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Review Article

Lifestyles and their Close Relationship with Gastrointestinal Diseases (Part I: Diet)

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Abstract: The gastrointestinal tract (GI) is a continuous hollow twisting tube from the mouth to the anus. Its hollow organs include the mouth, esophagus, stomach, small intestine, large intestine, and anus. The liver, pancreas, and gallbladder (solid organs) are also considered part of the GI tract. The principal functions of the GI tract are digestion, absorption, excretion, and protection. Digestion and absorption occur primarily in the stomach and small intestine. Desiccation and compaction of waste occur in the large intestine. The waste products are then stored in the sigmoid colon and rectum before their elimination. The GI tract is influenced by several lifestyles, including the amount and the composition of the diet. The macronutrients and micronutrients in the diet, if prudent, are important for maintaining good GI health. However, unhealthy choices may cause or influence the development of GI pathology (such as esophageal reflux, peptic ulcer, inflammatory bowel disease, dietary intolerance, or even GI cancers). The lifestyle GI connection is reviewed in this two-part manuscript.

Keywords: Gastrointestinal diseases, diet, plant-based diet, meat-based diet, alcohol, coffee.

INTRODUCTION

The gastrointestinal (GI) tract is primarily responsible for acquiring and digesting food, absorbing nutrients and water, and expelling wastes from the body as feces [1]. A proper diet and a normally functioning GI tract are important for the delivery of nutrients, prevention of nutrient deficiencies and malnutrition, repair of any damaged intestinal epithelium, restoration of normal luminal bacterial populations, promotion of normal GI motility, and maintenance of normal immune functions [2-5]. The caloric quantity of diet also affects the body weight [6]. The GI tract is extremely susceptible to lifestyles and an improper diet may result in or aggravate several GI diseases [7]. These include GI reflux esophagitis, peptic ulcer disease (PUD), irritable bowel syndrome (IBS), inflammatory bowel disease (IBD), GI cancer, and pancreatitis. Hepatic disorders and their relationship with lifestyles have been discussed by me in a recent publication [7]. Gastro-esophageal reflux disease (GERD) is defined based on chronic and recurrent typical symptoms, i.e., pyrosis and acid regurgitation as well as extra-esophageal manifestation, demonstrated to impair quality of life (QoL) [8]. GERD can be classified as non-erosive reflux disease or erosive reflux disease based on the presence or absence of esophageal mucosal damage seen on endoscopy. According to endoscopic findings and esophageal pH monitoring, some patients with GERD are asymptomatic [9]. Delayed gastric emptying and dysfunction of the lower esophageal sphincter is the main underlying pathogenesis [10]. Typical symptoms include heartburn and acid regurgitation which have a high specificity but low sensitivity for GERD [11]. Other symptoms include epigastric pain, dyspepsia, nausea, bloating, and belching. Extraesophageal symptoms are sometimes seen and include chronic cough, asthma, laryngitis, and dental erosions [12]. Effective treatments include lifestyle modification, proton pump inhibitors, and surgery. However, diet and lifestyle modifications are receiving increasing attention in their influence on the prevention and treatment of GERD [13-15]. Functional dyspepsia is a GI functional disorder characterized by symptoms, such as epigastric fullness and bloating, nausea, discomfort, and vomiting, which are provoked following food consumption [16]. Peptic ulcer disease (PUD) is a global problem with a lifetime risk of development ranging from 5% to 10% [17-21]. Peptic ulcer disease is characterized by discontinuation in the

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inner lining of the stomach (stomach ulcer) or proximal duodenal tract (duodenal ulcer) and may extend into the muscularis propria layer of the epithelium. Sometimes it may involve the lower esophagus, distal duodenum, or jejunum [22]. Duodenal ulcers are four times more common than gastric ulcers and appear more frequently in men. H. pylori – a gram-negative bacillus, is responsible for 90% of the duodenal ulcers and 70% to 90% of the gastric ulcers [23, 24]. Peptic ulcers may result in various complications such as bleeding, perforation, and gastric outlet obstruction [22]. Although the prevalence of PUD caused by H. pylori is on the decline, the prevalence of PUD induced by NSAIDs, or aspirin is increasing because of the worldwide increase in the use of these drugs by the growing aging population [25-27]. Acute pancreatitis (AP) is an inflammatory disease involving the pancreatic parenchyma and peripancreatic tissues [28]. It results from exocrine cell destruction by infiltrating inflammatory cells. Chronic pancreatitis (CP) is diagnosed if there is severe or recurring inflammation of the pancreas. The incidence of AP and CP has increased in recent decades [29-31]. It is a common cause of hospitalization and accounts for approximately 2.6 billion dollars in annual inpatient costs in the United States [32, 33]. In up to 20% of these cases, there are serious complications, and the mortality rate ranges from 10% to 30% [34-36]. Currently, there is no specific pharmacotherapy for AP. Cholelithiasis, excessive alcohol intake, hyperlipidemia, pancreatic trauma, infections, and medications are common risk factors [30, 31, 36, 37]. Chronic pancreatitis (CP) usually results from recurrent attacks of acute pancreatitis, leading to the development of pancreatic insufficiency, steatorrhea, diabetes, pancreatic calcification, and fibrosis. Although the incidence of CP is lower, patients with CP have a lower QoL and shorter lifespan than the general population [36]. Celiac disease results from exposure to gluten in susceptible individuals. It is relieved by eliminating gluten from the diet [38].

Irritable bowel syndrome (IBS) is a chronic GI functional disorder characterized by recurrent abdominal pain, as well as a change in bowel movements. This results in either diarrhea, constipation, or both without any known organic causes [39-41]. Patients with IBS are divided into four subtypes according to the stool pattern: diarrhea-predominant IBS, constipation-predominant IBS, mixed-diarrhea-and-constipation, and unclassified IBS [39, 42]. Patients with IBS are usually diagnosed at a young age, and IBS is more common in women than in men [43]. Although IBS is not associated with increased mortality, it reduces the quality of life to a significant degree [44]. It is also a major economic burden on society [45]. In contrast, inflammatory bowel disease (IBD) [46] is a relapsing inflammatory disease and includes both ulcerative colitis (UC) [47] and Crohn's disease (CD) [48]. UC is localized primarily in the large intestine [49, 50], whereas CD can affect any area of the GI tract [51, 52]. Both incidence and prevalence of IBD are currently increasing worldwide [53]. Diverticulosis usually results from obstruction of the diverticular ostium by a stool fragment or food particles and subsequent inflammation. Diverticula is characterized by the presence of extroflexions that occur when colonic mucosa and sub-mucosa herniate through defects in the muscle layer of the colon wall [54]. Inflammatory bowel diseases (IBDs) are a biologically complex set of conditions characterized by chronic, relapsing inflammation of the gastrointestinal (GI) tract. The two main types of IBDs are UC and CD. They are characterized by chronic inflammation of the GI tract. Ulcerative colitis usually affects the colon and rectum, while CD tends to involve the mouth, esophagus, stomach, colon, rectum, and anus. Both diseases can present with persistent diarrhea, rectal bleeding, vomiting, abdominal pain, weight loss, and fatigue. CD patients tend to have porridge like defecation while UC patients often have bowel movements with mucus and blood. UC patients may also experience rectal urgency and tenesmus. Colorectal cancer (CRC) is the third most common cause of cancer death in both men and women in the United States and ranks second when men and women are combined [55]. Colorectal cancer is more likely to be seen in elderly individuals. However, while overall CRC incidence rates have remained stable or declined in many high-income countries, the incidence of early-onset CRC (diagnosed before the age of 50 years) has recently been increasing worldwide [56].

DISCUSSION

Consuming a healthy diet helps prevent malnutrition as well as a range of noncommunicable diseases [57, 58]. However, changing lifestyles have resulted in higher consumption of foods rich in energy, fats, free sugars, and salt/sodium. The consumption of fruit, vegetables, and dietary fiber (whole grains) has decreased. A healthy diet for adults, according to the World Health Organization [59], should include at least 400 grama of fruits and vegetables per day (excluding starchy roots such as potatoes and cassava). They also recommend that free sugars (all sugars added to foods or drinks, as well as sugars naturally present in honey, syrups, fruit juices, and fruit juice concentrates) should be limited to 10% of total energy intake. Fats should be less than 39% of total energy intake. Unsaturated fats (found in fish, avocado, and nuts, and in sunflower, soybean, canola, and olive oils) are preferable. Saturated fats (found in fatty meat, butter, palm and coconut oil, cream, cheese, ghee, and lard) should be less than 10% of total energy intake. Industrially produced trans fats (found in baked and fried foods, and pre-packaged snacks and foods, such as frozen pizza, pies, cookies, biscuits, wafers, and cooking oils and spreads) should be avoided. Salt intake should be less than 5 g of salt (equivalent to about one teaspoon) per day. Salt should be iodized. A healthy diet (both in

calorie amount and in quality) helps prevent the development and progression of most GI diseases. The effect of diet on these ailments is the topic of discussion in this Part I of this two-part manuscript. Other four major lifestyles (smoking, alcohol intake, obesity, and exercise) and their relationship with GI diseases are discussed in part II.

Diet

Diet has a major influence on the GI tract. Zhang *et al*. in a review of 72 articles, found that GERD was less frequent in individuals on plant-based diets (Odds Ratio or OR=0.34) and not eating meat (OR=0.841), and more frequent in omnivores (daily meat, fish, and egg intake: OR=1.088) and with a high intake of saturated fat (high-fat diet: OR=7.568) [60]. Many patients find that GERD is aggravated by citrus fruits and tomatoes, mint, and spicy foods [61]. Chocolate, caffeine, and alcohol may also increase GERD symptoms in some [62]. Besides the type of food consumed, poor eating habits can also affect GERD. Zhang et reported that GERD is aggravated by midnight snacking (OR=5.08), skipping breakfast (OR=2.7), eating quickly (OR=4.06), eating very hot foods (OR=1.81), and eating beyond fullness: OR=2.85) [60]. Sleeping soon after dinner also worsens GERD - in their study, Zhang et al. noted that an interval of fewer than three hours between dinner and bedtime (OR=7.45) worsened GERD [60]. The American Gastroenterological Association and the American College of Gastroenterology do not recommend any special diet to prevent peptic ulcer formation or promote its healing [63]. However, as noted with GERD, certain nutritional component intake may help reduce the symptoms. Some patients feel better with the avoidance of pepper, caffeine, tea, peppermint, spearmint, chocolate, citrus foods, and tomatoes [64]. Fiber intake helps reduce symptoms [65]. H. Pylori is the main culprit behind PUD, and fermented foods, such as yogurt, kefir, sauerkraut, and kimchi, help inhibit the activity of H. pylori [66]. Fermented foods use several microorganisms for the fermentation process, and often contain helpful probiotics, (such as Lactobacillus, Streptococcus, Pediococcus, and Leuconostoc, Saccharomyces cerevisiae, Penicillium spp, and Aspergillus spp,) which often help mitigate peptic ulcers [67].

Alcohol is a major risk factor for pancreatitis and its role is discussed in part II of this manuscript. During acute pancreatitis (AP), early oral feeding helps reduce inflammation and improve outcomes [68]. Early feedings with low fat, soft oral diet, lead to a shorter length of stay, fewer complications, and lower costs. However, if oral feeding is not tolerated, supplemental enteral nutrition through gastric or jejunal feeding may be required. Although superior to parenteral nutrition, certain complications such as bowel obstructions, abdominal compartment syndrome, prolonged ileus, or mesenteric ischemia may necessitate the use of the latter [69]. Diet also remains important during the recovery period, and a low-fat diet (void of fried and processed foods), eaten in smaller amounts, usually, six times a day, may be better tolerated [70]. Nutritional management in chronic pancreatitis (CP) is unclear as studies are scarce. Avoidance of alcohol and consumption of a balanced diet is important in these patients. They are often underweighted or sarcopenic [71] and may require a high protein, high calorie diet [72, 73]. They also often have several micronutrient deficiencies especially that of vitamin D [74], and these should be corrected with supplementation [75].

Celiac disease involves the small intestine and is due to an immune reaction to eating gluten [38]. Patients with this disease may experience symptoms like diarrhea, bloating, gas, anemia, and growth problems. Gluten is the main structural protein of wheat and is also present in several other cereal grains, such as barley, rye, wheat berries, spelt, durum, emmer, semolina, farina, farro, graham, khorasan wheat, einkorn, and triticale. Cereals that are free of gluten include quinoa, brown, black, or red rice, buckwheat, amaranth, millet, corn, sorghum, teff, and gluten-free oats. Avoidance of gluten in the diet is an effective treatment for this disease [76, 77].

IBS patients often find intolerance to several food items [78, 79]. Studies have shown that the intake of low-fermentable oligo-, di-, monosaccharides, and polyols (FODMAP) foods lead to a positive clinical response in 50%-80% of IBS patients. These patients find improvements in several symptoms including bloating, flatulence, diarrhea, and chronic abdominal pain [80, 81]. FODMAP also improves the QoL in these patients [82, 83]. The list of foods that are high or low in FODMAP is extensive and can be obtained by visiting the website of the American College of Gastroenterolgy [84]. IBS patients are at risk of developing deficiencies in some vitamins, minerals, and naturally occurring antioxidants, and if FODMAP diet is continued for a long time, these may need to be supplementated [85, 86].

Inflammatory bowel disease is also affected by diet [87]. An improper diet can worsen IBD by several mechanisms, including dysregulating the immune system and promoting intestinal inflammation. It can also alter intestinal permeability and contribute to microbial dysbiosis. There is an increased risk of IBD, especially UC among people who consume greater amounts of n-6 polyunsaturated fatty acids (PUFA) — and a lower risk among people with diets high in fiber, fruits, vegetables, and n-3 PUFA [88, 89]. The Western diet has more red/processed meat, saturated fat, refined grains, sugar, beer, and spirits. It has a significant amount of linoleic acid (n-6 PUFA) which is a precursor for arachidonic acid, which in turn is a precursor of inflammatory mediators such as prostaglandins and leukotrienes [90]. In contrast, long-

chain n-3 PUFAs (eicosapentaenoic acid and docosahexaenoic acid) in a plant-based/fish diet, are anti-inflammatiory [91]. The benefits of n-3 PUFA rich diet was noted in the Nurses' Health Study (NHS) [92]. In this study, a higher ratio of n-3: n-6 PUFAs decreased the incidence of UC. Fiber intake is also important in IBD [93] and is often low in IBD patients [94]. In a meta-analysis, Hou *et al*. found that a high intake of dietary fiber was associated with a decreased risk of IBD [95]. In the NHS study, a large amount of fiber intake resulted in an approximately 40% reduction in the diagnosis of Crohn's disease [92]. Dietary fiber is associated with luminal production of short-chain fatty acids with immunomodulatory properties. They also help lower colonic pH, which benefits helpful microflora and inhibits potential pathogens. An adequate intake of dietary fiber can thus help reduce intestinal lesions, accelerate healing and regeneration, and help maintain remission [96]. IBD patients may also suffer from weight loss and deficiencies in essential vitamins, minerals, and other nutrients due to malabsorption [97]. Deficiencies have been noted with vitamin A [98, 99] and vitamin D [100]. Calcium deficiency is also sometimes noted [101]. Correction of these via supplementation is associated with better outcomes [102]. The increased level of n-6 PUFA in the Western diet has been mentioned before and this diet increases the risk of IBD and leads to a poor er prognosis [95, 103]. On the other hand, the Mediterranean-type dietary pattern consists mainly of fiber-rich sources, such as fruit and vegetables, and ω-3 fatty acid-rich food sources - and is associated with reduced risk of IBD development and progression [104-106].

Diet plays an important role in cancer [107, 108] including those of the GI tract [109]. It has been repeatedly documented that suboptimal dietary intake is associated with an increased risk of several GI cancers, including oral, esophageal, stomach, pancreatic, and colon/rectum [110]. Diets that are cancer preventive are primarily plant-based [111, 112]. Several studies have noted that greater fruit and vegetable consumption is preventive for GI cancers [113, 114]. Conversely, a diet rich in meat and animal produces is associated with higher rates of GI cancers [115]. According to Islami *et al*. red meat consumption was associated with 5.4% of colorectal cancers [112]. Processed meat intake is especially harmful [116]. It is estimated that processed meat consumption is associated with 8.2% of colorectal cancers [112]. Fiber in the diet is also important [117]. Islami *et al*. found that low dietary fiber accounted for 10.3% of colorectal cancer cases [118]. A proper diet also helps reduce several associated symptoms of cancer and its treatment and helps improve the quality of life in these individuals [119]. Mortality is also reduced [120, 121]. Cancer survivors are at an increased risk of secondary cancers [122], and a plant-based diet has been shown to retard the development of these [123].

A prudent diet is rich in vegetables, fruit, cereals and legumes, whole grains, rice/pasta, fish, low-fat dairy, poultry, and water. It discourages processed meat, refined carbohydrates, and saturated fats. There are several mechanisms by which a prudent diet influences GI cancer. A healthy plant-based diet allows decreased exposure to carcinogens including N-nitroso compounds and decreased formation of cyto- and genotoxic aldehydes. There is less obesity, decreased insulin levels, reduced inflammation, increased antioxidative capacity, and improved DNA repair. Circulating sex and growth hormones are more balanced. It also diminishes exposure to carcinogenic heterocyclic aromatic amines and polycyclic aromatic hydrocarbons that are formed during high heat cooking of meat [124, 125]. Vegetables diversify gut microbiomes and provide better immunity, decrease tumorigenesis, and potentiate immunotherapeutic effects in cancer prevention and treatment [126].

CONCLUSIONS

Healthy lifestyles can dramatically reduce the development and progression of major GI diseases. These include GERD, PUD, pancreatitis, IBS and IBD, and several GI cancers. Obesity worsens all GI diseases and increases the risk of cancer. A prudent diet (primarily plant-based) is overall beneficial for GI disorders. Certain dietary components may aggravate GI disorders and should be avoided depending upon the nature of the disease, and the experience of the patient. Part II of this manuscript reviews the influence of four other lifestyle factors on GI diseases – smoking, obesity, alcohol intake, and exercise.

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