Chapter 13
Role of Nutrition in Understanding Common Gastrointestinal Disorders

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Key Points

- Nutrition has a role in the etiology and management of gastrointestinal (GI) diseases.
- Overnutrition leading to overweight and obesity is a risk factor for gastroesophageal reflux disease.
- Nutritional requirements greatly increase with severe malabsorptive diseases such as celiac disease, pancreatic exocrine insufficiency, bariatric surgery, and Crohn's disease.
- To prevent weight loss associated with malabsorptive GI diseases, a variety of feeding methods, with emphasis on a high-calorie, high-protein diet that also includes micronutrient supplementation, should be the key.

Keywords Gastroesophageal reflux disease (GERD) • Peptic ulcers • Food allergy • Constipation • Diverticulosis • Inflammatory bowel disease • Colon cancer

Introduction

"Nutrition" is the term used in this chapter to characterize how food nourishes the body and influences health. Nutrition encompasses how food is consumed, digested, absorbed, and, also, how the waste products of digestion are eliminated. The gastrointestinal (GI) system receives food and extracts nutrients through complex mechanical and chemical processes involving several organs. Nutrients are substances in foods that are necessary for providing the body with energy and building blocks to support its structure and for regulating metabolism. GI disorders occur when there is malfunction of one or more of the digestive organs, or when there is disruption of the mechanical or chemical processes of digestion. GI diseases are commonly encountered in primary care, and the prevalence of some diseases, including celiac disease, is increasing. Of the top ten high-cost physical health conditions affecting people in the United States, GI disorders rank second [1].

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Gastroesophageal reflux disease (GERD) and peptic ulcers are common problems that affect the upper GI tract. These conditions are characterized by excessive acid production or reflux that cause frequent discomfort and tissue damage in the form of inflammation, ulceration, or even stricture formation. In addition, there is a strong association of peptic ulcer disease with *Helicobacter pylori* infection; therefore, eradication of the *Helicobacter pylori* infection is required when it is detected. Disorders of the middle and lower GI tract that have relationship with nutrition include food allergy and celiac disease, constipation, diarrhea, diverticulosis and diverticulitis, inflammatory bowel disease, and colorectal cancer.

Celiac disease is associated with genetic predisposition that is characterized by an abnormal immune response to proteins (e.g., gluten) in wheat, barley, and rye. A food allergy is a hypersensitivity reaction of the immune system to a particular food substance, usually a protein; eosinophilic esophagitis is associated with allergic responses to food and may respond to avoidance of allergens. Constipation is characterized by infrequent bowel movements, altered stool consistency or straining, that is difficulty with passage of bowel movements. Diarrhea is associated with passage of frequent stools of watery to loose consistency. Diverticulosis refers to the presence of pouches in the intestinal wall, most commonly affecting the colon; it can lead to diverticulitis if the pouches are inflamed. Inflammatory bowel diseases are chronic conditions associated with extensive damage to intestinal tissue which causes serious complications to the GI tract including bleeding, diarrhea, stricture or fistula formation, and cancer. The inflammatory bowel diseases include Crohn's disease and ulcerative colitis. Colorectal cancer is the third most frequently diagnosed malignant neoplasm in the United States.

Because of the intricate relationship between nutrition and the GI tract, diet has an impact on the development and subsequent medical management of GI disorders, and the diseases discussed subsequently may benefit from dietary adjustments.

The GI conditions are reviewed based on anatomical distribution of the disease or disorder.

Eosinophilic Esophagitis

This is a disease that often starts in childhood with eating difficulties and symptoms of GERD. However, it progresses with increasing inflammation, fibrosis, and strictures until the esophagus is anatomically narrowed, sometimes with the appearance of a ringed or "feline" appearance. The cellular, molecular, and genetic bases are increasingly understood [2] with involvement of an eotoxin produced by infiltrating eosinophils and inflammatory interleukins (e.g., IL-5).

Early recognition and treatment with an allergen-avoidance diet and topical steroids are key to treatment; an elemental diet is rarely required. The most common dietary allergens are cow's milk, wheat, eggs, seafood, soy, and peanuts.

Dietary intervention is efficacious in about two-thirds of patients [3]. Swallowed, viscous formulations of topical steroids, such as budesonide, are the main pharmacological therapies used, alone or in combination with diet. Effective treatment is essential to prevent long-term complications such as formation of strictures.

Gastroesophageal Reflux Disease

Gastroesophageal reflux disease (GERD) is a painful condition of the upper GI tract characterized by heartburn that occurs more than twice a week. About 19 million people in the United States experience GERD each year, making it one of the most prevalent GI disorders [4]. The main cause of GERD is a transient relaxation or weakening of the lower esophageal sphincter (LES) which allows regurgitation of gastric acid and other gastric contents, including bile, back into the esophagus, thereby

causing substernal discomfort and heartburn. The esophageal lining is susceptible to irritation by acid because it does not have the thick mucus protection of the stomach, attributable to the mucin-secreting gastric epithelial cells. Some people with GERD do not experience heartburn but may have difficulty swallowing, burning sensation in the mouth, a feeling that food is stuck at any level of the esophagus, or hoarseness in the morning [4].

There are a number of predisposing factors associated with GERD, including a hiatal hernia, cigarette smoking, alcohol use, being overweight or obese, and pregnancy. Foods such as citrus fruits, chocolate, caffeinated drinks, fried foods, garlic, onions, spicy foods, and tomato-based foods, such as chili, pizza, and spaghetti sauce, are associated with heartburn symptoms. Consumption of large high-fat meals requires prolonged gastric passage times and the increased stomach pressure may lead to movement of hydrochloric acid from the stomach into the esophagus. Additionally, lying prone after a meal promotes backflow of stomach contents and the development of symptoms [5].

GERD may result in persistent irritation of the esophageal lining; the resulting esophagitis may lead to malnutrition due to development of a stricture leading to dysphagia and a loss of appetite. Bleeding related to chronic inflammation or surface epithelial erosive change causes loss of iron as well as other blood nutrients (minerals, vitamins, amino acids, glucose, fatty acids).

Effective treatments for GERD include identifying and avoiding foods that trigger increased acid production. People can reduce symptoms by eating smaller meals, waiting at least 3 h after a meal before lying down, and elevating the head of the bed by 4–6 in. to allow gravity to keep stomach contents down. Diet therapy may also require replacing lost nutrients with the use of vitamin and mineral supplements. Patient compliance may be low, but these lifestyle modifications are the first step in management, before prescription of a proton pump inhibitor.

Peptic Ulceration

Peptic ulcers are erosions or sores of the mucosal lining of the stomach and duodenum. The majority of ulcers occur in the duodenum which lacks the thick, protective mucosal lining of the stomach and is, therefore, more susceptible to damage by the acidic chyme before it is neutralized by bicarbonate secreted from the pancreas. One in 10 Americans develops a peptic ulcer at some time in his or her life [4].

The primary cause of peptic and duodenal ulcers is now widely accepted to be an infection with *Helicobacter pylori* (*H. pylori*); prolonged use of nonsteroidal anti-inflammatory drugs (NSAIDs) remains an additional cause. For many years, the cause of ulcers was thought to be stress, alcohol, and spicy foods, but this focus on lifestyle and diet has changed since the discovery of *H. pylori* as the chief causative agent. However, stress is still thought to play a role because of its effects on behavioral changes such as increased use of alcohol which is a potential risk factor [4].

Upper abdominal pain occurring 1–3 h after eating remains a primary symptom. Duodenal ulcer discomfort may be relieved by eating, while the discomfort due to gastric ulcers may also be paradoxically aggravated by food and cause loss of appetite and subsequent weight loss. Peptic ulcers can also be accompanied by hemorrhaging, resulting in iron deficiency anemia, and vomiting, leading to electrolyte losses.

The goals for peptic ulcer treatment include relief of symptoms, promotion of mucosal repair, and prevention of recurrence. This is achieved with a combination of medications including antibiotics to eradicate *H. pylori*, mucosal protectants, antacids, proton pump inhibitors, and stopping NSAID use. Dietary recommendations are adapted to individual food tolerances. Foods that trigger acid secretion, such as alcohol, caffeine and caffeine-containing beverages, and spicy foods, should be avoided. Patient compliance is generally poor, and this is less important with the highly effective treatments with antibiotics and proton pump inhibitors. Dietary modification has not been shown to increase the rate of healing [6].

Gastroparesis

Gastroparesis results in symptoms and objective findings of delayed emptying from the stomach in the absence of mechanical obstruction. Typical causes are diabetic, post-vagotomy, or idiopathic. The disorder typically represents abnormal extrinsic or intrinsic neural supply to the gastric smooth muscle. Gastroparesis may present with significant nutritional deficiencies [7], and attention to hydration and nutrition are essential for proper management of patients. The mainstays of treatment are dietary change (low fat, low nondigestible residue [fiber], small particle size supplement), prokinetics, and antiemetics. A randomized controlled trial demonstrated symptomatic benefit of a small size particle diet [8]. Other management strategies for gastroparesis and diabetic gastroparesis are detailed elsewhere [9, 10].

Bariatric Surgery

Bariatric surgery, such as Roux-en-Y gastric bypass (RYGB), sleeve gastrectomy, and the less frequently performed biliopancreatic diversion with duodenal switch, is effective at inducing significant weight loss; dietetic counseling is mandatory during the first year to enhance the efficacy of the weight loss intervention. However, these operations can be associated with nutritional deficiencies and malnutrition. Preoperative nutritional assessment and correction of vitamin and micronutrient deficiencies, as well as long-term postoperative nutritional follow-up, are required. Bone mineral density, vitamin and micronutrient deficiencies (including thiamine, vitamins A, B_{12}, and D, calcium, copper, etc.) need to be monitored in the long term [11].

Operations, such as RYGB (especially with a long Roux limb) and biliopancreatic diversion, may result in significant steatorrhea and lead to enteric hyperoxaluria (as in Crohn's disease); this may be prevented by reduction of dietary oxalate (e.g., tea, spinach). Patients who have undergone such bariatric surgery may therefore show characteristic 24-h urine changes including low urine volume, low urinary pH, hypocitraturia, hyperoxaluria, and hyperuricosuria. Potassium citrate raises urinary pH, enhances the activity of stone inhibitors, reduces the supersaturation of calcium oxalate, corrects hypokalemia, and is useful in treating patients who develop renal calculi after bariatric surgery [12].

Food Allergy

A food allergy is characterized by an abnormal immune reaction to a particular component in food, usually a protein. Food allergies are far less common than most other GI disorders, but their prevalence appears to have increased markedly over the last 50 years. Approximately 30,000 Americans require emergency room treatment and 150 people die each year because of allergic reactions to food. However, these are predominantly the result of generalized anaphylactic reactions, as may occur with peanut allergy, rather than allergies associated with GI symptoms. Food allergy usually manifests in early childhood as part of the so-called atopic march and most commonly involves one or more of the following foods: cow's milk, hen's egg, soy, peanuts and tree nuts, wheat, sesame seed, kiwi fruit, and seafood [13].

The diagnostic approach to adverse reactions to food is based on accurate clinical history and objective examination, and further execution of specific tests when allergy or intolerance is suspected. Symptoms may be localized or systemic, and rarely lead to anaphylactic shock, though they may occur with certain seafoods such as shellfish. The treatment for food allergies is the elimination of the food to which hypersensitivity has been found; this strategy can lead, especially in pediatric age, to tolerance. If elimination diets cannot be instituted or if it is not possible to identify the food

to eliminate, some drugs (e.g., antihistaminics, steroids) can be administered. Specific allergen immunotherapy has been introduced. It is fundamental to prevent food allergy, especially in high-risk subjects [14].

Celiac Disease

Celiac disease or sprue is a genetic disorder characterized by intolerance to gluten, the primary protein found in wheat, rye, and barley. Approximately one in 133 people in the United States is affected by this disease though the prevalence differs by ethnic group [15]. More than 95% of celiac patients share the major histocompatibility complex II class human leukocyte antigen (HLA) DQ2 or DQ8 haplotype; patients negative for both haplotypes are unlikely to suffer from the disease [16]. Some cases of sprue develop in infancy or childhood, and others occur later in life.

In susceptible individuals, the cells of the small intestine mount an immune response against gluten, with subsequent damage and erosion of the intestinal villi. The damage to the brush border, which normally absorbs nutrients, can lead to malabsorption and, over time, malnutrition can occur. Deficiencies of fat-soluble vitamins (A, D, E, and K), iron, folate, and calcium are common in people afflicted with celiac disease. There is an increased risk of osteoporosis from poor calcium absorption, diminished growth because of overall nutrient malabsorption, and seizures as a result of inadequate folate absorption [17]. The only effective treatment for celiac disease is a gluten-free diet [18]. There are many gluten-free foods such as meats, milk, eggs, fruits, and vegetables. Rice, potatoes, corn, and beans are also gluten free. Specialty food stores and many supermarkets now provide specially formulated gluten-free breads, pasta, and cereal products.

Constipation

Constipation is a common problem of the lower GI tract and is associated with stools that are hard to pass and infrequent bowel movements. The prevalence of constipation (~15–20%) is higher in women than men and appears to increase with age over 65 years. A low-fiber diet (<12g/day) often contributes to constipation. The lack of bulk that comes with low-fiber diets causes slow colonic transit, resulting in excessive absorption of water from the colon. This leaves dry hard stools that are hard to pass. Other nutrition-related causes of constipation include use of aluminum-containing antacids and iron and calcium supplements [19]. Paradoxically, these substances are often used to treat other GI disorders or are a part of standard vitamin/mineral supplementation regimens. Although it is commonly recommended that a high water intake is necessary for normal bowel function, this is insufficient to change stool consistency unless there are osmotically active foods or medications in the lumen (osmotic laxatives) to retain water within the intestinal tract.

Diarrhea

Diarrhea is characterized by frequent (more than three) watery to loose stools in a 24-h period. Diarrhea can be classified as acute or chronic.

Acute diarrhea is usually caused by an infection from a bacteria, virus, or parasite, which may be present in animal and human fecal matter or in contaminated food, milk, or water. Symptoms may persist for 1–2 days with or without serious consequences; however, persistent diarrhea lasting more than 3 days may lead to dehydration and electrolyte imbalance and can be fatal, particularly in children and the elderly. Other symptoms of diarrhea may include cramping, abdominal pain, bloating, nausea, fever, and bloody stools.

Prolonged diarrhea that lasts for a month or longer is chronic; it may be caused by a large number of diseases, some of which are related to nutrients, such as allergies to cow's milk, lactose intolerance, celiac disease, or pancreatic insufficiency.

Nutritional therapy for diarrhea is aimed at replacing fluids and electrolytes through consumption of beverages, such as water, juices, or sports drinks, and eliminating the cause of diarrhea (contaminated foods). Juices and carbonated beverages should be diluted since they are often hyperosmolar and would otherwise aggravate the diarrhea. The optimal fluid replacement therapy has an osmolality at or below that of plasma (~280 mOsm/kg). If solid foods are tolerated, restricting insoluble fiber can assist in slowing gut transit time; yogurt intake may be helpful in replacing commensal gut flora; and increasing soluble dietary fiber intake may be helpful with chronic diarrhea; however, these suggestions are based more on belief than evidence [20].

Irritable Bowel Syndrome

In addition to the symptoms of chronic constipation or diarrhea, the association of altered bowel function and abdominal pain is commonly recognized as irritable bowel syndrome (IBS). This is sometimes associated with abdominal bloating and passage of gas. These symptoms may be reduced by dietary supplementation with single probiotics like *Bifidobacterium infantis* or combination probiotics, such as VSL#3. Probiotics are discussed below under inflammatory bowel diseases.

Diverticulosis and Diverticulitis

Diverticulosis refers to a disorder in which pouches develop in weakened areas of the intestinal wall, typically at the site where arteries normally penetrate from the outside of the wall toward the internal lining or mucosa. Most people with diverticulosis are asymptomatic. However, some people may develop inflammation (diverticulitis), typically when the pouch is blocked; this can manifest as persistent abdominal pain, and alternating constipation and diarrhea, with possible loss of fluids and electrolytes. Patients have tenderness on examination over the inflamed area of the colon.

About 10% of Americans older than age 40 and about 50% of people over 60 years have colonic diverticulosis [21]. A major risk factor for developing this includes a low-fiber diet. Such a diet facilitates development of increased intraluminal pressure that induces tubular sacs or pouches to form and protrude on the serosal side, away from the intestinal lumen of the colon.

Nutrition may play a role in treatment of diverticulosis and diverticulitis. When diverticulitis occurs, a low-fiber diet is recommended to facilitate smooth passage of stools through the inflamed area. Once healing is restored, the approach is to encourage an increase in fluids and the insoluble fiber content of the diet to prevent future diverticuli. Previous recommendations for patients with diverticular disease to avoid nuts and seeds are no longer indicated since there is no firm evidence that these foods trigger inflammation.

Inflammatory Bowel Diseases

Inflammatory bowel diseases (IBDs) are characterized by chronic inflammation and diarrhea of the lower GI tract and include Crohn's disease and ulcerative colitis. Crohn's disease usually affects the small and large intestines, and less frequently the mouth, esophagus, and stomach, and causes damage that may extend through all layers of the gut wall. In contrast, ulcerative colitis involves the colon and the very end of the small intestine with tissue damage limited to the surface layers. IBDs usually

present between 15 and 30 years of age and are now generally classified as autoimmune diseases with a genetic basis [22].

The pattern of ulcerations in Crohn's disease is patchy, with normal tissue separated by diseased regions. Patients with Crohn's disease may require surgical resection to remove affected areas, but new regions often become ulcerated.

The main consequence of Crohn's disease is malnutrition resulting from intestinal resections as well as from impaired digestion and absorption. Reduced nutrient intake and eventual weight loss are common due to poor absorption of bile salts as a result of the interruption of the enterohepatic circulation. Thus, if the ileum is involved, bile acids may become depleted because of the loss of the active transport site for bile acids; this may cause malabsorption of fat, fat-soluble vitamins, calcium, magnesium, and zinc. Additionally, vitamin B_{12} deficiency can occur with ileal involvement, resulting in anemia.

The rectum is always involved in ulcerative colitis and lesions may extend into the colon. In mild cases, patients experience diarrhea and there may be weight loss, fever, and weakness, but in more severe forms, the disease is characterized by anemia, dehydration, electrolyte imbalance, and protein losses.

Dietary treatment for both Crohn's disease and ulcerative colitis should aim at preventing symptoms associated with the diseases, correcting malnutrition, promoting healing of affected tissue, and enhancing normal growth and development in children. Approaches to nutritional therapy are variable and are based on individual symptoms, complications, and documented nutritional deficiencies. A high-calorie, high-protein diet is generally indicated, and adults with advanced disease may require 40 kcal/kg/day, or approximately 2.2 times the basal metabolic energy needs due to catabolic state and poor nutrient absorption [23]. Nutritional supplements may be recommended, especially for children whose growth has been retarded. Special high-calorie liquid formulas are sometimes used for this purpose. A small number of patients may require periods of parenteral feeding to provide extra nutrition, allow the intestines to rest and hopefully heal, or to bypass the intestines for individuals whose guts cannot absorb enough nutrition from ingested food. Because of fat malabsorption, limiting fat intake may help, and medium-chain triglycerides may be better tolerated as they can be absorbed without the participation of bile salts. In some patients, a low-fiber diet may be indicated if there is a partial narrowing of the small intestine, while in others lactose restriction is to be recommended if the patient has proven lactose intolerance [24].

Prebiotics are nondigestible dietary oligosaccharides that affect the host by selectively stimulating growth, activity, or both of selective intestinal (probiotic) commensal bacteria. These bacteria may provide protection, stimulate local immune responses to combat infectious organisms, or suppress inflammation caused by antigens [25]. Although more clinical studies need to be done, preliminary results from animal models and humans indicate that prebiotics and probiotics may provide effective treatments for people with IBD [26]. There is evidence to support the use of probiotics in the treatment of pouchitis, a common problem among those who have had ileal pouch-anal anastomosis surgery for ulcerative colitis, and in ulcerative colitis, but not in Crohn's disease [27].

There has been an explosion of these products in the market in recent years. They are added to dairy products, such as yogurt drinks, and are also sold in the form of capsules. The role of omega–3 fatty acids in the management of IBD is not clear. Results from some studies show they may have the potential to alleviate intestinal inflammation [28], but findings from other investigations do not support this anti-inflammatory role [29].

Colorectal Cancer

People with either ulcerative colitis or Crohn's disease are at an increased risk of colon cancer. Excluding skin cancers, colorectal cancer is the third most common cancer diagnosed in both men and women in the United States, and the lifetime risk of developing colorectal cancer is about 1 in 21 (4.7%) for men and 1 in 23 (4.4%) for women [30].

Although a high-fat diet was thought to contribute to an increased risk of colon cancer, recent studies reveal factors found in red meat, other than fat, that are correlated with a higher risk [31]. Some epidemiological data indicate that a high-fiber diet is protective against colorectal cancer; however, short-term human clinical trials have not produced supportive findings. Other population studies show that people who consume higher amounts of raw and cooked garlic lower their risk for colorectal cancer [32]. A study on the adherence to the USDA Food Guide, Dietary Approaches to Stop Hypertension (DASH) Eating Plan, and the Mediterranean Dietary Pattern concluded that people who follow these dietary recommendations have a reduced risk of colorectal cancer, and the risk reduction is higher for men [33]. It is possible that these diets are protective against colorectal cancer because they emphasize consumption of generous amounts of fruits and vegetables—foods rich in antioxidants and fiber—though their causative links remain unconfirmed. Intriguingly, colorectal cancer mortality was found to be inversely proportional to serum vitamin D levels [34]. In summary, though quite often recommended, the role for many supplements, including omega–3 fats, vitamin D, folate, and vitamin B_6, remains unproven. Only calcium and vitamin D supplementation appear to add a modest benefit, particularly in those with a low intake [35].

Further investigation of vitamin D's effects is needed and further long-term studies are needed to clarify the role of nutrients, including folic acid and fat, as well as fiber.

Conclusion

The digestive system serves as the gateway into the body for nutrients that are derived from mechanical and chemical digestion of food. Foods and nutrients, such as caffeine and caffeine-containing beverages, alcohol, spicy foods, onions, garlic, and fried foods, affect the secretory function of the stomach, possibly aggravating GERD and peptic ulcers. Inadequate fiber and fluids in the diet can cause hypomotility of the intestinal wall, leading to constipation.

The absorptive function of the gut is impaired by diseases of the small and large intestines, including celiac disease, IBDs, diverticulitis, and colorectal cancer. In severe cases, these malabsorptive diseases can result in serious energy and nutritional deficiencies. Nutritional care is important in the prevention and management of GI diseases and should adapt food intake to the symptoms and complications of the disease and at the same time consider individual food tolerances. Current dietary recommendations, such as the USDA's Food Guide and the DASH diet, provide useful dietary practices for reducing risk of some diseases, such as colorectal cancer. Additionally, prebiotics and probiotics have potential as treatments for Crohn's disease, ulcerative colitis, and irritable bowel syndrome and warrant further investigation.

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