

## METEORISM AND ABDOMINAL DISTENSION

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**Summary:** Meteorism or bloating in the abdomen and abdominal distension are among the most common digestive issues that patients experience at both primary and secondary care levels. Up to 10-30% of the general population experiences bloating problems. Symptoms are even more prevalent in patients with functional gastrointestinal disorders. Bloating is often associated with a feeling of increased pressure in the abdomen and the release of gas from the intestines. A healthy individual can tolerate up to 500 ml of air in the gastrointestinal tract without major symptoms, but in patients with irritable bowel syndrome, symptoms can be triggered by even minimal increases in gas volume in the gastrointestinal tract. The composition of intestinal gases partly explains their origin: nitrogen (N<sub>2</sub>) is usually from swallowed air; hydrogen (H<sub>2</sub>) is produced by bacterial fermentation of carbohydrates; carbon dioxide (CO<sub>2</sub>) is produced by bacterial fermentation of carbohydrates, fats, and proteins; methane (CH<sub>4</sub>) is produced during anaerobic bacterial metabolism. When there is an imbalance between gas production and expulsion in the digestive system, it manifests as a feeling of bloating with or without visible abdominal distension. When defining functional disorders related to bloating, it is crucial to exclude possible organic causes of symptoms. Bloating and abdominal distension occasionally occur even in healthy individuals as a result of normal digestion (especially after meals rich in fats and fermentable sugars). The characteristic of "physiological" bloating and distension is that they occur shortly after meals, are short-lived, and disappear after urination or passing gas. Initially, bloating and abdominal distension were only understood as consequences of excessive air in the intestines. Today, we know that the pathophysiology of both conditions is much more complex and the result of different mechanisms. In addition to increased gas production, which accumulates in the intestines along with fluid, altered intestinal microbiota and functionally altered enteric nervous system, which cause visceral hyperalgesia and motility disorders, also have a significant impact. The epidemiological dimension and numerous causes, including malignancies, indicate the need for this type of diagnostic approach in patients with bloating. Diagnosis can involve many tests, including invasive ones, which may pose a certain risk to the patient and a financial burden on the healthcare system. Therefore, a step-by-step approach and a targeted approach are necessary when managing each individual case. The purpose of this study is to present the treatment approach for patients with bloating and to draw attention to the most common medical conditions that may cause increased gas in the gastrointestinal tract.

**Keywords:** meteorism, bloating, gastrointestinal tract, diagnostics

### INTRODUCTION

The primary characteristic of meteorism is the accumulation of gases in the gastrointestinal (GI) tract, which causes a feeling of bloating and abdominal distension. Meteorism and abdominal distension are among the most common digestive issues that patients experience at both primary and secondary care levels. Meteorism is a very common symptom occurring in people of all ages, equally prevalent in all races, and can be present in both babies and older individuals. Approximately 15-23% of Asians and 15-30% of Americans suffer from bloating [1,2]. In Slovenia, about 10-30% of the general population have bloating problems [3].

This issue was highlighted in the past by the Persian physician Avicenna in his Canon of Medicine. Avicenna used keywords such as bloating and gases, attributing the causes of bloating to dietary factors, inappropriate lifestyle, gastrointestinal, and other reasons. Furthermore, Avicenna classified the causes based on the location of origin, dividing them into the upper part of the abdomen (stomach) and the intestinal part of the abdomen. He also listed 38 medicinal plants used as remedies. Modern scientific data support most of the causes of bloating mentioned in Avicenna's Canon [4].

Symptoms of meteorism are even more prevalent in patients with functional gastrointestinal disorders [5]. Meteorism is almost invariably associated with symptoms such as bloating, distension, and the passage of gas from the intestines. The causes of meteorism are usually benign, such as overeating, swallowing air during meals, or excessive fermentation in the intestinal microbiota. More concerning causes may include bowel obstruction, kidney stones, functional disorders related to overeating, bacterial overgrowth, inflammatory bowel diseases, food intolerance, allergies, blunt trauma to solid abdominal organs, peritonitis, and idiopathic causes.

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Meteorism and abdominal distension - definition of terms:

Meteorism, bloating, and distension are different terms used to describe the same condition: increased gas in the digestive tract. Meteorism is the medical term for this condition, while bloating and distension are more common terms in everyday language. Bloating refers to a feeling of tightness or fullness in the abdomen, while distension refers to a visible increase in abdominal girth. Flatulence is another medical term that refers to the passage of gas from the anus.

In a healthy individual, the gastrointestinal tract usually contains 100 to 200 ml of gas, which is physiological and reflects the dynamic process of gas formation during digestion. Gases can enter the gastrointestinal tract during feeding (aerophagia), arise from the breakdown of substances and bacterial fermentation. They are eliminated during defecation, through the diffusion of gases from the intestines into the systemic circulation, and some gases are necessary for the metabolism of the intestinal microbiota. In addition to causing discomfort, intestinal gases can be associated with more serious symptoms. In the intestinal microbiota, bacteria such as *Bacteroides*, *Ruminococcus*, *Roseburia*, *Clostridium*, *Eubacterium*, *Desulfovibrio*, and *Methanobrevibacter* are among the most common microbes responsible for the formation of intestinal gases. More than 99% of intestinal gas consists of hydrogen, carbon dioxide, and methane, while less than 1% consists of other odorous compounds. Food groups associated with intestinal gases include legumes, vegetables, fruits, cereals, and for some individuals, dairy products. This food is rich in indigestible carbohydrates such as oligosaccharides of the raffinose family, fructans, polyols, and for sensitive individuals, lactose. These carbohydrates are fermented by colonic bacteria, producing gases directly or through cross-fermentation [8].

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Meteorism (bloating) is a symptom that patients describe as a feeling of increased pressure in the abdominal cavity. Simultaneously, abdominal distension may accompany it, wherein we find an objectively increased volume of the abdomen; however, abdominal distension can also occur as an independent sign [8,9]. Bloating and abdominal distension occasionally occur even in healthy individuals as a result of normal digestion (especially after meals rich in fats and fermentable sugars). The characteristic of "physiological" bloating and distension is that they occur shortly after meals, are short-lived, and disappear after urination or passing gas. Initially, bloating and abdominal distension were only understood as consequences of excessive air in the intestines. Today, we know that the pathophysiology of both conditions is much more complex and the result of different mechanisms. In addition to increased gas production, which accumulates in the intestines along with fluid, altered intestinal microbiota and functionally altered enteric nervous system, which cause visceral hyperalgesia and motility disorders [9,10].

The pathophysiology of functional gastrointestinal disorders with meteorism and abdominal distension is multifactorial and not fully understood. Several underlying mechanisms have been proposed that may coexist in individual patients:

1. **Intraluminal content of the gut** (increased gas and fluid volume)
2. **Visceral hypersensitivity**
3. **Abdominal-diaphragmatic dysenergia** (Instead of the relaxation of the diaphragm and contraction of the abdominal walls, food intake leads to relaxation of the abdominal walls, and the diaphragm moves lower and closer to the abdomen. This leads to increased pressure in the abdominal cavity, which can lead to meteorism, pain, and in some cases, constipation. ADD is often seen together with pelvic floor muscle disinhibition.)
4. **Constipation**
5. **Obesity**
6. **Dysbiosis** (leading to chronic inflammation, which then leads to sensory and motor dysfunction)
7. **Psychogenic comorbidities** (anxiety and depression) [1,3]

These factors can interact and contribute to the development and persistence of symptoms associated with meteorism and abdominal distension.

#### **Approach to patients with meteorism:**

The etiology of meteorism and abdominal distension is highly diverse, categorized into organic and functional causes. Diagnosis is often demanding, prolonged, and costly.

Understanding the most common pathological conditions is essential for the rational treatment of patients with meteorism. Patients can be spared from many unpleasant and potentially risky examinations, and prompt symptom improvement can be achieved through proper disease recognition and treatment. When organic causes are ruled out, particular attention must be paid to alarm symptoms. (Alarm symptoms are indicators of possible organic diseases, and it is necessary for a gastroenterologist to examine the patient as soon as they are noticed. These symptoms include: sudden onset anemia due to bleeding from the digestive tract, significant unintended weight loss, persistent vomiting, difficulty swallowing, and the presence of a palpable mass in the abdomen.) The presence of these signs with bloating should prompt us to quickly perform endoscopic and imaging diagnostics to rule out potential significant organic diseases. Otherwise, endoscopic and imaging diagnostics often provide little information when diagnosing the causes of functional meteorism [7,10,11g].

Patient dietary habits are important in history taking. Consuming large individual meals and fast eating can cause postprandial bloating. Such patients are advised to eat smaller meals several times a day. Additionally, certain foods can cause excessive bloating: onions, legumes, coffee, carbonated beverages, or fruit sugars [11]. In particular, these latter mentioned foods produce a lot of gas during breakdown, which is the cause of the problem. This knowledge formed the basis for the very popular "FODMAP" diet today. The FODMAP diet is a dietary approach used to alleviate symptoms of irritable bowel syndrome (IBS), which include pain, bloating, diarrhea, and constipation. FODMAP is an acronym for fermentable oligosaccharides, disaccharides, monosaccharides, and polyols, which are types of carbohydrates that some people cannot digest well. The FODMAP diet reduces the intake of these substances and can help reduce inflammation and gas production in the intestines. The FODMAP diet is conducted in three phases: elimination, reintroduction, and adaptation. In the first phase, all high-FODMAP foods are eliminated, in the second phase, they are gradually reintroduced one by one to determine which foods cause symptoms, and in the third phase, the diet is adjusted based on individual tolerance. The effectiveness of a diet avoiding fermentable oligo-, di-, monosaccharides and polyols has been demonstrated in randomized studies in patients with irritable bowel syndrome [12,13]. Dietary history is also important for identifying possible diseases resulting from the harmful effects of food on the gastrointestinal system. Among them, lactose intolerance is the most common [14]. If problems occur after consuming gluten in the diet, celiac disease diagnosis is necessary [15]. Exocrine pancreatic insufficiency in older individuals is not so rare [16].

Bloating can also result from certain medications, and it is one of the side effects of metformin, while opioid analgesics can cause both bloating and constipation simultaneously [11]. In the case of constipation, there is disrupted stool and gas expulsion, which then accumulate in the digestive tract. Up

to 80% of patients report bloating symptoms when they have constipation. In most patients, bloating symptoms will disappear after resolving constipation [17]. When further defining the causes of bloating, the timing of the onset of symptoms can be helpful. If discomfort occurs shortly after eating, the cause of bloating is usually in the upper gastrointestinal tract - "gastric bloating." However, if a patient reports bloating long after eating, the cause is usually lower in the digestive tract - "intestinal bloating."

In summary: When "gastric" meteorism is present, we usually think of disorders of gastric emptying, gastroparesis, functional dyspepsia, GERD, or biliary gastritis. In this case, the most commonly used diagnostic tools are gastroscopy or X-ray imaging of the upper GI tract. If it is "intestinal" meteorism, we suspect intolerance to food ingredients, small intestinal bacterial overgrowth (SIBO), celiac disease and gluten sensitivity, malabsorption syndrome, bowel malignancy, intestinal infections, bowel ischemia (abdominal angina), exocrine pancreatic insufficiency, or functional bowel diseases. Diagnostic procedures include serological tests for celiac disease, hydrogen breath test, imaging and endoscopic diagnostics, and if necessary, anorectal manometry. A simplified algorithm for the initial treatment of meteorism is summarized in Figure 1 [3].

Figure 1. Simplified procedure for the initial treatment of a patient with flatulence

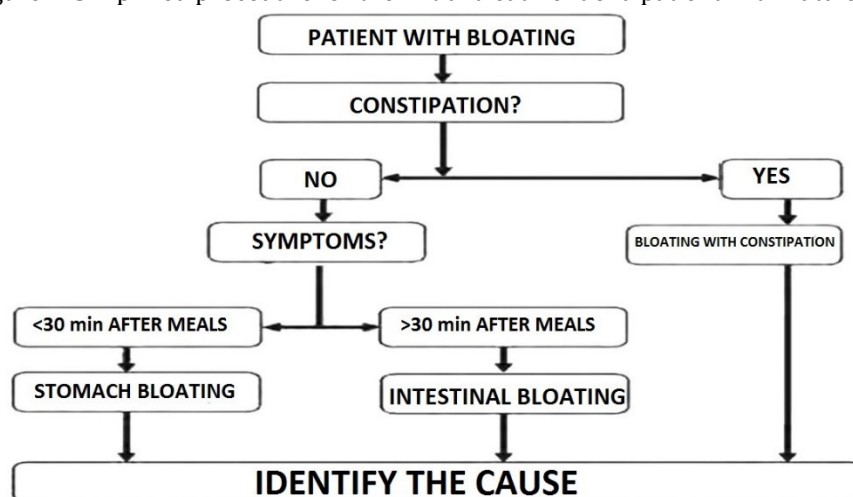


Table 1 shows some of the previously mentioned etiologically most common conditions and common diagnostic procedures [3].

Table 1. Common etiology and some of the diagnostic tests for flatulence

<p><b>"STOMACH" BLOATING</b></p>	<ul style="list-style-type: none"> <li>• Stomach emptying disorders</li> <li>• Gastroparesis</li> <li>• Functional dyspepsia</li> <li>• GERD (Gastroesophageal Reflux Disease)</li> <li>• Biliary gastritis</li> </ul>	<ul style="list-style-type: none"> <li>• Gastroscopy</li> <li>• Gastric motility tests</li> <li>• Systemic diseases – diabetes, scleroderma...</li> </ul>
<p><b>"INTESTINAL" BLOATING</b></p>	<ul style="list-style-type: none"> <li>• Food ingredient intolerance</li> <li>• Small intestinal bacterial overgrowth (SIBO)</li> <li>• Celiac disease and gluten sensitivity</li> <li>• Malabsorption syndrome</li> <li>• Intestinal malignancies</li> <li>• Intestinal infections</li> <li>• Intestinal ischemia (abdominal angina)</li> <li>• Exocrine pancreatic insufficiency</li> <li>• Functional bowel diseases</li> </ul>	<ul style="list-style-type: none"> <li>• Serology for celiac disease</li> <li>• Hydrogen breath test</li> <li>• Imaging and endoscopic diagnostics</li> <li>• Anorectal manometry</li> </ul>

### **Certain more significant conditions that cause bloating**

Among the more common causes of bloating are diseases due to altered absorption of nutrients and food intolerances. The most common causes of malabsorption can often be ruled out without invasive interventions, even at the primary healthcare level. In recent years, gluten-related diseases have become significant gastrointestinal tract disorders. We must consider them, among other reasons, because of their epidemiological dimensions. According to some estimates, celiac disease, non-celiac gluten sensitivity, and wheat allergy affect up to 6% of the general population, and they all share symptoms resulting from the harmful effects of gluten. Introducing a gluten-free diet for most patients leads to objective and subjective improvement of the disease [14,18].

#### **Celiac disease**

Celiac disease is a condition that should always be considered in patients with bloating. It affects 1-2% of the population and is the most common enteropathy. Special attention must be paid to it in all age groups, especially in patients with type 1 diabetes and Hashimoto's thyroiditis, where a lower threshold of suspicion for testing should be maintained [18,19]. Serological diagnostics play a role as a screening test, with the determination of IgA antibodies against tissue transglutaminase (IgAtTG) being the first-choice test. Despite the high specificity and sensitivity of serological testing, it is not sufficient for diagnosing celiac disease in adults. Confirmation through endoscopic examination and histological examination of duodenal mucosa biopsy is necessary for a definitive diagnosis. All patients with positive serological findings should be referred for endoscopic diagnosis. Regardless of the serological test result, endoscopic diagnosis is performed in patients with a high probability of celiac disease. Patients with symptomatic malabsorption, unexplained diarrhea with weight loss, unexplained iron-deficiency anemia, herpetiform dermatitis, or symptomatic patients who are first-degree relatives of celiac disease patients fall into this category [19]. Serological testing and endoscopic examination must be performed in patients following a gluten-containing diet. If the patient is on a gluten-free diet at the time of testing, they must be gluten-loaded. Recent studies have shown that even small amounts of gluten can induce inflammation. The gluten challenge should last at least 2 weeks, and if the patient tolerates the diet, it can be extended up to 6 weeks [20,21]. Genetic testing for celiac disease may be used in patients already on a gluten-free diet to determine the presence of HLA DQ2 and DQ8 alleles, which are necessary for celiac disease development; the absence of these alleles excludes the disease with a probability of over 99%. However, genetic testing is not used in routine practice and is indicated for unclear forms of celiac disease and diagnosing refractory forms of the disease [21].

Non-celiac gluten sensitivity (NCGS) has emerged as a separate nosological entity in recent years. Symptoms are varied and similar to those of celiac disease and other functional gastrointestinal disorders, associated with gluten consumption. Since the mechanism of the disease is poorly understood, there is still no diagnostic biomarker. Therefore, the diagnosis of non-celiac gluten sensitivity is made by excluding celiac disease. Wheat allergy, on the other hand, results from a classic allergic reaction (type 1 hypersensitivity) to proteins contained in wheat, including gluten. When antigens enter the body, the allergy can affect the skin, respiratory system, or digestive system. Gastrointestinal symptoms are nonspecific, including bloating, distension, diarrhea, but allergic reactions can also manifest as anaphylaxis. The diagnosis involves excluding celiac disease through serological testing and, if indicated, performing endoscopic examination and histopathological examination of duodenal mucosa biopsy. Allergy to wheat is confirmed through skin prick tests or by determining specific antibodies [23].

*A gluten-free diet is crucial in gluten-related diseases.* It involves eliminating all foods containing wheat, rye, barley, and related grains. Compared to a normal diet, a gluten-free diet is more expensive and less accessible. Patients must also pay close attention to hidden sources of gluten, as it appears in various sauces, soups, processed seafood, dried meat products, and dressings. Additionally, the managing physician must be aware that a gluten-free diet is not always balanced, and the patient may consume insufficient fiber, B-complex vitamins, iron, and trace elements (zinc, copper, selenium...) [24,25]. Celiac disease is a chronic, lifelong condition that, if left untreated, can lead to many serious complications (osteoporosis, the development of other autoimmune diseases, T-cell lymphoma). Therefore, strict lifelong dietary adherence is the cornerstone of therapy. A gluten-free diet in patients with celiac disease reduces symptom occurrence, improves quality of life, enhances nutritional status, and prevents disease complications. Symptoms disappear within 2-4 weeks, serological tests normalize within weeks to months, and the mucosa completely regenerates after about a year. Measurement of antibodies specific to

celiac disease is the most suitable test for assessing patient compliance with a gluten-free diet. If after 6-12 months of strict gluten-free diet, antibody levels in blood cells normalize but the patient still reports symptoms, further evaluation by a dietitian and gastroenterologist is required. It is necessary to exclude gluten contamination, refractory forms of the disease, or possible accompanying pathology [18,20,22].

A gluten-free diet is also the foundation of treatment for non-celiac gluten sensitivity. The goal is symptom remission and subjective well-being of the patient. Currently, there are no clear recommendations regarding the necessity of a lifelong gluten-free diet in these patients. There is insufficient research on whether non-celiac gluten sensitivity is only transient or a chronic disease state [18].

Pancreatic exocrine insufficiency (PEI) is a common and often overlooked cause of bloating, especially in older individuals. The causes of pancreatic exocrine insufficiency are divided into pancreatic or primary and non-pancreatic or secondary. In practice, elastase determination in stool is used in diagnostics, but lately, secretin MRCP (with much higher sensitivity and specificity) has been employed. PEI significantly reduces the quality of life and is diagnosed through clinical presentation and pancreatic function tests. Treatment involves lifestyle adjustments, vitamin supplementation, and pancreatic enzyme replacement therapy. Long-term goals include eliminating clinical symptoms and correcting malnutrition, addressing only the underlying disease when present. Enzyme replacement therapy has both diagnostic and therapeutic significance and leads to significant symptom improvement and better quality of life for patients [26].

The treatment of meteorism and abdominal distension caused by functional disorders, after excluding alarm signs and organic diseases, involves gradual, individualized treatment. Patients with mild functional bloating may only require reassurance that the condition is benign, well, and not indicative of any life-threatening disease.

*Symptomatic treatment* - Several agents are available for treating these disorders. Antispasmodics have shown some clinical benefit in alleviating symptoms in some patients [27]. Simethicone has been shown to reduce the frequency and severity of meteorism, distension, and bloating [28,29]. Peppermint oil reduced abdominal distension compared to placebo [30,31]. Despite their popularity, evidence is lacking regarding other commonly used agents such as activated charcoal, Iberogast, and magnesium salts.

*Dietary intervention* - The role of dietary therapy in managing bloating symptoms is crucial and is generally introduced early in the treatment plan. The main reason for dietary therapy is to identify foods that the patient does not tolerate and thus reduce excessive fermentation of food residues. Initially, empirical lactose and other poorly absorbed carbohydrate restrictions may be implemented [12]. Alternatively, FODMAP diet or other elimination diets may be offered to patients with meteorism and abdominal distension if they have not improved on a restrictive diet [32].

*Addressing constipation* - Patients with chronic idiopathic constipation (CIC) and irritable bowel syndrome with constipation (IBS-C) usually report bloating in their medical history. Lubiprostone has been found to reduce bloating in two placebo-controlled clinical trials involving patients with IBS-C [16,34]. Prucalopride, a selective 5-HT<sub>4</sub> receptor agonist, enhances spontaneous bowel movements and reduces bloating [35]. Similarly, linaclotide, a guanylate cyclase C agonist, improves constipation symptoms and reduces abdominal pain and bloating in patients with CIC and IBS-C [36-42].

*Microbiota modulation* - Reducing gas-producing bacteria or inducing changes in their metabolic activities may reduce excessive fermentation and bloating. Rifaximin, a poorly absorbed broad-spectrum antibiotic, has been found to reduce bloating and flatulence in controlled trials in patients with and without IBS [45,46]. Probiotics may become a therapeutic option in FABD; however, studies have yielded different results, likely due to the lack of standardized study methods [47,48]. A recent review suggested that probiotics have a role in the treatment of functional gastrointestinal disorders [49]. In a double-blind study, Ringel et al. found that *Lactobacillus acidophilus* and *Bifidobacterium lactis* Bi-07 reduced bloating in patients with functional gastrointestinal disorders without constipation [50].

*Abdominal biofeedback therapy* - As described, postprandial meteorism and abdominal distension may result from abnormal relaxation of the anterior abdominal wall and diaphragmatic contraction. It has been shown that patients can be educated to use their abdominal and diaphragmatic muscles to reduce discomfort associated with meteorism and abdominal distension [51].

*Modulation of the brain-gut axis* - If heightened perception of bowel wall stretching and visceral hypersensitivity are key components in the pathogenesis of functional gastrointestinal disorders with

meteorism and abdominal distension, then modulation of the brain-gut axis appears to be a reasonable treatment option. The efficacy of antidepressants, such as tricyclic antidepressants (TCA) and selective serotonin reuptake inhibitors (SSRI), has been evaluated in patients with IBS. In a small, controlled crossover study, citalopram (SSRI) showed an increase in the number of days without bloating after 3 and 6 weeks. In another study, desipramine in combination with cognitive-behavioral therapy reduced bloating. Hypnotherapy and cognitive-behavioral therapy, also offered to patients with IBS, may be effective in patients with functional gastrointestinal disorders [55].

### CONCLUSION

Meteorism and abdominal distension represent a common clinical problem. Like any other health condition, the clinical assessment of gastrointestinal disorders with meteorism and abdominal distension begins with a detailed medical history, physical examination, and appropriate diagnostic tests. It is crucial to exclude any organic cause of bloating and distension. Alarm symptoms, which may indicate more serious pathology, should not be overlooked. Depending on the frequency, gluten-related diseases should always be considered, and in the elderly, pancreatic exocrine insufficiency should also be considered. Celiac disease can be sufficiently excluded with serological testing, even at the level of primary or secondary medical facilities. In treatment, a gradual, multidisciplinary, individualized approach is desirable. Therapy may target bowel motility, muscle tone, microbiota, visceral sensitivity, nutrition, and/or psychological comorbidities. Additionally, an "ex juvantibus" response to treatment – improvement of symptoms with pancreatic enzyme replacement therapy – indicates pancreatic exocrine insufficiency.

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