

Characterization of irritable bowel syndrome and constipation in children with allergic diseases

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Abstract Allergy is believed to play a role in the pathogenesis of irritable bowel syndrome (IBS) and constipation. We investigated whether allergic patients are more prone to constipation or IBS. In a multicenter study, two groups of outpatient children aged 3–13 years were included. In group 1, children with allergic symptoms were enrolled. Group 2 consisted of nonallergic children. In both groups, the assessment of IBS and constipation was carried out using a questionnaire based on the Rome criteria for functional gastrointestinal disorders. All children were examined and underwent skin prick tests (SPT) to foods and aeroallergens. The allergic group ($n=196$) and controls ($n=127$) were comparable with respect to sex, age, and anthropometric parameters. IBS was found in 6.6% of the allergic children and in 6.3% of the controls ($p=0.581$). The

frequency of constipation was similar in the two groups. In allergic children, positive SPTs to food and self-reported reactions to food were associated with IBS. Our results show that evaluation of constipation comorbidity is not required in allergic children. In allergic children with positive SPT to foods attention may be paid to IBS symptoms.

Keywords Abdominal pain · Constipation · Allergy · Childhood

Abbreviations

IBS irritable bowel syndrome
FGID functional gastrointestinal disorder
SPT skin prick tests

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OR	odds ratio
CI	confidence interval
SD	standard deviation
n	number

Introduction

Irritable bowel syndrome (IBS) [28] and functional constipation [1, 16] are common functional gastrointestinal disorders (FGIDs) in children.

Current standard treatments for IBS [10] and constipation [1] have been to some extent unsatisfactory. This has led many investigators during the last decades to attempt to explain their elusive pathophysiology. The possibility that allergy contributes to constipation has been supported by preliminary studies showing a causal relationship between ingestion of cow's milk and chronic constipation in selected populations [14, 30]. However, a cell-mediated immune response rather than an IgE-mediated mechanism seems to be involved [30]. Conflicting results have been reported on the efficacy of empirical exclusion diets in children with IBS [2, 5, 7, 15, 20, 21]. It is also uncertain whether IgE sensitization is involved in any reported association [2, 3, 23]. Therefore, children suffering from allergic diseases may be a suspected risk group for IBS or constipation [6]. However, so far the extent to which IBS or constipation are a problem in children with atopy and/or allergic diseases still needs to be evaluated. Prevalence studies on IBS and constipation have reported discordant results, which seem to be mostly attributable to the lack of universally accepted diagnostic criteria. Therefore, an International Consensus Group has provided a new classification for FGIDs in childhood, with operational diagnostic criteria, known as the Rome criteria [24].

The aim of the present study was to investigate the prevalence of constipation or IBS, defined according to the Rome criteria for children, in a wide sample of patients with allergic symptoms admitted to allergologic centers in Italy. Furthermore, we have assessed the association between constipation or IBS and IgE sensitization, allergic diseases or both.

Materials and methods

Subjects

A multicenter collaborative group was set up to evaluate the frequency of constipation and IBS among children affected by allergic diseases. Participating centers were from the same region but in districts with different climate and

location (near the sea, on the plain, on the hills, in a town with 150,000–300,000 inhabitants, in a rural area).

One hundred and ninety-six child outpatients with allergic symptoms referred to eight allergologic pediatric centers were consecutively recruited over a 4-month period. Children aged 3–13 years with conditions such as atopic eczema, asthma, urticaria, allergic rhinoconjunctivitis, food allergy, and anaphylaxis were included in the study. Allergic symptoms were diagnosed by a specialist on the basis of history and physical examination. A food reaction was defined as a clear history of immediate reaction to food with a concordant positive skin prick test (SPT). Respiratory allergic symptoms were considered IgE-associated when they were associated with a positive SPT to inhalants and atopic eczema or urticaria when associated with a positive SPT to foods [8].

One hundred and twenty-seven sex- and age-matched subjects were enrolled as controls from among children attending the same centers for suspected allergic symptoms, which were not confirmed on the basis of history, examination, and SPT results. Controls with the following conditions were excluded from the study: atopic eczema, asthma, urticaria, food allergy, anaphylaxis, and positive SPT results. Informed consent to take part in the study was obtained from parents. Children whose parents/guardians were unable to cooperate were excluded from the study.

Methods

After enrollment, a standardized questionnaire was handed out to parents of all children. All parents completed the questionnaire. The questionnaire included information regarding date of examination, age, gender, and family history of allergy. Simple questions covered whether a doctor had ever diagnosed chronic intestinal inflammatory disease and also the identification of the person who completed the questionnaire.

Questions on lifetime prevalence of IBS and constipation were developed using previously published clinical definitions for childhood, known as the Rome criteria [24] (Table 1). IBS was established through a positive answer to the question: “Has your child ever had abdominal pain for 12 weeks (need not be consecutive) within a year?” and to at least two of the following three questions: “Was it relieved by defecation?”; “Was its onset associated with a change in frequency of stool?”; “Was its onset associated with a change in form (appearance) of stool?” Furthermore, it was asked if the child had ever had abnormal stool frequency (more than three bowel movements per day or less than three bowel movements per week), abnormal stool form (lumpy/hard or loose/ watery stool), abnormal stool passage (straining, urgency, or feeling of incomplete evacuation), passage of mucus, bloating or feeling of

Table 1 Rome II criteria for irritable bowel syndrome, functional constipation, and functional fecal retention in children [24]

Rome II criteria and features

Irritable bowel syndrome. In children mature enough to provide an accurate pain history, at least 12 weeks (need not be consecutive) within the preceding 12 months of abdominal discomfort or pain that has two of three features:

Relieved by defecation

Onset associated with a change in frequency of stool

Onset associated with a change in form (appearance) of stool

There are no structural or metabolic abnormalities to explain the symptoms

The following symptoms also support a diagnosis of IBS:

Abnormal stool frequency defined as >3 bowel movements per day or <3 bowel movements per week

Abnormal stool form (lumpy/hard or loose/watery)

Abnormal stool passage (straining, urgency, or feeling of incomplete evacuation)

Passage of mucus with stool

Bloating or feeling of abdominal distention

Functional constipation. In infants and preschool children, at least 2 weeks of scybalous, pebble-like, hard stools for a majority of stools or firm stools 2 or fewer times per week.

There is no evidence of structural, endocrine, or metabolic disease

Functional fecal retention. From infancy to 16 years of age, a history of at least 12 weeks of passage of large-diameter stools at intervals <2 times per week and retentive posturing, avoiding defecation by purposefully contracting the pelvic floor. As pelvic floor muscles fatigue, the child uses the gluteal muscles, squeezing the buttocks together

abdominal distension. Questions were asked to establish whether patients met the diagnostic criteria for functional constipation or functional fecal retention (Table 1). A sample of 15 subjects found the questionnaire to be easy to understand and to answer.

The questionnaire was followed by measurement of height and weight and a visit by a pediatrician. In children with IBS or constipation, pediatricians were invited to exclude organic diseases. Pediatricians had the discretion to require additional investigations to rule out organic diseases. Children with organic causes of IBS and constipation were excluded from the study. All children were skin prick tested using commercial extracts for locally relevant inhalant and food allergens (grasses, plantain, *Alternaria*, pellitory, birch, hazel, mugwort, *Cladosporium*, *Aspergillus*, *Dermatophagoides pteronyssinus* and *farinae*, cat and dog epithelium, milk, egg, cod, tomato, wheat, soya, rice, peanuts) and further allergens suggested by history. The positive control was histamine 1 mg/ml. The negative control was diluent. The results were evaluated after 10 min. SPT weals at least 3 mm greater in diameter than weals at the site of the negative control were considered positive. SPTs were performed if patients were free from antihistamines for 7 days.

Statistical analysis

The frequency of positive constipation has been reported to vary from 2 to 27% in a general population and IBS from 3 to 25%. A power calculation was performed, based on the assumption that the frequency of controls with constipation was 12% and with IBS 6%. Estimating 120 children in the control group, we calculated that we needed 135 children for constipation and 190 for IBS in the group with allergic diseases to provide a 80% power at the 5% level of significance to detect a 1-fold increase of constipation and 1.5-fold increase of IBS.

In the case of two independent samples, the mean values of age or of anthropometric measurements were compared by Student's *t*-test. We also compared age distribution between the two groups using the Kolmogorov-Smirnov test for two independent samples. In the case of more than two independent samples, continuous variables were compared between groups by analysis of variance (i.e., to study the intercenter variability of age), and the post hoc test (Bonferroni) for multiple comparisons was applied.

Chi-square analysis with Yates' correction or Fisher's exact test were used to test differences between variables with dichotomous data (i.e., in 2×2 tables when allergic and controls were compared or in 2×8 tables when differences between centers were assessed). Results were considered significant if $p < 0.05$. The odds ratio (OR) and 95% confidence intervals (CI) were also calculated.

Results

The allergic and control groups were comparable with respect to sex, age, and anthropometric parameters, as shown in Table 2. Allergic children had an increased percentage of family history of atopic diseases [$p < 0.001$; OR (95% CI): 3.195 (2.001–5.104)]. As for the age of the

Table 2 Characteristics of allergic children and controls

Factor	Allergic group (<i>n</i> =196)	Control group (<i>n</i> =127)	<i>p</i> value
Male (%)	119 (60.7)	77 (60.6)	0.988
Mean (range) age (years)	8.041 (3–13)	7.531 (3–13)	0.119
Mean (range) height (cm)	129.19 (89–176)	125.46 (90–163)	0.084
Mean (range) weight (kg)	31.19 (12–70)	28.79 (12–63)	0.075
Mean (range) body mass index	17.96 (12.2–27.3)	17.87 (12.8–29.5)	0.802
Atopic family history (%)	120 (61.2)	42 (33.1)	<0.001

allergic and control groups, beside the difference between the mean values (reported in Table 2), we also compared the two age distributions using the Kolmogorov-Smirnov test, $p=0.735$. The proportion between allergic and control subjects was similar in all the centers which participated in the study ($p=0.420$). The same can be said for the male to female proportion both in the allergic group ($p=0.453$) and in the control group ($p=0.085$). Regarding the remaining baseline subject characteristics, the only slight imbalance may be found in the mean values of age in different centers. The ages of the control groups were consistent between the various centers ($p=0.081$), whereas the mean age (5.41 years) of the allergic group contributed by one small center (12 cases) was significantly lower than that of allergic groups from other centers ($p<0.05$).

In the allergic group, there were 129 (65.8%) children with rhinitis, 100 (51%) with asthma, 65 (33.2%) with conjunctivitis, 64 (32.6%) with atopic eczema, and 14 (7.1%) with urticaria. The mean age of onset of atopic eczema was 2 years and 3 months, of asthma 4 years and 5 months, and of rhinitis 5 years and 5 months. There were 22 (11.2%) children with a history of quick-onset food reaction with a concordant SPT. There was no significant difference in frequency of allergic respiratory symptoms, urticaria, or atopic eczema between centers.

The prevalence of IBS and constipation reported by parents of children with allergic diseases and controls is given in Table 3. The prevalence of IBS diagnosed by the Rome criteria and of IBS-associated symptoms tended to be similar in allergic and healthy children. Furthermore, we found no significant difference between the allergic group and controls in the frequency of constipation.

There was no difference between the two groups in the doctors' diagnosis of chronic intestinal inflammatory

disease. The questionnaire was more frequently filled in by the mother in both groups. The frequency of gastrointestinal symptoms did not significantly differ both in the allergic group and in the control group between centers.

One hundred and sixty-four (83.7%) children with allergic symptoms had at least one positive skin prick test reaction. One hundred and sixty-two (82.6%) children with allergic symptoms had a positive skin prick test reaction to inhalants and 20 (10.2%) to food allergens. Among aeroallergens, positive skin prick test reactions to grasses were found in 99 (50.5%) children, to house dust mites in 95 (48.5%), to *Alternaria* in 39 (19.9%), to cat epithelium in 24 (12.2%), to dog in 22 (11.2%), to pellitory in 5 (2.5%), and to mugwort in 6 (3.1%). Positive skin prick test reactions to plantain, birch, hazel, *Cladosporium*, *Aspergillus*, and single foods were observed only occasionally. There were significant differences between centers regarding children with at least a positive skin prick test reaction ($p=0.001$), positive skin prick test reactions to inhalants ($p=0.001$), cat ($p=0.021$), dog ($p=0.001$), or mugwort ($p=0.004$). There was no significant difference in positive skin prick test reactions to food or other aeroallergens between centers.

Asthma, rhinitis, and conjunctivitis were defined as IgE-associated if they were associated with a positive skin prick test reaction to aeroallergens. Atopic eczema and urticaria were considered IgE-associated in children presenting a positive skin prick test reaction to food allergens. Seventy-seven percent of allergic children had IgE-associated symptoms. Table 4 provides details on the prevalence of IBS and constipation in children with IgE-associated allergic symptoms. Children with IgE-associated allergic symptoms were no more likely to have IBS or constipation, as diagnosed by the Rome criteria, than controls. Among

Table 3 Frequency of intestinal symptoms in children with allergic symptoms and in controls

Intestinal symptoms	Allergic group (n=196) Number (%)	Control group (n=127)	OR (95% CI)	p
IBS questions				
IBS by Rome criteria	13 (6.6)	8 (6.3)	1.219 (0.215–6.922)	0.581
Abdominal pain 12 weeks/year	17 (8.7)	11 (8.7)	1.022 (0.453–2.215)	0.997
Pain relief by defecation	14 (7.1)	9 (7.1)	1.037 (0.144–7.477)	0.671
Change in frequency of stool	8 (4.1)	2 (1.6)	4 (0.659–24.297)	0.124
Change in form of stool	13 (6.6)	7 (5.5)	1.857 (0.352–9.795)	0.376
Abnormal stool passage	14 (7.1)	5 (3.9)	5.6 (1.001–31.319)	0.052
Passage of mucus	4 (2)	0	–	0.116
Bloating/abdominal distension	10 (5.1)	3 (2.4)	3.810 (0.738–19.663)	0.102
Constipation questions				
Constipation by Rome criteria	31 (15.8)	21 (16.5)	0.948 (0.518–1.737)	0.864
Functional constipation	27 (13.8)	15 (11.8)	1.193 (0.607–2.343)	0.608
Functional fecal retention	6 (3.1)	8 (6.3)	0.47 (0.159–1.387)	0.163
Chronic inflammatory disease	1 (0.5)	0	–	0.607
Questionnaire completed by mother	168 (85.7)	114 (89.8)	0.684 (0.34–1.377)	0.286

Table 4 Frequency of intestinal symptoms in children with IgE-associated allergic symptoms and in controls

Intestinal symptoms	IgE-associated allergic symptoms group (<i>n</i> =152) Number (%)	Control group (<i>n</i> =127)	OR (95% CI)	<i>p</i> value
IBS questions				
IBS by Rome criteria	12 (7.9)	8 (6.3)	2.25 (0.304–16.632)	0.378
Abdominal pain	14 (9.2)	11 (8.7)	1.07 (0.468–2.447)	0.873
Pain relief by defecation	13 (8.6)	9 (7.1)	2.889 (0.226–36.868)	0.407
Change in frequency of stool	7 (4.6)	2 (1.6)	4.5 (0.703–28.794)	0.110
Change in form of stool	11 (7.2)	7 (5.5)	2.095 (0.356–12.322)	0.351
Abnormal stool passage	12 (7.9)	5 (3.9)	7.2 (1.066–48.639)	0.043
Passage of mucus	3 (2)	0	–	0.158
Bloating/abdominal distension	8 (5.3)	3 (2.4)	3.556 (0.651–19.412)	0.138
Constipation questions				
Constipation by Rome criteria	21 (13.8)	21 (16.5)	0.809 (0.42–1.561)	0.527
Functional constipation	19 (12.5)	15 (11.8)	1.067 (0.518–2.196)	0.861
Functional fecal retention	4 (2.6)	8 (6.3)	0.402 (0.118–1.368)	0.133
Questionnaire completed by mother	128 (84.2)	114 (89.8)	0.608 (0.296–1.250)	0.173

IBS-associated symptoms, in the children with IgE-associated asthma, rhinitis, conjunctivitis, atopic eczema, or urticaria, a higher prevalence of abnormal stool passage was found. The frequency of gastrointestinal symptoms did not significantly differ in children with IgE-associated allergic symptoms between centers.

Univariate analysis was performed to examine the importance of IgE sensitization, allergic symptoms, and heritability components for the risk for IBS in allergic children. Only sensitization to at least one food allergen

was significantly associated with IBS, as diagnosed by the Rome criteria (Table 5). There was no association between family history of atopy, allergic symptoms, or skin prick test results and constipation (Table 6). There was a significant association between a clear history of immediate reaction to food in children presenting a concordant positive skin prick test reaction and IBS [OR (95% CI): 6.103 (1.795–20.750); *p*=0.008] but not with constipation [OR (95% CI): 2.235 (0.798–6.257); *p*=0.109].

Table 5 Frequency of IBS by Rome criteria according to atopic familiarity, SPT, and allergic symptoms

	IBS		OR (95% CI)	<i>p</i> value
	Yes (<i>n</i> =13)	No (<i>n</i> =183)		
Atopic family history (%)	9 (69.2)	111 (60.7)	1.459 (0.433–4.917)	0.540
Skin prick tests				
At least 1 positive (%)	13 (100)	151 (82.5)	5.792 (0.386–23.928)	0.091
At least 1 positive to foods (%)	4 (30.8)	16 (8.7)	4.639 (1.284–16.762)	0.031
At least 1 positive to inhalants (%)	13 (100)	149 (81.4)	6.231 (0.416–25.678)	0.077
Grasses(%)	8 (61.5)	91 (49.7)	1.618 (0.51–5.131)	0.410
House dust mites (%)	8 (61.5)	87 (47.5)	1.766 (0.557–5.6)	0.329
<i>Alternaria</i> (%)	4 (30.8)	35 (19.1)	1.879 (0.547–6.456)	0.244
Cat (%)	3 (23.1)	21 (11.5)	2.314 (0.589–9.089)	0.202
Dog (%)	1 (7.7)	21 (11.5)	0.643 (0.08–5.198)	0.558
Pellitory (%)	0 (0)	5 (2.7)	–	–
Mugwort (%)	1 (7.7)	5 (2.7)	2.967 (0.321–27.457)	0.341
Allergic diseases				
Asthma (%)	5 (38.5)	95 (51.9)	0.579 (0.183–1.836)	0.349
Allergic rhinitis (%)	10 (76.9)	119 (65)	1.793 (0.476–6.748)	0.292
Allergic conjunctivitis (%)	4 (30.8)	61 (33.3)	0.889 (0.263–3.003)	0.558
Atopic eczema (%)	4 (30.8)	60 (32.8)	0.911 (0.27–3.079)	0.574
Urticaria (%)	1 (7.7)	13 (7.1)	1.09 (0.131–9.047)	0.630

Table 6 Frequency of constipation by Rome criteria according to atopic familiarity, SPT results, and allergic symptoms

	Constipation		Odds ratio (95% CI)	p value
	Yes (n=31)	No (n=165)		
Atopic family history (%)	21 (67.7)	99 (60)	1.4 (0.62–3.163)	0.417
Skin prick tests				
At least 1 positive (%)	23 (74.2)	141 (85.5)	0.489 (0.196–1.22)	0.120
At least 1 positive to foods (%)	5 (16.1)	15 (9.1)	1.923 (0.644–5.745)	0.189
At least 1 positive to inhalants (%)	23 (74.2)	139 (84.2)	0.538 (0.217–1.332)	0.175
Grasses (%)	19 (61.3)	80 (48.5)	1.682 (0.768–3.687)	0.191
House dust mites (%)	13 (41.9)	82 (49.7)	0.731 (0.336–1.588)	0.428
<i>Alternaria</i> (%)	4 (12.9)	35 (21.2)	0.55 (0.181–1.677)	0.288
Cat (%)	3 (9.7)	21 (12.7)	0.735 (0.205–2.631)	0.451
Dog (%)	3 (9.7)	19 (11.5)	0.823 (0.228–2.97)	0.528
Pellitory (%)	1 (3.2)	4 (2.4)	1.342 (0.145–12.424)	0.581
Mugwort (%)	3 (9.7)	3 (1.8)	5.786 (1.111–30.120)	0.052
Allergic diseases				
Asthma (%)	14 (45.2)	86 (52.1)	0.756 (0.35–1.635)	0.477
Allergic rhinitis (%)	19 (61.3)	110 (66.7)	0.792 (0.359–1.748)	0.563
Allergic conjunctivitis (%)	13 (41.9)	52 (31.5)	1.569 (0.716–3.442)	0.258
Atopic eczema (%)	8 (25.8)	56 (33.9)	0.677 (0.285–1.611)	0.376
Urticaria (%)	2 (6.5)	12 (7.3)	0.879 (0.187–4.137)	0.614

Discussion

This is the first study that describes the frequency of IBS and constipation in children with allergic diseases. We evaluated the frequency of IBS and constipation defined according to the Rome criteria in a large sample of outpatients from eight pediatric allergologic centers. We observed that neither IBS nor constipation was more common in children with allergic symptoms than in the general population. Furthermore, we evaluated the relation between IgE sensitization, type of allergic symptoms, or heritability and IBS or constipation. We found that in children with allergic diseases a positive SPT to food was associated with IBS.

Previous investigations [12, 25, 27, 31] have reported contrasting data on the prevalence of IBS in children with allergic symptoms. It has been found that bronchial hyper-responsiveness to methacholine was similar in asthmatics with IBS and without IBS [25]. Along this line, we found that IBS was not significantly more common in children with asthma in comparison with children free of allergic symptoms. In contrast to our results, IBS has been reported to be more common in asthmatic adults than in the general population [12, 27, 31]. This may indicate that asthma may precede the onset of IBS. If this is the case the presence of a mast cell colonic infiltrate in patients with IBS [4] may support the notion that IBS in some adults may be a consequence of a chronic systemic inflammation. These possibilities await further evaluation.

Previous studies have offered an indirect indication of a concurrence of constipation and allergic symptoms by

showing a high frequency of coexistent allergic manifestations in children with constipation investigated for cows' milk allergy in tertiary centers [14, 30]. At variance, we have found no association between constipation and allergic symptoms. Our study differs from these others in that we have investigated constipation in children with allergic symptoms.

The question arises whether IBS or constipation are not associated primarily with allergic symptoms but with IgE-associated allergic diseases. So, we matched the symptoms with skin prick test results. Our results showed that IBS or constipation were not associated with IgE-associated allergic diseases in children.

In the context of the present study, some limitations should be considered. First, diagnosis of intestinal diseases relied on self-reported symptoms, resulting in the possibility of misclassification error as a result of parents' recall bias. However, in the present study we analyzed data obtained by the same objective procedures in children with and without allergic symptoms. The questionnaire was written and compiled by parents. Thus, we believe that a data bias is unlikely. Another important potential source of bias may arise from the method of sampling. Our study should have been carried out on a representative sample of the allergic general population. This was not feasible on this occasion.

We used a multicenter design because multicenter trials have the advantage over single-center trials in that participants may better represent the whole population. In spite of thorough standardization and strict diagnostic criteria we, therefore, expected intercenter variability. In

one center, the age of allergic children was lower than in the other centers. Nevertheless, children were within the established age range. So, we think that intercenter variability of age was not relevant with respect to the results. We also found differences in skin prick test results to aeroallergens, especially cat, dog, and mugwort, between centers. As sensitization depends upon exposure to common allergens, we believe that these differences may be explained by the different climates and locations of participating centers. In view of that, it may be relevant that in our population, which followed a similar diet, positive skin prick tests to foods did not differ between centers. Another possible explanation is that there are local differences in referring children to the allergologic center.

The possible mechanisms underlying IBS are unclear. Diet has been proposed as playing a pathogenetic role in a subset of patients with IBS. More than 60% of IBS patients consider their symptoms to be related to food intake [29]. Elimination of food antigens has been reported to improve IBS [2]. In our study, a role for dietary antigens in the onset of IBS is supported by the frequent association between IBS and a positive SPT to food. However, it is well documented that only a proportion of positive SPT to foods reactions indicates clinical hypersensitivity reactions [26]. The definitive assessment of the role of foods in IBS requires that children have symptomatic benefit from an exclusion diet and occurrence of intestinal symptoms following double-blind food challenges. This is outside of the scope of the present study. Another possibility is that food hypersensitivity does not play a primary role, but it is instead a consequence of a great degree of gut inflammation which favors sensitization to foods in predisposed individuals.

Previous studies have shown that constipation may be a clinical manifestation of cow's milk allergy in patients referred to a tertiary pediatric gastroenterology clinic [14, 30]. In a population of allergic children, we have not been able to find such an association. Overall, the data suggest that prospective population-based studies which investigate the development of constipation after cows' milk exposure are needed to establish the association between constipation and milk hypersensitivity.

A number of studies assessed the prevalence of IBS or constipation in the general community with conflicting results [13, 19, 28]. The discrepancies between previous studies may reflect differences in study design, including selection and variation in the symptom-based definitions. Such potential problems were taken into account in our study. The population sample was restricted to the sensitive age range of 3–13 years, cases and controls were well-matched, and intestinal diseases were diagnosed using diagnostic criteria established by international consensus.

In population-based surveys, the diagnosis of IBS has a prevalence varying from 3 to 25% [19, 28] and increases

with age. The prevalence of IBS symptoms was 6% in a cohort of middle school students, 14% in high school students [13], and is 10–15% in most adult studies [19]. The prevalence of IBS in our allergic (6.6%) and control group (6.3%) is consistent with these figures.

Studies on the prevalence of constipation have also reported discordant results. The reported prevalence of constipation in the US varied between 2 and 27% [1]. Constipation affects 2.9% of infants in the 1st year of life, 10.1% in the 2nd year of life [16], and 28% at 8–10 years [9]. The prevalence of constipation defined according to the Rome II criteria was 14% in adults in written questionnaire studies [11, 22]. This proportion is in agreement with our results (15.8% in allergic children, 16.5% in controls).

We were able to find in the literature a few studies that assessed the frequency of FGIDs in childhood by the Rome criteria [17, 18]. In China, a questionnaire study by Dong et al. [17] in children aged 6–12 years found a prevalence of IBS of 11.86%. They found differences of prevalence in different areas probably due to stress of competition, food habits, and climatic conditions. These reasons and genetic factors may also account for our different results. At variance with our findings, Miele et al. [18] found that the current prevalence of IBS was 0.28% and of functional constipation was 0.68% in 9,660 children, with a mean age 52.2 ± 25.7 months. It is not easy to make a comparison with our results because they based the diagnosis on a questionnaire compiled by a pediatrician according to the Rome criteria and because our population was older.

This study was carried out on a large group of allergic children who attended allergy centers in Italy. We cannot extend our results to the whole population of children with allergic diseases; on the contrary, our patients are likely to represent a select group with severe allergy. However, our results may have practical implications for the management of children attending allergy centers. In these patients, the presence of clinical atopy is not sufficient for the development of IBS or constipation. On the other hand, more attention may be paid to IBS symptoms in allergic children with positive SPT to foods. Larger studies are warranted to evaluate whether an elimination diet may improve the quality of life in such children with IBS.

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