Diet and Functional Abdominal Pain in Children and Adolescents

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ABSTRACT

Functional abdominal pain (FAP) is a common complaint among children and adolescents. For many patients, symptoms exacerbate with eating. This review discusses findings concerning the role of diet in FAP. The foods that are discussed are divided into 2 major groups: food allergies or intolerances, which focus on milk, gluten, and fermentable oligosaccharides, disaccharides, monosaccharides, and polyols; and functional foods, which hone in on foods that reduce abdominal pain in adolescents such as fiber, peppermint oil, and probiotics. Lastly, we discuss the role of eating habits in FAP and how the physiology of eating may be the real culprit of symptoms associated with eating.

Key Words: diet, eating disorders, fiber, food intolerance, functional abdominal pain, functional foods, irritable bowel syndrome

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Chronic functional abdominal pain (FAP) without a clear organic cause is a common complaint in childhood and adolescence (1). Sometimes it is associated with changes in stool, for which a diagnosis of irritable bowel syndrome (IBS) would be appropriate. For the sake of this review, we use the terms FAP and IBS interchangeably. FAP and IBS are associated with school absences, reduced quality of life, and increased psychological distress (2–4). Treatment options are scarce and consist of a combination of education, reassurance, trial of medications, dietary advice, and possibly referral to a psychologist (5). The reason for the limited treatment options is that the cause of abdominal pain is not well known. It is thought to be a combination of physiological, psychological, and social factors (5), but in each patient, a different combination of these factors can be identified, and addressing each of these factors may not be sufficient to make the child free of pain. Parents often perceive diet as a major factor in their child's pain—>90% of adolescents with IBS report that eating induces their symptoms and have made changes to their diet accordingly (6). Avoiding certain foods is the most common strategy, but some patients resort to more troublesome practices such as vomiting and skipping meals (6). Given the importance of diet to the patient and the alarming rate of disordered eating habits, it is an important area for the physician to assess. In this review, we examine the role of diet in childhood/adolescent FAP and IBS. We examine whether certain foods can exacerbate symptoms, whether some foods improve symptoms, and what role dietary habits play in perpetuating symptoms.

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DATA SOURCES AND STUDY SELECTION

One of the authors searched PubMed for articles up to January 2013. The included key words were ''Functional abdominal pain,'' ''IBS,'' and ''Recurrent abdominal pain'' in combination with ''Allergy,'' ''Food intolerance,'' ''Food sensitivities,'' ''Diet,'' ''Fiber,'' ''Probiotics,'' ''Fermentable Oligosaccharides, Disaccharides, Monosaccharides And Polyols (FODMAPS),'' ''Milk,'' ''Gluten,'' ''IgG antibodies,'' ''Peppermint oil,'' ''Obesity,'' and ''Eating disorders.'' The main focus was on studies in children ages 0 to 18 years, although some literature in adults was assessed as well. Relevant literature was examined for additional studies not identified by initial PubMed search.

FOOD ALLERGIES AND INTOLERANCES

The majority of patients with IBS/FAP develop symptoms after eating (6), instigating the idea that certain foods trigger their symptoms. In addition, the gastrointestinal (GI) symptoms associated with FAP and IBS are also typical for food allergies and intolerances. These symptoms include nausea, abdominal pain, abdominal cramping, bloating, and diarrhea. When combined, these factors lead to the suspicion of food allergies/intolerances and the most likely culprits have been milk and gluten. Table 1 gives an overview of all of the studies in this area. Below is a narrative description and synthesis of the findings.

Milk

Traditionally, clinical experience indicates that families of children with FAP/IBS have come to the clinic suspecting milk intolerances or allergies in their child. A recent population study in Finland gives support to this clinical observation: almost half of mothers with children ages 10 to 11 years who experience frequent GI symptoms reported that these are related to milk and most of them avoided mild products (7); however, only 14% of those with GI symptoms had a cow's-milk allergy or lactose intolerance (7). Thus, a full two-thirds of the children who avoided milk did not have milk allergy or lactose intolerance. Other studies have also shown that lactose intolerance is not increased in patients with FAP ages 6 to 14 years (8), and there is evidence that avoiding milk products—even in those who are lactose intolerant—is not consistently associated with pain reduction in children with FAP/IBS (8–12). A recent Cochrane review concluded that there is no evidence suggesting that lactose-free diets are of benefit to patients

TABLE 1. Studies investigating food allergies and intolerances in FAP

References	No. subjects	Age range, y	Diagnosis/study population	Study information	Findings
Kokkonen et al (7)	N = 404	10–11	Parents of all 4th and 5th graders in a rural Finnish town	Self-report of GI symptoms in the last 2 y; those with GI symptoms underwent a clinical examination	N = 110 reported GI symptoms. N = 51 (46.4%) reported symptoms were caused by milk. N = 14 (12.7%) tested positive for milk protein or lactose intolerance. Celiac disease was found in N = 5 (4.5% of those with GI symptoms).
Lebenthal et al (8)	N = 103	6–14	Patients with physician diagnosis of RAP; control patients obtained from patients who underwent intestinal biopsies as a diagnostic procedure for diarrhea	Lactose tolerance tests, intestinal biopsies, and 6-wk food challenge*	31% patients with RAP had lactase deficiency compared with 26.4% controls ($P > 0.05$). 47.6% of lactose malabsorbers versus 23.5% of lactose absorbers report increase in pain with dietary milk challenge. 33.3% of lactose malabsorbers versus 23.5% of lactose absorbers report increase in pain with dietary soy challenge.
Gremse et al (9)	N = 146	5–18	Patients with abdominal pain at tertiary care center who underwent lactose breath hydrogen testing	Medical records and phone interview with patient or parent	32/90 (35.5%) patients with IBS and 18/56 (32.1%) of non-IBS patients had lactose malabsorption.
Wald et al (10)	N = 40	6–17	Children with RAP of at least 3 mo duration	H_2 breath test and 6-food challenge*	N = 12 (30%) were lactose malabsorbers. Lactose elimination improved pain in 25% of lactose malabsorbers and 18% of lactose absorbers (not significant).
Ockeloen and Deckers-Kocken (11)	N = 37	1.8–17.8	Children with physician diagnosis of chronic abdominal pain and abnormal breath hydrogen testing	Treatment with probiotics or lactose-restricted diet	N = 18 were lactose intolerant. Eighty-eight percent improved on lactose-free diet at 5 months and 56% after 15 months. N = 20 had SIBO, 70% improved with probiotics after 5 months, 40% after 15 months.
Gijsbers, Kneepkens, and Buller (12)	N = 220	4.1–16.0	Children with physician diagnosis of RAP	H_2 breath tests, food challenge,* and double-blind placebo-controlled provocation	N = 57 had possible lactose intolerance and N = 79 possible fructose intolerance based on H_2 test. None of these patients were positive on a double-blind provocation test.
Hyams et al (17)	N = 227	5–18	Children evaluated for RAP at tertiary care clinic	Questionnaire completed by physician	N = 46 had lactose intolerance and N = 1 had CD.

Turco et al (23)	N = 156	4–17	Children with physician diagnosis of CD; control group presenting at primary care clinic	Questionnaires completed by parent/child 1 year after enrollment.	At enrollment 79.2% of children with CD were symptomatic. After 1 year of treatment, 28% of patients with CD and 9% of controls fulfilled Rome III criteria for a functional GI disorder.
Gomara et al (29)	N = 32	7–17	Children with diagnoses of IBS, functional dyspepsia, or functional abdominal pain	H_2 breath test followed by low fructose diet	N = 11 (33%) had positive fructose breath test. N = 9 or N = 11 patients (81%) improved after 2 wk of limited fructose intake.
Wintermeyer et al (30)	N = 75	3–14	Children with RAP without GI disease and malabsorption	Children were given a fructose restricted diet for 4 wk.	A decrease of weekly pain frequency from 4 to 1. Intensity of pain decreased from median 6 to median 3. Other factors (daily stool frequency, missed school days) also improved significantly.
Chumpitazi, Weidler, and Shulman (31)	N = 448	N/A	N/A	14 pediatric gastroenterologists rated stool forms with a modified stool scale.	A new Stool Form Scale for Children was created and evaluated. Improved the scales interrater reliability, intrarater reliability, and agreement among pediatric gastroenterologists
Gijsbers et al (47)	N = 220	4–16	Children with physician diagnosis of RAP in secondary care	Diagnostic testing followed by food challenge* and DBPCFC.	N = 1 diagnosed as having CD, but did not improve on gluten-free diet. N = 5 (2.3%) pain-free *H* pylori eradication N = 5 (2.3%) food allergy after DBPCFC N = 52 positive lactose breath test, none responded to DBPCFC N = 72 positive fructose breath test, none responded to DBPCFC
Grazioli et al† (48)	N = 153	Mean age 4	Children with IBS (defined as diarrhea and abdominal pain for ~10 mo)	Skin prick test, followed by elimination diet or SCG treatment in those who are positive.	17% had positive skin prick test to at least 1 allergen. Elimination diet and SCG showed improvement in, respectively, 87% and 97% of children.

CD = celiac disease; DBPCFC = double-blinded placebo-controlled food challenge; FAP = functional abdominal pain; GI = gastrointestinal; IBS = irritable bowel syndrome; RAP = recurrent abdominal pain; SCG = sodium cromoglycate; SIBO = small intestinal bacterial overgrowth.

*A food challenge consists of an open-label elimination and provocation with foods containing lactose, fructose, or other ingredients to which the child is expected to react.

†This article is in Italian and we were therefore only able to examine the English abstract.

with FAP/IBS (13). In turn, one can infer that lactose intolerance is probably not the true culprit for patients with FAP/IBS.

Gluten

The second most common foods that patients with IBS avoid, besides milk, are carbohydrates (14,15). Lately, the interest in the role of gluten intolerance or celiac disease (CD) in IBS seems to be rising as an increased number of the general population avoids gluten ingestion (16). Despite these increases in concerns about gluten, the sparse literature in children suggests that CD is not a major culprit in FAP/IBS. In Finland, gluten intolerance was found in only 4.5% of 10- to 11-year-old children with recurrent GI problems (7). In the United States, only 1 of 227 patients (5–18 years old) with recurrent abdominal pain had CD upon testing (17). A meta-analysis in adults showed that the prevalence of CD did not exceed 4% of patients with IBS (18). More recent studies showed even lower percentages of CD in adults: 0.4% in Norwegian (19) and US patients with IBS (20), 2% among Turkish patients with IBS (21), and 3.2% in Jordanian patients with IBS (22). Thus, CD does not play a major role in causing GI symptoms in this patient population. In addition, up to one-third of 4- to 17-year-old children with known CD remain symptomatic even after 1 year on a gluten-free diet, suggesting that the symptoms have been caused by a comorbid functional disorder rather than the gluten intolerance (23).

Recently, a thought-provoking study in adults has suggested that non-CD wheat sensitivity is of importance in IBS (16). Many patients avoid gluten, show IgA anti-gliadin antibodies, but do not have CD upon biopsy. A double-blind placebo-controlled food challenge revealed wheat sensitivity in 30% of adult patients with IBS (16). Patients with wheat sensitivity had higher IgG/IgA anti-gliadin compared with patients without wheat sensitivity. In another study, patients with IBS who had self-reported gluten intolerance, but in whom CD could not be diagnosed, were given either gluten or a placebo in a double-blind randomized placebo-controlled trial. Of the patients in the gluten group, 68% reported their symptoms were not adequately controlled versus 40% in the placebo group. These findings suggest that some patients with IBS do react to gluten despite having no diagnosed gluten intolerance (24). Even though these data are intriguing, further exploration is needed of the prevalence and mechanism of wheat sensitivity before gluten avoidance can be recommended for children with FAP/IBS.

FODMAPs

Besides gluten, another set of carbohydrate intolerances has been suspected to play a role in FAP/IBS. FODMAPs are short-chain carbohydrates that are poorly absorbed by the GI system and can lead to gas production, distention of the large intestine, bloating, and abdominal pain. The acronym is created from the following: fermentable oligosaccharides, disaccharides, monosaccharides, and polyols. These sugars are found in an array of foods including wheat, milk, legumes, sugar-free mints, and apples; in other words, FODMAPs are ubiquitous in everyday meals. Not all FODMAPs trigger symptoms in patients—only those that are malabsorbed, which vary from patient to patient. In adults, there is some evidence that a low-FODMAP diet is effective in reducing IBS symptoms. In a study in which adult patients with IBS were asked to restrict their intake of FODMAPs, 74% reported improvement and those who followed the diet restrictions were more likely to respond than those who did not (85% vs 36%) (25). No control group was included in this study. In a clinic, where standard dietary advice was replaced by advocating a restricted FODMAP diet, symptom improvement jumped from 52% to 76% (26). There is some evidence that FODMAPs exert their influence on IBS by altering gas production. FODMAPs are poorly absorbed in the small intestine (27), making them a prime target for gas production in the colon. In fact, both healthy controls and adult patients with IBS increase gut hydrogen production on a high-FODMAP diet, but even more for patients with IBS (28). In addition, healthy controls responded to the increased gas production with more flatus, whereas patients with IBS did not. Thus, FOMAPs not only increases gas production in adult IBS but the gas also stays in the colon longer, which may account for increased bloating and abdominal discomfort.

In children, much less evidence is available for the effect of FODMAPs on IBS symptoms. Two studies revolved solely around fructose intolerance in children with FAP ages 7 to 17 years old (29,30). As the researchers gave increased amounts of fructose to these children, their symptoms increased. In 1 study, children who reacted positively to fructose were asked to limit fructose in their diet. The majority (81%) reported improvements in their symptoms within 2 weeks (29). In another study, patients with FAP without fructose malabsorption showed decline in pain on a 4-week fructose-free diet. Unfortunately, these 2 studies did not include a control group and, in turn, the findings must be considered preliminary. A recent study reveals that out of 79 patients with FAP (4–16 years old) with fructose malabsorption, none tested positive in a double-blind fructose provocation test; thus, patients did not respond to fructose with increased symptoms (12). Most remarkably, 30 (38%) patients did not even undergo double-blind testing because the abdominal pain had resolved by itself. These findings are consistent with observations from studies in adults, although many more studies should be conducted to examine the role of fructose in FAP. A trial of FODMAP in children is under way at Baylor College (*www.clinicaltrials.gov* identifier NCT01018498). Initial results have shown that 19% of children with IBS reduced at least 75% of their symptoms (31). Randomized controlled trials are needed to determine whether FODMAPs truly reduce IBS symptoms in children.

Other Allergies/Intolerances

Besides those for milk and carbohydrates, data on other allergies and intolerances are unavailable for children, but the literature on adults with IBS provides some clues. The prevalence of food allergies is increased in adult patients with IBS, especially those with atopic disease; however, little evidence has been found that food allergies play a major role in IBS or that elimination diets can be helpful (32–38). Interestingly, the vast majority of adult patients with IBS who have food allergies cannot identify the culprit food, and some actually report reacting to foods to which the patient is not allergic (39–41). These data suggest a similar picture as has been found for reactions to milk in children: patients report reactions to foods to which they have no intolerances/allergies. Interestingly, they often do not report reactions to foods to which they are sensitive. Most studies have examined the ''classic'' food allergy based on IgE antibody responses. A groundbreaking study by Atkinson et al (42) in 2004 opened the field to consider an alternative pathway by which food could cause symptoms. These authors tested the presence of IgG antibodies to food, a measure that has been associated with food hypersensitivity (43). Adult patients with IBS were asked to adhere to an elimination diet for 12 weeks either based on foods to which the IgG test showed sensitivity or based on foods to which they did not show sensitivity. Compared with the sham, or placebo group, those who eliminated IgG-sensitive foods showed greater improvement in IBS symptoms. These findings have been replicated in 2 independent studies among British and Chinese patients with IBS (44,45), suggesting that IgG food intolerances deserve testing in children as well. Similar to the

findings on wheat sensitivity, it is not clear what the mechanism nor value would be of IgG testing in children with FAP/IBS, so these data should be seen as preliminary and in need of much more research.

Despite the high prevalence of self-diagnoses among children and adolescents, the data suggest that the true prevalence of allergies and intolerances is much lower. In the overall population, food allergies are reported in 12% of children, whereas the true prevalence is only 3% (46). Among patients with FAP/IBS, a similar overestimation of food allergies and intolerances can be observed. In a study of 220 children with FAP (4–16 years old), 20% reported food intolerances, but only 2.3% of them actually had a food allergy (47). In an Italian study, 70% of children (mean age of 4 years old) reported IBS symptoms with eating, but in only 17% could a food allergy be observed (48). In addition, as discussed earlier, removing the culprit food does not always improve symptoms. These data suggest that a food allergy/intolerance can exist in conjunction with FAP/IBS, but is likely not the sole source of the symptoms. It is important to emphasize that studies in children are still largely lacking and are often small and of poor methodological quality. More research is needed before any definitive conclusions can be drawn. On the basis of the limited data, it can be concluded that reactions to food in IBS/FAP do not seem to be immunity based.

FUNCTIONAL FOODS FOR FAP

Foods are not solely considered deleterious in FAP; some foods can be beneficial for this patient population. Foods that are proposed to increase health or decrease disease are often referred to as ''functional foods.'' Several functional foods have been proposed for FAP, including fiber, peppermint oil, and probiotics. A summary of all studies focused on functional foods is included in Table 2. A narrative review of these studies is given below.

Fiber

As much as parents worry about intolerance and allergies, they also acknowledge that unhealthy eating habits can cause abdominal symptoms (49). Consumption of fiber below the daily recommended amount is a risk factor for FAP (50). (References 51–101 are available online only at *http://links.lww.com/MPG/A230*.) Fiber softens stool and relieves constipation (51). Hard stool and its associated gas build-up can lead to abdominal discomfort. This is of particular relevance for IBS, in which the child experiences both pain and changes in stool such as constipation. In adults, there is some evidence that fiber is helpful for IBS (52), especially psyllium, a soluble fiber (53), but a recent Cochrane review of 12 studies could not find an effect of fiber on IBS (54). Conversely, much less data is available in children. Two small randomized controlled trials of children and adolescents ranging in the ages 3 to 15 years could not find evidence for the benefits of fiber in FAP (55,56). Two of 3 trials in children between the ages of 1 and 13 years with constipation did not find fiber ameliorated abdominal pain (57–59). In a recent randomized double-blind study among 8- to 16-year-old patients with FAP, partially hydrolyzed guar gum reduced clinical symptoms compared with placebo (60).

Thus, fiber intake is lower in patients with FAP, but there is not much evidence that adding fiber is helpful. The recent findings on partially hydrolyzed guar gum are intriguing and in need of replication. If the child has constipation as well, fiber can be considered as a treatment alternative (61).

Peppermint Oil

Peppermint oil has antispasmodic properties by relaxing GI smooth muscle (62,63). Given these properties, it has been widely used for IBS. There is evidence from various randomized controlled trials that peppermint oil is better than placebo in adults with IBS (52,64). Fewer data are again available for the efficacy of peppermint oil in children. During a 2-week double-blind randomized controlled trial, 76% of 8- to 17-year-old patients with IBS reported improvements in pain severity when using enteric-coated peppermint oil capsules, as compared with 19% receiving a placebo (65). These data are promising but in need of replication. Although the risks of using peppermint oil are relatively limited, precautions should still be taken. Excess peppermint oil has been associated with intestinal nephritis and acute renal failure. Most relevant to patients with FAP/IBS is the known property of peppermint oil to reduce esophageal pressure, which can lead to exacerbation of gastroesophageal reflux disease (66). In addition, in infants and young children it can cause bronchospasms and apnea (66). Given the relatively low dosage, peppermint oil is usually sold in (eg, in over-the-counter capsules, teas, topical rubs) it is considered a relatively well tolerated and cheap treatment option.

Probiotics

There is evidence of changes to gut microbiota in children with FAP/IBS (67,68). The addition of probiotics can have significant health benefits for the consumer by restoring the microbial community (69). Probiotics have been shown to alleviate symptoms of IBS in adults (70–74). Studies in children show similar effects. There is evidence from 2 randomized controlled trials that *Lactobacillus* GG significantly reduces abdominal pain in children ages 5 to 16 years (75,76), although 1 study of 6- to 10-year-old patients with IBS could not replicate these findings (77). A study of children and adolescents ages 4 to 18 years also found evidence that a probiotic mixture (VSL#3) is effective in reducing abdominal pain (78). In an observational study of the use of Symbioflor 2, 203 patients with IBS (4–18 years old) were studied until they reported improvements in pain. More than 80% of patients reported the treatment to be good to very good (79). *Lactobacillus casei rhamnosus* Lcr35 and *Bifidobacterium longum* decreased constipation and abdominal pain in constipated children, whereas *Bifidobacterium lactis* DN-173 010 was not effective (80–82). The role of these probiotics in FAP still needs to be examined.

Thus, there is good initial evidence for the use of probiotics in FAP; however, more studies are needed to determine which strain is most effective. A common issue with probiotics is that only 10% of food labels claim a correct composition of its contents, making it difficult for consumers and health professionals to know exactly what is in certain foods (83).

DIET CONTENT VERSUS DIETARY HABITS IN IBS/FAP

From the discussion above, it is clear that there is little proof that diet plays a role in childhood FAP/IBS. A 2009 Cochrane review concluded that there is no high-quality evidence for dietary interventions to treat chronic abdominal pain in children and adolescents (13). Most of this is because of the paucity on good data in children. Notwithstanding these results, patients continue to seek information about dietary changes to ease their symptoms (84). It seems reasonable to suspect diet when eating is one of the main culprits in exacerbating symptoms (6); however, because of the limited evidence that diet changes are effective for the treatment of FAP/IBS, many physicians may be unwilling to offer specific advice on diet. In response, a large offering of books, materials, and supplements containing dietary advice and help can be found on the Internet and through alternative medicine providers catering to the needs of many patients. There is a risk of inadequate nutrition

TABLE 2. Studies investigating functional foods to ameliorate FAP

References	No. subjects	Age range, y	Diagnosis/study population	Study information	Findings
Christensen MF (55)	40	3–15	Children with RAP	7-wk double-blind randomized controlled trial of fiber (ispaghula husks)	No differences in number of episodes of abdominal pain between fiber and placebo (authors did not provide any means or statistics)
Feldman et al (56)	52	5–15	Children with RAP in primary care	6-wk randomized, double-blind placebo-controlled study of 5 g corn fiber	Half of individuals in the fiber group saw significant improvements in pain versus 27% in the control group
Loening-Baucke, Miele, and Staiano (57)	46	4.5–11.7	Children with functional constipation in tertiary care	8-wk double-blind, randomized placebo controlled trial of fiber (glucomannan) with crossover	In the fiber group, 19% had <3 bowel movements/wk compared with 52% on placebo ($P < 0.05$)
Castillejo et al (58)	56	3–10	Tertiary care patients diagnosed as having chronic idiopathic constipation	4-wk controlled, randomized, double-blind trial of fiber (cocoa husk)	Number of bowel movements (3.2 vs 2.4) and colonic transit time (61.4 vs 71.5) were not different between fiber and placebo, respectively.
Kokke et al (59)	147	1–13	Constipated children in tertiary care clinic	8-wk double-blind randomized controlled trial of fiber versus lactulose	Fiber and lactulose are equally effective in increasing bowel movements/wk (increased from 3–7 and 6/wk, respectively).
Romano et al (60)	60	8–16	Children with Rome III functional bowel disorders	4-wk double-blind randomized trial of PHGG	More patients reported treatment success with PHGG (43%) versus placebo (5%, $P = 0.025$).
Kline et al (65)	42	8–17	Children with IBS	2-wk randomized double-blind controlled trial of peppermint oil	76% of those receiving peppermint oil had reduced severity of abdominal pain compared with 19% who received a placebo ($P < 0.001$).
Francavilla (75)	141	5–14	Children with IBS or FAP mostly from primary care	8-wk randomized, double-blind, placebo-controlled trial of LGG	LGG significantly reduces the frequency ($P < 0.01$) and severity ($P < 0.01$) of abdominal pain. These differences were maintained 2 mo after the end of the treatment period. LGG was associated with a decrease in the number of children with abnormal permeability test (−40% compared with −20% in placebo group; $P < 0.03$).
Gawronska et al (76)	104	6–16	Children in tertiary care who fulfilled the Rome II criteria for functional dyspepsia or IBS or FAP	4-wk double-blind, randomized controlled trial of LGG	No pain at the end of treatment was reported significantly more in the LGG (25%) versus placebo group (9.6%).
Bausserman and Michail (77)	50	6–20	Children in tertiary care clinic fulfilling the Rome II criteria for IBS	6-wk controlled, double-blind, randomized study of LGG	No difference in response rate was found between placebo 40%) LGG group (44%; $P = 0.77$).
Guandalini et al (78)	59	4–18	Children from 5 pediatric tertiary care centers who have been diagnosed as having IBS according to the Rome II criteria	6-wk randomized, double-blind, placebo-controlled, crossover trial of VSL#3	VSL#3 was more effective than placebo in increasing relief of symptoms ($P < 0.05$), reducing abdominal pain ($P < 0.05$), and reducing bloating ($P < 0.05$).
Martens, Enck, and Zeiseniss (79)	203	4–18	Patients with IBS from 14 general practitioner and pediatric private practices	Observational study; patients who received doctor's prescription of Symbioflor 2 were studied until significant improvement in symptoms occurred (maximum of 3 mo)	Mean duration of treatment was 40–50 days; pain and stool frequency improved ($P < 0.001$). 81.8% judged Symbioflor 2 as ''very good'' or ''good.''

FAP = functional abdominal pain; IBS = irritable bowel syndrome; LGG = *Lactobacillus* GG; PHGG = partially hydrolyzed guar gum; RAP = recurrent abdominal pain.

and the development of eating disorders because of these dietary practices. Lower fruit consumption, increased rates of eating disorders, and obesity have been found in young patients with FAP/IBS (85–88).

So far the literature investigating the role of diet in FAP/IBS has largely focused on identifying particular trigger foods that exacerbate symptoms; however, it may not be food that is triggering the symptoms but the act of eating itself (89). Eating stimulates the gut by initiating the gastrocolonic reflex and disrupting the migrating myoelectric complex (90). The visceral nerves and muscles overreact to this stimulation in patients with FAP/IBS, resulting in motility disturbances and visceral hypersensitivity, 2 major causes of FAP/IBS. In fact, a study among adult patients with IBS found that duodenal lipid infusion lowered colonic thresholds for pain (91). Eating has been found to precede symptoms of IBS in adults about 50% of the time (92). Among adolescents with IBS >90% report symptoms with eating (6). Thus, patients may be sensitive to ''normal'' GI processes associated with eating. This explains why patients often report a reaction to high-fat foods, large meals, and spicy foods (6) because these types of meals stimulate the gut to a larger degree. Examples are increased gastric accommodation after a large meal, slower gastric emptying, and increased visceral hypersensitivity with a fatty meal or increased sensitivity to pain after ingesting chili that contains capsaicin (93–97).

Although it is undoubtedly helpful to reduce foods that upset one's stomach (fatty, spicy, large meals) >40% of adolescents with IBS report that they stop eating altogether, even when hungry, to avoid eating associated symptoms (6). Patients skip 1 meal or can go for up to 3 days without food (98). From the eating disorder literature, we know that significant, recurrent skipping of meals and other maladaptive eating patterns can lead to changes in motility. GI disturbances have been well described in anorexia and bulimia (99) and include diminished gastric relaxation, delayed gastric emptying, and delays in whole-gut transit times. These disturbances lead to symptoms such as early satiety, fullness, bloating, and constipation (99). The GI disturbances and symptoms normalize with the return to normal eating patterns (99,100). A similar effect may be present in patients with FAP/IBS who adjust their eating patterns in response to their symptoms. In a small study, we found that adolescent patients with IBS who regularly skip meals to avoid symptoms show increased gastric sensitivity and decreased whole-gut transit time (101). Thus, in an attempt to avoid symptoms by not eating, patients possibly increase symptoms (by exacerbating motility symptoms) in the long term. This suggests that not only dietary content but also dietary patterns should be considered in IBS/FAP. Eating restriction and motility disturbances possibly drive each other in a continuous vicious cycle. The patient becomes caught in a vicious cycle of diet restriction, aimed at symptom relief, exacerbating existing motility disturbances and increasing symptoms when refeeding, causing more diet restriction, motility disturbances, and so on. A combination of medication (depending on symptoms, these include antidiarrheals, laxatives, antispasmodics, or prokinetic drugs) and establishing regular eating patterns should bring relief by normalizing motility disturbances. So far, this model is largely unproven and studies are needed to test its assumptions. It may, however, be a novel advance in the understanding and treatment of eating and GI symptoms among patients with FAP/IBS. Given the present state of the literature, we are in need of more alternative models to explain why >90% of young patients with FAP/IBS report symptoms with eating (6) and how we can bring these patients relief.

CONCLUSIONS

The majority of young patients with FAP/IBS will have symptoms associated with eating. When examining the literature, it is obvious how much more work needs to be done to determine whether food plays a role in FAP/IBS in children. Many studies are of low quality and include small sample sizes. More research in this patient population is needed before any definitive conclusions can be drawn. On the basis of the limited literature, supplemented with data from adults, the cautious conclusions should be that there is little evidence for food allergies or intolerances as a major culprit in FAP/IBS or that supplemental foods can reduce symptoms, with the possible exception of probiotics that generally seem helpful. We introduced an alternative model in which the focus is not on the type of food that is consumed, but rather on the physiological response to all foods in combination with dietary habits. We hope that alternative models for the role of diet in FAP/IBS invigorate this research area. The long-term goal is to help families in desperate need of answers to their questions about food and abdominal pain.

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