female related models were not developed for analysis, respectively. Second, this study was unable to determine the outcome of MetS and Pre-MetS during follow-up, as well as whether intervention for MetS and Pre-MetS had an effect on the incidence of IBS. Third, this study was conducted in a single center, and there may be regional, racial differences, which easily lead to the occurrence of selection bias.

In conclusion, MetS and IBS share some common pathophysiological factors as two diseases with high prevalence. MetS and even pre-MetS status may increase the risk of IBS, of course, MetS and IBS may be mutual influencing factors. However, the specific mechanism linking the two diseases has not been fully clarified, especially the study of intestinal flora is still lacking, but whether this can give us inspiration:
intervention for MetS is a potential means to prevent IBS. Therefore, more prospective studies with larger sample sizes and multiple centers are needed to clarify this relationship.

**Declarations**

**Acknowledgments**

The authors thank Jun Zhang, Information Center, People's Hospital of Xinjiang Uygur Autonomous Region, for his contribution to data analysis.

**Author contributions**

Feng Gao participated in study conception and design. Zhiyuan Wang, Yan Feng and Tian Shi collected data and statistically analysed. Zhiyuan Wang wrote the first draft and each author agreed to the final manuscript.

**Funding**

No funding was received for conducting this study.

**Ethics approval**

The ethics committee of the Xinjiang Uygur Autonomous Region People's Hospital approved the study.

**Consent to participate**

As the retrospective observational study design, which had no impact on the patients, exempting them from the requirement of informed consent.

**Conflict of interest** The authors declare no competing interests.

**Data availability**

The data analyzed in this study is available on the request from corresponding author.

**References**


Figures
Figure 1

Flowchart of the study
Figure 2

Cumulative incidence rate of IBS in MetS, Pre-MetS and healthy control group
Figure 3

The ROC curve of waist circumference (A) and TG (B).