

# Development of a Multidimensional Measure for Recurrent Abdominal Pain in Children: Population-Based Studies in Three Settings

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**ABSTRACT.** *Objective.* Recurrent abdominal pain (RAP) is a common problem in children and adolescents. Evaluation and treatment of children with RAP continue to challenge physicians because of the lack of a psychometrically sound measure for RAP. A major obstacle to progress in research on RAP has been the lack of a biological marker for RAP and the lack of a reliable and valid clinical measure for RAP. The objectives of this study were (1) to develop and test a multidimensional measure for RAP (MM-RAP) in children to serve as a primary outcome measure for clinical trials, (2) to evaluate the reliability of the measure and compare its responses across different populations, and (3) to examine the reliabilities of the measure scales in relation to the demographic variables of the studied population.

*Methods.* We conducted 3 cross-sectional studies. Two studies were clinic-based studies that enrolled children with RAP from 1 pediatric gastroenterology clinic and 6 primary care clinics. The third study was a community-based study in which children from 1 elementary and 2 middle schools were screened for frequent episodes of abdominal pain. The 3 studies were conducted in Houston, Texas. Inclusion criteria for the clinic-based studies were (1) age of 4 to 18 years; (2) abdominal pain that had persisted for 3 or more months; (3) abdominal pain that was moderate to severe and interfered with some or all regular activities; (4) abdominal pain that may or may not be accompanied by upper-gastrointestinal symptoms; and (5) children were accompanied by a parent or guardian who was capable of giving informed consent, and children over the age of 10 years were capable of giving informed assent. The community-based study used standardized questionnaires that were offered to 1080 children/parents from the 3 participating schools; 700 completed and returned the questionnaires (65% response rate). The questionnaire was designed to elicit data concerning the history of abdominal pain or discomfort. A total of 160 children met Apley's criteria

and were classified as having RAP. Inclusion criteria were identical to those criteria for the clinic-based studies. Participating children in the 3 studies received a standardized questionnaire that asked about socioeconomic variables, abdominal pain (intensity; frequency; duration; nature of abdominal pain, if present, and possible relationships with school activities; and other upper gastrointestinal symptoms). We used 4 scales for the MM-RAP: pain intensity scale (3 items), nonpain symptoms scale (12 items), disability scale (3 items), and satisfaction scale (2 items). Age 7 was used as a cutoff point for the analysis as the 7-year-olds have been shown to exhibit more sophisticated knowledge of illness than younger children.

*Results.* A total of 295 children who were aged 4 to 18 years participated in the study: 155 children from the pediatric gastroenterology clinics, 82 from the primary care clinics, and 58 from the schools. The interitem consistency (Cronbach's coefficient  $\alpha$ ) for the pain intensity items, nonpain symptoms items, disability items, and satisfaction items were 0.75, 0.81, 0.80, and 0.78, respectively, demonstrating good reliability of the measure. The internal consistencies of the 4 scales did not significantly differ between younger ( $\leq 7$  years) and older ( $> 7$  years) children. There was also no significant variation in the coefficient  $\alpha$  of each of the 4 scales in relation to gender or the level of the parent's education. Reliability was identical for the pain-intensity items (0.74) among children who sought medical attention from primary care or pediatric gastroenterology clinics. The intercorrelations of factor scores among the 4 scales showed a strong relationship among the factors but not high enough that correlations would be expected to be measuring the same items. The results of the factor analysis identified 5 components instead of 4 components representing the 4 scales. The 12 items of the nonpain symptoms scale were classified into 2 components; 1 component included heartburn, burping, passing gas, bloating, problem with ingestion of milk, bad breath, and sour taste (nonpain symptoms I), and the other included nausea/vomiting, diarrhea, and constipation (nonpain symptoms II). The program ordered the 5 components on the basis of the percentage of the total variance explained by each component and consequently by the strength of each component in the following order: nonpain symptoms I, pain intensity, pain disability, satisfaction, and nonpain symptoms II. Of the 20 items that composed the MM-RAP, 17 met the inclusion criteria of having a correlation of  $\geq 0.40$  on the primary factor analyses. The 3 items that assessed pain intensity met the inclusion criteria as well as the 2 items that assessed satisfaction. Two of the 3 items that assessed disability met the inclusion criteria; however, the missed school item did not. The sleep problem and the loss of appetite items in the nonpain items

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also did not meet the inclusion criteria in both components of the nonpain symptoms scale. However, the loss of appetite item met the inclusion criteria in the disability scale with a correlation of 0.6. The 2 items that did not meet the inclusion criteria (missed school days and sour taste) will be eliminated in the revised measure for RAP.

**Conclusion.** The MM-RAP demonstrated good reliability evidence in population samples. Children who have RAP and are seen at pediatric gastroenterology or primary care pediatric clinics have similar responses, showing that the measure performed well across several populations. Age did not affect the reliability of responses. The MM-RAP included 4 dimensions, each with several items that may identify disease-specific dimensions. In addition, dividing the nonpain symptoms scale into 2 components instead of 1 component could assist in creating a disease-specific measure. The present study focused exclusively on developing the multidimensional measure for RAP in children that could assist physicians in evaluating the efficacy of RAP treatment independent of psychological evaluations. In addition, the measure was designed for use in clinical trials that evaluate the efficacy of RAP treatment and to allow comparison between intervention studies. In conclusion, we were able to identify 4 dimensions of RAP in children (pain intensity, nonpain symptoms, pain disability, and satisfaction with health). We demonstrated that these dimensions can be measured in a reliable manner that is applicable to children who experience RAP in various settings. *Pediatrics* 2005;115:e210–e215. URL: [www.pediatrics.org/cgi/doi/10.1542/peds.2004-1412](http://www.pediatrics.org/cgi/doi/10.1542/peds.2004-1412); recurrent abdominal pain, children, scale, outcome measure.

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ABBREVIATIONS. RAP, recurrent abdominal pain; MM-RAP, multidimensional measure for RAP.

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Recurrent abdominal pain (RAP) is 1 of the most common gastrointestinal disorders in children, with estimates of prevalence ranging between 10% and 15% of children.<sup>1–3</sup> RAP is an especially noteworthy disorder because it often interferes with the child's school attendance and performance; peer relationships; and participation in organizations, sporting events, and family activities.<sup>1–6</sup> Recent studies have shown that children who experience RAP also exhibit anxiety, depression, withdrawal, and low self-esteem.<sup>6–9</sup> Community- and school-based studies reported that abdominal pain occurred in 7% to 25% of school-aged children<sup>2,5,10–13</sup> and was severe enough to affect activities in 21%.<sup>5</sup> Children with RAP are also frequent users of medical services.<sup>5,14</sup>

Over the past 3 decades, a number of symptoms-based criteria have been proposed to help clinicians and researchers diagnose and identify children with RAP. The original Aply's criteria were designed to identify RAP in community samples without medical assessment.<sup>1</sup> Von Baeyer et al<sup>15</sup> modified Aply's criteria and reported that the primary outcome should measure both amount of pain and the level of disability. The ROME I and ROME II diagnostic criteria<sup>16–18</sup> recommended that evaluation of RAP be based on medical assessment, the patient's report of pain, and psychological measures done at baseline. However, it was reported recently that the interrater reliability of the ROME II criteria was low among pediatric gastroenterologists and the development of

improved criteria was recommended.<sup>19</sup> Despite improved diagnostic criteria and potentially more effective treatment, the treatment of pediatric patients with RAP continues to challenge physicians.<sup>7</sup> A major obstacle to progress in research on RAP has been the lack of a biological marker for RAP and the lack of a reliable and valid clinical measure for RAP.

We aimed to develop and evaluate the reliability of an instrument for measuring RAP in children to serve as a primary outcome measure for clinical trials. In the current research, we describe the development of a multidimensional measure for RAP (MM-RAP) and report the results of the reliability testing of the measure. Furthermore, we examined the reliabilities of the measure subscales in relation to the demographic variables of the study.

## METHODS

### Scale Development and Scale Evaluation

The development of the MM-RAP in children was based on the need for an effective primary outcome measure of RAP. The initial items chosen were influenced by our previous work on the severity of dyspepsia assessment scale for adults<sup>20–22</sup> as well as other sources.<sup>23–25</sup> First, we critically appraised the literature and found that most of the existing measures are based on single items.<sup>6,7,23</sup> In general, single-item scales have poor reliability<sup>24</sup> and fail to account adequately for the complexity of RAP in children. Second, we reviewed the literature on pain intensity and designed test items to assess pain intensity for children with RAP. Third, we created test items related to nonpain symptoms that were based on the most and the least common symptoms reported by children with RAP. Finally, we reviewed the literature and created test items that assess the disability and satisfaction with health consequences resulting from RAP, which we thought would distinguish pain affect from pain intensity. This work led to the development of test items for RAP to measure 4 components: pain intensity, nonpain symptoms, sense of well-being (health satisfaction), and disability scales.

1. The Pain Intensity Scale is derived from 3 items; first is the Wong-Baker Face scale,<sup>26,27</sup> which is used to rate the pain now (0 = very happy face; 5 = tearful face/hurts as much as you can imagine); second is rating the Worst Pain over the previous 3 months measured on scales from 0 to 10 (0 = no pain; 10 = pain as bad as it could be), and third is Average Pain over a period of 3 months measured on scales from 0 to 10 (0 = no pain; 10 = pain as bad as it could be); all 3 then are summed to give a final pain intensity score.

2. The Nonpain Symptoms Scale is derived from 12 items that consist of the range of RAP-related symptoms (nausea/vomiting, heartburn, diarrhea, constipation/hard stool, passing gas, loss of appetite, burning/belching, bloating/abdominal distention, sour taste, bad breath, sleep problem, and problem with ingestion of milk). Each symptom is rated from 1 to 5 (1 = no problem; 5 = very severe problem).

3. The Disability Scale is derived from 3 items. The first item rates how the child's abdominal pain interfered with her or his school attendance during the previous 3 months measured on a 10-point scale (0 = never missed a school day; 10 = missed 10 or more days); the second and third items rate how the child's abdominal pain interfered with daily and weekly activities, respectively, during the previous 3 months measured on scales from 0 to 10 (0 = never; 10 = always).

4. The Satisfaction Scale consisted of 2 items that evaluated the overall RAP condition. The 3 items were how pleased and satisfied the child/parent is in regard to the level of abdominal pain. Both items included responses to questions measured on 1- to 5-points scales (1 = definitely true that I feel pleased [first item] or satisfied [second item] with my health with regard to my/my child's RAP; 5 = definitely false).

### Study Population

Cross-sectional studies were conducted on 3 populations: children who attend the Harris County Pediatric Health Clinics, chil-

dren who are patients at the pediatric gastroenterology clinic at Texas Children's Hospital, and children who attend Houston Independent School District. These groups represent 2 clinic-based (Harris County Pediatric Health Clinics and Texas Children's Hospital) studies and 1 community-based (Houston Independent School District) study.

The 2 clinic-based studies were conducted at 6 primary care pediatric clinics and 1 pediatric gastroenterology clinic in Houston, Texas. Children who were identified by their assigned physicians as having RAP were screened by the study coordinator for eligibility for the study. The inclusion criteria were (1) age of 4 to 18 years; (2) abdominal pain that had persisted for 3 or more months; (3) abdominal pain that was moderate to severe and interfered with some or all regular activities; (4) abdominal pain that may or may not be accompanied by upper-gastrointestinal symptoms; and (5) children were accompanied by a parent or guardian who was capable of giving informed consent, and children who were over the age of 10 years were capable of giving informed assent.

After the assigned physician referred the patient, it was the study coordinator's responsibility to ensure that the child met the inclusion criteria. On agreement to participate in the study, a self-administered questionnaire was given to the parent/child to obtain data regarding sociodemographic characteristics and general information regarding the abdominal pain symptoms that led to the doctor's visit. The second part of the questionnaire was designed to obtain a detailed description of the child's history of abdominal pain and to obtain responses to all items related to the MM-RAP for children. That part of the questionnaire was completed by the study coordinator, and responses from both parent and child were obtained at the same time.

The third study was a community based-study that was conducted on 2 middle schools and 1 elementary school in Houston, Texas. The study aimed to measure the prevalence of RAP among children in the community and describe the clinical constellation of RAP. Standardized questionnaires were offered to 1080 parents/children from the 3 participating schools; 700 completed and returned the questionnaires (65% response rate). The questionnaire was designed to elicit data concerning socioeconomic parameters and the history of abdominal pain or discomfort (intensity; frequency; duration; nature of abdominal pain, if present; and possible relationships with school activities, eating pattern, and other upper-gastrointestinal symptoms). A total of 160 children met Apley's criteria for RAP and were classified as having RAP; 100 of their parents were contacted by telephone. When verbal approval was obtained, an interview with the child and parents was scheduled to complete the MM-RAP. Inclusion criteria were identical to criteria for the clinic-based studies.

Written consent/assent from all participating children from the 3 settings was obtained from each parent/child before enrollment in the study. Baylor College of Medicine's Committee for the Protection of Human Subjects approved the protocol for the 3 studies.

## Analyses

### Reliability

The goal of our current work was to test the reliability of the MM-RAP in children. The measure was intended to measure the

severity of abdominal pain in children, all of whom had abdominal pain. Our focus in these analyses was to evaluate the reliability of the 4 scales: pain intensity, nonpain symptoms, disability, and satisfaction.<sup>24</sup> We evaluated the reliability of each scale by calculating interitem consistency among the items using Cronbach's coefficient  $\alpha$ .<sup>25</sup> We calculated the median values for standardized Cronbach's  $\alpha$  when the scales were administered (ie, at enrollment). An accepted method for estimating the reliability of a measure that is based on a single administration is to calculate the internal consistency of the scale.

### Factor Analyses

Factor analysis was applied to examine the different components of the current MM-RAP and to distinguish the important items for these dimensions. We initially anticipated 4 components because our multidimensional measure consisted of 4 scales (pain intensity, nonpain symptoms, disability, and satisfaction with RAP). The 4 dimensions were revised on the basis of the results of the factor analysis, which required that items have a correlation of 0.40 or greater with the primary factor. Such criteria were used to ensure that the scales consisted of items with strong associations with the primary factor being measured.

The extraction method (principal component analyses) with all 20 items of the 4 scales was applied to identify the total variance between items and help reconstruct the components of the RAP scales identified through factor analyses. Then the rotation method (Varimax with Kaiser Normalization) was used to identify these components.<sup>25</sup> The data were analyzed by using the SPSS program (SPSS Inc, Chicago, IL).

## RESULTS

### Patient Characteristics

A total of 295 children between the ages of 4 and 18 years participated in the current study: 155 children from the pediatric gastroenterology clinics, 82 from the primary care clinics, and 58 from the school. The distribution of age, gender, ethnicity, and parent's level of education of the total studied children and by each setting independently are presented in Table 1. We used age 7 as a cutoff point for the analysis as 7-year-olds have been shown to exhibit more sophisticated knowledge of illness than 4-year-olds.<sup>28</sup>

### Reliability of the Scale in Relation to the Study Variables

Because the items have different numbers of response categories, the variance was not similar across items and we therefore used the standardized  $\alpha$  for these values. The interitem consistency (Cronbach's coefficient  $\alpha$ ) for the pain intensity items, nonpain symptoms items, disability items, and satisfaction items were 0.75, 0.81, 0.80, and 0.78, respectively, demonstrating good reliability of the measure. Age is

**TABLE 1.** Demographic Characteristics of the Total Population

Variables	Total Studied Children (N = 295)	Pediatric GI Clinic (N = 155)	Primary Care Clinics (N = 82)	School Children (N = 58)
Age, n (%)				
<7 y	55 (19)	34 (22)	12 (15)	8 (14)
≥7 y	240 (81)	121 (78)	70 (85)	49 (86)
Mean age (+SD)		9.6 (3.7)	9.6 (2.9)	10.4 (2.4)
Gender, n (%)				
Boys	120 (41)	69 (44)	27 (33)	24 (43)
Girls	175 (59)	87 (56)	55 (67)	34 (57)
Parent's level of education, n (%)				
High	153 (52)	101 (64)	31 (38)	21 (36)
Middle and low	139 (47)	54 (36)	51 (62)	34 (59)
Missing	3 (1)	1	0	3 (5)

GI indicates gastrointestinal.

**TABLE 2.** Cronbach's  $\alpha$  for Each of the 4 Scales of MM-RAP in Children

Variable	Total Reliability	Below Age 7	$\geq$ Age 7	Male	Female	Group 1*	Group 2†	Group 3‡	Education Middle to Low	Education High
Pain intensity	0.75	0.72	0.75	0.75	0.74	0.74	0.74	0.67	0.78	0.71
Nonpain symptoms	0.81	0.86	0.79	0.81	0.81	0.80	0.83	0.72	0.80	0.81
Pain disability	0.80	0.75	0.80	0.76	0.82	0.75	0.85	0.65	0.80	0.82
Level of satisfaction	0.78	0.93	0.74	0.84	0.78	0.77	0.79	0.72	0.76	0.83

Because the items have different numbers of response categories, the variance is not similar across items; therefore, we used the standardized  $\alpha$  for these values.

\* Children who were seen at pediatric GI clinic.

† Children who were seen at primary care clinics.

‡ School children.

a critical factor for children's responses; we therefore tested the reliability of the 4 scales of our measure in relation to age and used the cutoff point of 7 years.<sup>28</sup> The internal consistencies of the 4 scales did not differ significantly between younger and older children. There was also no significant variation in the coefficient  $\alpha$  of each of the 4 scales in relation to gender or the level of the parent's education (Table 2).

Because it was previously reported that the severity of a disease could vary on the basis of whether patients are recruited from primary or tertiary settings,<sup>10</sup> we compared the responses of our measure between children who were recruited from 3 different settings: primary care and pediatric gastroenterology clinics and school children. The Cronbach's  $\alpha$  for the pain intensity and the disability scales dropped slightly below 0.7 among school children. This likely is attributable to the smaller sample size in that group or to the heterogeneity of the studied population. The Cronbach's  $\alpha$  was identical for the pain intensity scale (0.74) among children who sought medical attention from general primary care clinics or pediatric gastroenterology clinics.

### Intercorrelations and Descriptive Statistics of MM-RAP Scales

The intercorrelations of factor scores among the 4 scales are presented in Table 3. These correlations showed a strong relationship among the factors but not high enough that correlations would be expected to be measuring the same thing.

Means and SDs of each of the 4 scales as well as for the MM-RAP measure are presented in Table 4. The process for scoring the scales and final MM-RAP measure involved 4 steps. First, we transformed the scale for each item to a 0 to 100 scale. Second, we took the average of the items in the scale, which resulted in equal weighting of all items. Third, we transformed the scale total to a 0 to 100 scale to facilitate interpretation of scores. Finally, we took the average of all 4 scales to get the total MM-RAP score. This

**TABLE 3.** Intercorrelations Among the MM-RAP Scales

	Pain Disability	Pain Intensity	Nonpain Symptoms	Level of Satisfaction
Pain disability	1.0			
Pain intensity	0.46	1.0		
Nonpain symptoms	0.42	0.45	1.0	
Level of satisfaction	0.36	0.45	0.32	1.0

means that we weighted each subscale equally. The total MM-RAP score was 42.0 (SD: 18).

### Results of the Factor Analyses

The results of the factor analysis applying the principal component analysis with varimax rotation are presented in Table 5. A principal component was defined as having an initial Eigen value of  $>1$ . The factor analysis identified 5 components. The 12 items of the nonpain symptoms scale were classified into 2 components; 1 component included heartburn, burping, passing gas, bloating, problem with ingestion of milk, bad breath, and sour taste; and the second component included nausea/vomiting, diarrhea, and constipation. The program ordered the 5 components on the basis of the percentage of the total variance explained by each component and consequently by the strength of each component in the following order: nonpain symptoms I, pain intensity, pain disability, satisfaction, and nonpain symptoms II (Table 5). Because we anticipated 4 components corresponding to the 5 scales, we retested the Cronbach's  $\alpha$  for the 2 components of the nonpain symptoms items. The interitem consistency (Cronbach's coefficient  $\alpha$ ) did not change: 0.80 and 0.81 for the first and the second components, respectively.

Of the 20 items that compose the MM-RAP, 17 met the inclusion criteria on the basis of having a correlation of 0.40 on the primary factor analyses. The 3 items that assessed pain intensity met the inclusion criteria as well as the 2 items that assessed satisfaction. Two of the 3 items that assessed disability met the inclusion criteria; however, the missed school item did not meet the inclusion criteria. The sleep problem and the loss of appetite items in the nonpain items also did not meet the inclusion criteria in both components of the nonpain symptoms subscale. However, the loss of appetite item met the inclusion criteria in the disability scale with a correlation of 0.6. The 2 items that did not meet the inclusion criteria (missed school days and sour taste) will be eliminated in a revised scale for RAP.

### DISCUSSION

To facilitate standardization of methodologic intervention for RAP in children, a group of international experts on functional gastrointestinal disorders in adults and children met in Rome, Italy, and made recommendations for the diagnosis of RAP.<sup>15-17</sup> Rome II criteria suggested that children with RAP should be classified into subgroups of

**TABLE 4.** Descriptive Statistics on MM-RAP Scales

Scale	Mean	SD	Minimum	Maximum
Pain disability	30.7	23.5	0	100
Pain intensity	58.3	24.4	0	100
Nonpain symptoms	20.3	15.5	0	75.0
Level of satisfaction	65.0	30.6	0	100
MM-RAP	42.0	18.1	0	89.3

abdominal pain such as irritable bowel syndrome, functional abdominal pain, abdominal migraine, functional dyspepsia, and aerophagia.<sup>17</sup> In addition, Rome II recommended that a primary efficacy evaluation of treating a child with RAP should be based only on clinical outcomes. Several recent studies of therapies for childhood RAP have used the number of pain episodes as a primary outcome,<sup>29,30</sup> with the exception of 1 study that used missed activities as a result of pain as a primary outcome.<sup>18</sup> Despite continued research on RAP and improved diagnostic criteria,<sup>31–35</sup> the treatment of pediatric patients with RAP continues to challenge physicians,<sup>36,37</sup> and there is still a lack of consistency in methods used by researchers. Therefore, we developed and tested an MM-RAP.

This is the first study to report on the development of an MM-RAP in children. We confirmed the existence of at least 4 dimensions for measuring RAP (pain intensity, nonpain symptoms, pain disability, and satisfaction with health). We were able to iden-

tify items that are necessary to distinguish these dimensions and showed that each dimension can be assessed in a reliable manner. The major finding of the study was that the 4 dimensions of the MM-RAP showed acceptable internal consistency for each scale to be measured in a reliable manner. Nunnally et al<sup>24</sup> recommended a reliability standard of 0.70 for group level, which was achieved by most of our scales. It is interesting that the pain intensity scale achieved a reliability of 0.75, the nonpain symptoms scale achieved a reliability of 0.81, and disability scale achieved a reliability of 0.80. Because classification of RAP severity depends on the dimension that is assessed, not all measures will prove equally responsive or sensitive in detecting treatment effects. For example, if therapy is intended to relieve pain, then one would expect that a pain intensity measure would be of greatest value as the primary outcome measure for detecting treatment effect rather than a measure that includes other dimensions. Understanding the multidimensional nature for RAP in children is relevant in the light of our current efforts to evaluate new treatment strategies. Thus, researchers should carefully select a measure to evaluate the severity of RAP in children.

Our study also found no difference between the pain intensity and the nonpain symptoms scales reported in pediatric gastroenterologic clinics and from those who seek medical attention in primary care

**TABLE 5.** Rotated Component Factors of All Items From the MM-RAP With the Five Components

	Factors Scores				
	I Nonpain Symptoms (I)*	II Pain Intensity	III Pain Disability	IV Satisfaction	V Nonpain Symptoms (II)†
Pain disability					
Missed school days	0.12	0.12	<b>0.51</b>	0.06	-0.04
Daily activities	0.10	0.36	<b>0.70</b>	0.26	-0.14
Weekend activities	0.04	0.40	<b>0.68</b>	0.25	-0.13
Pain intensity					
Wong-Baker face	0.12	<b>0.62</b>	0.22	0.12	0.06
Worst pain in 3 mo	0.21	<b>0.73</b>	0.18	0.35	-0.01
Average pain in 3 mo	0.17	<b>0.71</b>	0.12	0.35	0.08
Nonpain symptoms					
Nausea/vomiting	0.11	0.14	0.48	-0.10	<b>0.51</b>
Loss of appetite	0.26	0.05	<b>0.64</b>	0.11	0.20
Heartburn	<b>0.78</b>	0.25	0.14	-0.10	-0.10
Diarrhea	0.17	0.11	0.06	0.00	<b>0.75</b>
Constipation/hard stool	0.30	0.40	0.01	-0.23	<b>0.47</b>
Bloating/abdominal distention	<b>0.57</b>	0.14	0.02	0.19	0.11
Passing gas	<b>0.51</b>	0.62	-0.15	0.29	0.47
Burping/belching	<b>0.54</b>	-0.12	0.04	0.30	0.40
Problem with ingestion of milk	<b>0.60</b>	-0.16	0.33	0.04	0.11
Sleep problem	0.03	0.59	0.27	-0.09	0.12
Bad breath	<b>0.74</b>	0.28	0.13	-0.08	0.08
Sour taste	<b>0.50</b>	0.02	0.23	0.27	0.25
Level of satisfaction					
How satisfied with RAP	0.04	0.10	0.17	<b>0.74</b>	0.10
How pleased with RAP	0.06	0.28	0.15	<b>0.78</b>	0.00

Boldface items will be retained in the revised scale for RAP. The Cronbach's  $\alpha$  of revised components identified by the factor analysis:

Component 1, nonpain I = 0.81

Component 2, pain intensity = 0.63

Component 3, disability = 0.75

Component 4, satisfaction = 0.80

Component 5, nonpain II = 0.80

\* Burping, problem with ingestion of milk, passing gas, bloating, heartburn, bad breath.

† Nausea/vomiting, diarrhea, constipation/hard stool.

clinics. This observation was similar with a previous study that found no difference in the level of pain between children who were referred by pediatric gastroenterologists and those who were referred by community general pediatricians.<sup>30</sup>

Several issues that need to be addressed arise from our work. First, our study reports on the development and the reliability of a new measure for RAP in children. Before standardizing the measure for clinical use, the sensitivity and the validity must be examined in follow-up visits, comparing the responses before and after intervention. We are currently in the process of validating the measure. Second, additional efforts should investigate the importance of additional dimensions such as the duration of the pain. Third, our measure did not include the psychological aspects of RAP. The present study focused exclusively on developing a measure that could assist physicians in evaluating the efficacy of RAP treatment in children independent of psychological evaluation. In addition, our outcome measure was designed for use in clinical trials that evaluate the efficacy of RAP treatment and to allow comparison between intervention studies. Finally, we did not evaluate whether our measure is disease specific (ie, it does not distinguish between children who have irritable bowel syndrome or gastroesophageal reflux disease, functional dyspepsia, or other organic conditions that could be the underlining cause of RAP). However, our measure included 4 dimensions, each with several items that may identify disease-specific dimensions. In addition, dividing the nonpain symptoms scale into 2 components instead of 1 component could assist in creating a disease-specific measure. Work toward achieving this goal is in progress.

In conclusion, we were able to identify 4 dimensions of recurrent abdominal pain in children (pain intensity, nonpain symptoms, pain disability, and satisfaction with health). We demonstrated that these dimensions can be measured in a reliable manner and are applicable to children who experience RAP in various settings.

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