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Original research

Multinational prevalence and burden of paediatric disorders of gut–brain interaction: results of the Rome Foundation paediatric global study

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ABSTRACT

Background Global prevalence estimates of paediatric disorders of gut–brain interaction (DGBI) are largely unknown and published studies are hindered by heterogeneous methodology.

Objective To determine the multinational prevalence and burden of paediatric DGBI as defined by Rome V.

Design Caregivers of 8000 children aged 0–17 years from China, Italy, Mexico and the USA completed an online Rome V survey assessing gastrointestinal symptoms, illness burden and comorbid health conditions. Prevalence was calculated by DGBI category, country, sex and age.

Results Paediatric DGBI were highly prevalent, affecting 28.0% (95% CI 27.0% to 29.0%) of children. Upper DGBI were present in 8.7% (95% CI 8.2% to 9.5%) and lower DGBI in 23.7% (95% CI 22.8% to 24.7%). The most common lower DGBI were defecation and anorectal disorders (20.2%) followed by abdominal pain disorders (4.4%) and discomfort disorders (1.8%). The most common upper DGBI were gastroduodenal disorders (6.6%), followed by functional feeding disorders (3.4%) and oesophageal disorders (0.6%). Significant geographic differences were observed with the highest prevalence in Mexico and the lowest in China. There was a female predominance in gastroduodenal and discomfort disorders. Overall prevalence declined with age, from approximately 41% in children aged 0–3 years to 22% in adolescents. DGBI were associated with significant anxiety, depression, functional disability and healthcare utilisation, as well as parental time spent in care and coordination particularly when upper and lower DGBI overlapped.

Conclusions This global Rome V study demonstrates the high multi-national prevalence, burden and heterogeneity of paediatric DGBI, supporting improved recognition, classification, research and clinical care

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Paediatric disorders of gut–brain interaction (DGBI) are common based on prior heterogenous studies.

WHAT THIS STUDY ADDS

⇒ This is the first global population-based paediatric study. It shows that paediatric DGBI according to the Rome V criteria affect nearly one-third of children in a multinational sample, with substantial variation by disorder and country, and having a high burden on children and caregivers.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ These findings provide standardised global prevalence data that can improve recognition of paediatric DGBI and result in efforts to reduce their burden on the patients, the caregivers and the healthcare systems.

INTRODUCTION

Paediatric disorders of gut–brain interaction (DGBI) represent one of the most common groups of chronic gastrointestinal conditions affecting children worldwide and are increasingly recognised as major contributors to impaired quality of life, psychosocial dysfunction, healthcare utilisation and family burden.[1–7]

Comprehensive global data on the prevalence and burden of paediatric DGBI are lacking. Prior studies have used heterogeneous methodologies, focused on selected age groups or individual disorders and were usually conducted in single countries or regions. As a result, the worldwide prevalence, impact, overlap among DGBI and associated psychosocial and healthcare burden remain incompletely understood.[1–5]

In the last decade, the Rome Foundation (RF) conducted the first global epidemiologic study of DGBI in adults,[8] reshaping the understanding of disease prevalence, risk factors and geographic variation. However, there have been no comparable paediatric data. Building on this work and the recently revised Rome V Paediatric criteria,[9 10] which introduced major changes and new diagnoses, the RF undertook the first large-scale multinational study to evaluate the prevalence, impact and factors associated with the development and persistence of paediatric DGBI.

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The aims of the study were to (1) evaluate the multinational prevalence of paediatric DGBI using the revised Rome V criteria and (2) assess the burden of DGBI in children and their caregivers.

METHODS

The online survey used the Rome V paediatric diagnostic questionnaire,[11] following methods similar to the validated Rome IV questionnaires.[8 11 12] Female caregivers of children aged 0–17 years were recruited through Qualtrics LLC (Provo, UT)[8 11] to complete an anonymous survey on 'child health', without mention of gastrointestinal symptoms, to minimise selection bias. Caregiver age quotas were 40% aged 18–34 years, 40% aged 35–44 years and 20% aged ≥45 years. Caregivers with more than one child selected the child whose first name came first alphabetically.

The study was conducted in China, Italy, Mexico and the USA, representing four major world regions. The questionnaire was professionally translated into Simplified Chinese, Italian and Mexican Spanish, with linguistic validation via cognitive debriefing and cultural adaptation supervised by each country's principal investigator.

We aimed to recruit 2000 participants per country. Children with caregiver-reported IBD or coeliac disease were excluded from meeting Rome V criteria for all DGBI except functional feeding disorders (FFD), which assess behavioural responses to gastrointestinal symptoms.

Surveys were administered online between 12 December 2024 and 1 February 2025. Built-in quality assurance measures were used to exclude poor-quality responses.[8 11]

Patients or the public were not involved in the design, conduct, reporting or dissemination plans of our research.

Survey structure

Background information

Data collected are shown in table 1.

Rome V diagnostic questionnaire

142 items assessing gastrointestinal symptoms (9, 10), with additional questions for children aged 0–3 years, yielding 29 paediatric DGBI diagnoses. The new Rome V paediatric criteria were divided into Upper DGBI and Lower and Biliary DGBI.[9 10] Upper DGBI included oesophageal, FFD and gastroduodenal disorders.[9] Lower DGBI group included pain, defecation and anorectal as well as discomfort disorders.[10] New diagnoses were introduced, particularly oesophageal disorders that included functional heartburn, non-reflux oesophageal pain disorder and air transit disorders, FFD including hypersensitive dysphagia, anticipatory restrictive feeding, hunger dysregulation, medically triggered disorders and pain disorders including centrally mediated abdominal pain disorder (CAPS) and biliary pain. Although proctalgia fugax was introduced as a new lower gastrointestinal disorder, it was not included because its diagnostic criteria had not yet been fully defined at the time of survey administration. Specific diagnostic criteria are provided in the online supplemental table 1.

The questionnaire also assessed symptom impact on daily activities and caregivers, prior organic gastrointestinal diagnoses and symptom severity using a 0–10 (0=not at all, 10=extremely) scale. Development of the Rome V paediatric questionnaire has been described elsewhere.[11]

Supplemental questionnaire and DGBI burden

An additional 82-item questionnaire assessed sociodemographic factors, healthcare utilisation, medications, living conditions, psychosocial variables, bullying, diet, culture and religion. DGBI burden was evaluated using the following validated measures: Functional Disability Inventory (FDI),[13 14] Short-Mood and Feelings Questionnaire–Parent Version[15] and Spence Children's Anxiety Scale–Parent Version.[16] Published cutoffs were used to define significant symptoms: anxiety >7.4,[16] depression >7.9[15] and FDI scores of 0–12, 13–29 and >30 for none/minimal, moderate and severe disability, respectively.[13 14] Bullying was defined as caregiver-reported bullying at least once per week during the past year.

Statistical analyses

SPSS v.32 (Chicago, IL, USA) was used. Rome V diagnoses were identified using criteria-based syntax and verified by two study team members (TT, JPH). Means with SDs or SEs and percentages were calculated as appropriate. To gauge the global DGBI symptom severity for each child, a sum of the severity score (0–10) for each DGBI was calculated with median (IQR) due to non-normally distributed data.

Prevalence estimates with 95% CIs were calculated overall and by country, age group and sex at birth. Non-overlapping 95% CIs were interpreted as statistically significant at $p<0.05$.[17]

Continuous variables were compared using t tests or analysis of variance, as appropriate. Effect sizes for t-tests were evaluated using Cohen's d (0.2=small, 0.5=medium, 0.8=large).[18] Categorical variables were analysed using χ^2 tests. Effect size was reported as Cramer's V for nominal variables (V effect sizes: 0.10=small, 0.30=moderate and 0.50=large)[19] and Goodman–Kruskal's gamma for ordinal associations[20] (γ effect sizes: 0 to 0.29=small/weak, 0.3 to 0.49=moderate/relatively strong and >0.49=large/strong).[20]

RESULTS

The survey was completed by 8000 female caregivers, of whom 282 were excluded because of data integrity violations. Therefore, 7718 surveys were included in the final analysis (table 1). Caregiver characteristics differed significantly across countries, with higher educational attainment among caregivers in China. Caregiver DGBI prevalence also varied by country, with functional dyspepsia more common in China and IBS more common in the other countries.

Global prevalence

The overall prevalence of DGBI was 28.0% (95% CI 27.0% to 29.0%). The overall prevalence by country is shown in figure 1 and of each diagnosis in tables 2,3 and online supplemental tables 2,3. There were significant differences with prevalences being significantly lower in China and higher in Mexico. Age differences also existed, with a significantly higher prevalence of any DGBI in children 0 to 3 years compared with 11 to 17 years who had a significantly lower prevalence ($p<0.001$). Females also had a significantly higher prevalence of any DGBI as compared with males (figure 2).

We found a mild association between caregiver and child DGBI. Presence of IBS, functional dyspepsia and chronic constipation in the caregivers were each associated significantly with child DGBI, although effect sizes were small: IBS prevalence of 36.4% versus 26.9% with no DGBI 9$p<0.001$, effect size=0.080; functional dyspepsia 938.0% vs 27.7% ($p<0.001$, effect size=0.06); and chronic constipation, 41.4% vs 26.1% ($p<0.001$, effect size=0.12).

Upper DGBI

Overall, 8.7% (95% CI 8.2% to 9.5%) of children met criteria for an upper DGBI (table 2 and online supplemental table 2, figure 1).

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Table 1 Distribution of caregiver demographics by country

Variable	All (n=7718)	China (n=1882)	Italy (n=1969)	Mexico (n=1926)	USA (n=1941)	P V[a]
Relationship to child						
Biological or adoptive parent	7532 (95.3%)	1809 (96.1%)	1919 (97.5%)	1852 (96.2%)	1772 (91.3%)	
Step-parent	42 (0.5%)	1 (0.1%)	8 (0.4%)	8 (0.4%)	25 (1.2%)	< 0.001
Grandparent	176 (2.3%)	50 (2.7%)	4 (0.2%)	17 (0.9%)	105 (5.4%)	0.10
Foster parent	35 (0.5%)	0 (0%)	19 (1.0%)	10 (0.5%)	6 (0.3%)	
Other relative	98 (1.3%)	21 (1.1%)	15 (0.8%)	37 (1.9%)	25 (1.3%)	
Other non-relative	15 (0.2%)	1 (0.1%)	4 (0.2%)	2 (0.1%)	8 (0.4%)	
Age						
18–34	2810 (36.4%)	695 (36.9%)	388 (19.7%)	1174 (61.0%)	553 (28.5%)	
35–44	3201 (41.5%)	966 (51.3%)	859 (43.6%)	573 (29.8%)	803 (41.4%)	< 0.001
45 and older	1707 (22.1%)	221 (11.7%)	722 (36.7%)	179 (9.3%)	585 (30.1%)	0.27
Highest completed education						
Did not finish primary school	32 (0.4%)	0 (0%)	3 (0.2%)	2 (0.1%)	27 (1.4%)	
Finished primary school	191 (2.5%)	45 (2.4%)	78 (4.0%)	16 (0.8%)	52 (2.7%)	< 0.001
Finished high school	2078 (26.9%)	119 (6.3%)	686 (34.8%)	360 (18.7%)	913 (47.0%)	0.32
Graduated from trade school	1114 (14.4%)	145 (7.7%)	284 (14.4%)	414 (21.5%)	271 (14.0%)	
Undergraduate degree	3066 (39.7%)	1409 (74.9%)	319 (16.2%)	900 (46.7%)	438 (22.6%)	
Post-graduate degree	1192 (15.4%)	164 (8.7%)	586 (29.8%)	215 (11.2%)	227 (11.4%)	
Prefer not to say	45 (0.6%)	0 (0%)	13 (0.7%)	19 (1.0%)	13 (0.7%)	
Marital status						
Married	4892 (63.4%)	1852 (98.4%)	1198 (60.8%)	1050 (54.5%)	792 (40.8%)	
Living with a partner	1302 (16.9%)	10 (0.5%)	471 (23.9%)	451 (23.4%)	370 (9.1%)	< 0.001
Widowed	91 (1.2%)	0 (0%)	12 (0.6%)	16 (0.8%)	63 (3.2%)	0.28
Divorced/separated	589 (7.6%)	17 (0.9%)	151 (7.7%)	124 (6.4%)	297 (15.3%)	
Never been married	844 (10.9%)	3 (0.2%)	137 (7.0%)	285 (14.8%)	419 (21.6%)	
Community size						
City (> 50 000 people)	4977 (64.5%)	1758 (93.4%)	935 (47.5%)	1276 (66.3%)	1008 (51.9%)	
Town (2500–50 000 people)	2007 (26.0%)	(100 (5.3%)	891 (45.3%)	437 (22.7%)	579 (29.8%)	< 0.001
Village (< 2500 people)	578 (7.5%)	22 (1.2%)	117 (5.9%)	200 (10.4%)	239 (12.3%)	0.24
Countryside	156 (2.0%)	2 (0.1%)	26 (1.3%)	13 (0.7%)	115 (5.9%)	
Number of children <18 in household						
1	4710 (61.0%)	1780 (94.6%)	1106 (56.2%)	857 (44.5%)	967 (49.8%)	
2	2204 (28.6%)	85 (4.5%)	737 (37.4%)	766 (39.8%)	616 (31.7%)	<0 .001
3 or more	804 (10.4%)	17 (0.9%)	126 (6.4%)	303 (15.7%)	3581 (8.4%)	0.25
Social media use						
Never	96 (1.2%)	8 (0.4%)	48 (2.4%)	4 (0.2%)	36 (1.9%)	
Sometimes	559 (7.2%)	53 (2.8%)	220 (11.2%)	71 (3.7%)	215 (11.1%)	< 0.001
Often	1979 (25.6%)	430 (22.8%)	706 (35.9%)	3932 (0.4%)	450 (23.2%)	0.14
Very often	5084 (65.9%)	1391 (73.9%)	995 (50.5%)	1458 (75.7%)	1240 (63.9%)	
Self-reported history of						
Irritable bowel syndrome	1186 (15.4%)	61 (3.2%)	321 (16.3%)	495 (25.7%)	309 (15.9%)	
Functional dyspepsia	490 (6.3%)	449 (23.9%)	18 (0.9%)	13 (0.7%)	10 (0.5%)	<0 .001
Chronic constipation	1116 (14.5%)	306 (16.3%)	275 (14.0%)	368 (19.1%)	167 (8.6%)	0.22

Cells: n (%) ; Effect size for nominal variables presented as Cramer's *V* (small=0.1, medium=0.3, large=0.5).

Gastroduodenal disorders 6.6% (95% CI 6.1% to 7.2%) were the most common, followed by functional feeding 3.4% (95% CI 3.0% to 3.8%) and oesophageal disorders 0.6% (95% CI 0.4% to 0.8%) (table 2). Significant geographic differences were observed, with the highest prevalence in Mexico and the USA and the lowest in China (table 2, figure 1). Prevalence rates were similar between males and females but declined with age, from 12.3% in children aged 0–3 to 10.4% in those 4–10 years and 7.5% in adolescents aged 11–17 years (figure 2 and online supplemental table 2).

Oesophageal disorders

Overall, oesophageal disorders were rare with all conditions having prevalences below 1%. Reflux disorders (non-reflux oesophageal pain and reflux hypersensitivity) were the most common oesophageal disorders (table 2), followed by supragastric belching and aerophagia. Symptoms consistent with oesophageal disorders were most prevalent in Italy, followed by Mexico, whereas China and the USA had significantly lower rates (table 2, figure 1). Prevalence did not differ by sex or age (figure 2 and online supplemental table 2).

Functional paediatric feeding disorders

The most common FFD was reduced-type hunger dysregulation disorder. Anticipatory restrictive feeding disorder, hypersensitive dysphagia, excessive-type hunger dysregulation disorder and medically triggered feeding disorder each had prevalences below

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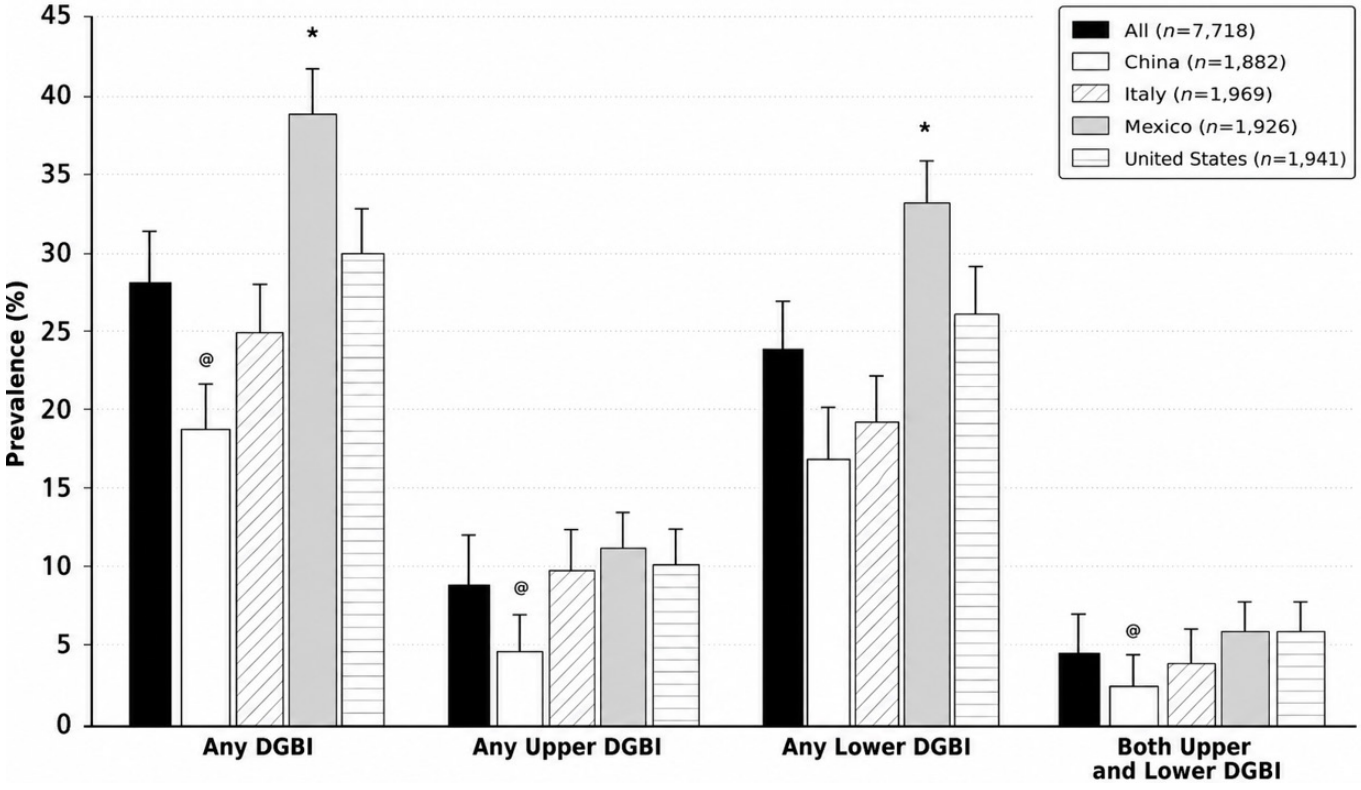

Figure 1 Prevalence of paediatric DGBI by country. Significant differences in prevalence were observed across countries. *Group prevalence rate is significantly higher at p<0.05 level based on non-overlapping 95% CI. [@]Group prevalence rate is significantly lower at p<0.05 level based on non-overlapping 95% CI. DGBI, paediatric disorders of gut–brain interaction.

1% (table 2). Prevalence rates were similar in Italy, Mexico and the USA (approximately 3.7%) but significantly lower in China (table 2, figure 1). No sex differences were observed (online supplemental table 2). As with other upper DGBI, prevalence was highest in children aged 0–3 years and declined significantly with age (figure 2 and online supplemental table 2).

Gastroduodenal disorders

Functional dyspepsia was the most common gastroduodenal disorder, with postprandial distress syndrome (PDS) occurring more frequently than epigastric pain syndrome (EPS) (table 2). Chronic nausea syndrome, cyclic vomiting syndrome and rumination syndrome each had prevalences near 1%, and no child met criteria for cannabinoid hyperemesis syndrome, probably related to under-reporting.[21] Gastroduodenal disorders were most prevalent in Mexico and the USA, slightly lower in Italy and lowest in China (table 2, figure 1). Females were significantly more likely to meet criteria for a gastroduodenal disorder, and prevalence was lower in adolescents than in younger children (figure 2 and online supplemental table 2).

Lower DGBI

In the total sample, 23.7% (95% CI 22.8% to 24.7%) of children met criteria for a lower DGBI (table 3, figure 1). The most common lower DGBI were defecation and anorectal disorders 20.2% (95% CI 19.3% to 21.0%) followed by abdominal pain disorders 4.4% (95% CI 3.9% to 4.9%) and then discomfort disorders 1.8% (95% CI 1.5% to 2.1%) (table 3, figure 1). Children in Mexico had significantly higher rates of lower DGBI (table 3, figure 1). Approximately one-quarter of children in the USA met criteria for a lower DGBI, which was significantly more than in Italy. Children in China had the lowest prevalence of lower DGBI of the four countries. Lower DGBI were more common in female than male children (figure 2 and online supplemental table 3) and were most prevalent in children ages 0–3 years (figure 2 and online supplemental table 3). Prevalence rates significantly declined with increased age, p<0.001 (figure 2 and online supplemental table 3).

Abdominal pain disorders

CAPS, irritable bowel syndrome (IBS) and abdominal migraine were the most common and had similar prevalences (table 3). IBS subtypes were evenly distributed. The prevalence of IBS was 1.5%. Very few children met criteria for abdominal pain not otherwise specified (AP-NOS), and no cases of biliary pain syndrome were identified.

Abdominal pain disorders were most prevalent in Mexico and the USA, followed by China and Italy (table 3, figure 1). No significant sex differences were observed, and prevalence was similar between children aged 4–10 years and 11–17 years (figure 2 and online supplemental table 3).

Defecation and anorectal disorders

Functional constipation was the most common defecation and anorectal disorder at 16.3% (95% CI 15.4% to 17.1%). Low prevalences were found for non-retentive faecal incontinence (2.7%), functional diarrhoea (1.6%) and infant dyschezia (2.2%). Approximately one-third of children in Mexico met criteria for a defecation or anorectal disorder, significantly higher than rates in the USA, Italy and China (table 3, figure 1). No sex differences were observed. Prevalence was highest in children aged 0–3

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Table 2 Global prevalence rates of paediatric upper DGBI using Rome V criteria by country

Upper DGBI					
Diagnosis	**All (n=7718)**	**China (n=1882)**	**Italy (n=1969)**	**Mexico (n=1926)**	**USA (n=1941)**
Oesophageal disorders					
Disorders of air transit					
Aerophagia	0.1% (0.03%–0.2%) n=8	0.3% (0.03%–0.5%) n=5	0%	0.05% (0%–0.2%) n=1	0.1% (0%–0.3%) n=2
Supragastric belching	0.2% (0.08%–0.3%) n=13	0.05% (0%–0.2%) n=1	0.2% (0%–0.4%) n=4	0.2% (0%–0.4%) n=4	0.2% (0%–0.4%) n=4
Non-reflux oesophageal pain disorder	0.3% (0.2%–0.5%) n=26	0.3% (0.06%–0.6%) n=6	0.1% (0%–0.2%) n=2	0.4% (0.09%–0.6%) n=7	0.6% (0.2%–0.9%) n=11
Reflux hypersensitivity	0.3% (0.2%–0.5%) n=26	0.3% (0.06%–0.6%) n=6	0.1% (0%–0.2%) n=2	0.4% (0.09%–0.6%) n=7	0.6% (0.2%–0.9%) n=11
Any oesophageal disorder	**0.6% (0.4%–0.8%)** n=46	**0.6% (0.2%–0.9%)** n=11	**0.3% (0.06%–0.6%)** n=6	**0.6% (0.3%–1.0%)** n=12	**0.9% (0.5%–1.3%)** n=17
Functional paediatric feeding disorders					
Anticipatory restrictive feeding disorder	0.7% (0.5%–0.9%) n=53	0.6% (0.3%–1.0%) n=12	0.6% (0.2%–0.9%) n=11	0.5% (0.2%–0.8%) n=10	1.0% (0.6%–1.5%) n=20
Hunger dysregulation disorder					
Excessive type	0.9% (0.7%–1.1%) n=66	0.6% (0.3%–1.0%) n=12	0.8% (0.4%–1.2%) n=16	0.7% (0.4%–1.1%) n=14	1.2% (0.7%–1.7%) n=24
Reduced type	2.5% (2.1%–2.8%) n=192	1.6% (1.0%–2.2%) n=30	2.9% (2.2%–3.6%) n=57	3.1% (2.3%–3.9%) n=60	2.3% (1.7%–3.0%) n=45
Hypersensitive dysphagia	0.4% (0.3%–0.6%) n=32	0.3% (0.03%–0.5%) n=5	0.5% (0.2%–0.8%) n=9	0.3% (0.06%–0.6%) n=6	0.6% (0.3%–1.0%) n=12
Medically triggered feeding disorder	0.4% (0.2%–0.5%) n=28	0.2% (0%–0.4%) n=4	0.3% (0.06%–0.6%) n=6	0.3% (0.06%–0.6%) n=6	0.6% (0.3%–1.0%) n=12
Any functional feeding disorder	**3.4% (3.0%–3.8%) n=262**	**2.0% L (1.4%–2.7%) n=38**	**3.9% (3.0%–4.7%) n=76**	**4.0% (3.1%–4.9%) n=77**	**3.7% (2.8%–4.5%) n=71**
Gastroduodenal disorders					
Chronic nausea syndrome	0.7% (0.5%–0.9%) n=51	0.4% (0.07%–0.7%) n=10	0.8% (0.3%–1.2%) n=14	0.5% (0.1%–0.9%) n=9	1.0% (0.5%–1.6%) n=18
Cyclic vomiting syndrome (CVS)	1.1% (0.9%–1.4%) n=105	1.1% (0.6%–1.6%) n=24	1.3% (0.8%–1.8%) n=26	1.2% (0.7%–1.7%) n=23	1.7% (1.1%–2.2%) n=32
CVS: cannabinoid hyperemesis	0%	0%	0%	0%	0%
Functional dyspepsia	5.5% (4.9%–6.1%) n=441	2.0% **L** (1.3%–2.7%) n=48	6.3% (5.0%–7.4%) n=122	8.4% (7.0%–9.9%) n=151	5.9% (4.7%–7.0%) n=120
Epigastric pain syndrome	1.5% (1.2%–1.8%) n=101	0.6% (0.2%–1.0%) n=10	1.5% (0.9%–2.1%) n=24	2.5% (1.7%–3.4%) n=41	1.6% (0.9%–2.2%) n=26
Postprandial distress syndrome	4.4% (3.9%–4.9%) n=371	1.5% **L** (0.9%–2.1%) n=39	5.0% (3.9%–6.1%) n=103	6.8% (5.5%–8.2%) n=126	4.8% (3.8%–5.9%) n=103
Rumination	0.7% (0.6%–0.9%) n=57	0.2% (0%–0.3%) n=3	0.6% (0.2%–0.9%) n=11	0.8% (0.4%–1.2%) n=16	1.4% (0.9%–1.9%) n=27
Any gastroduodenal disorder	**7.3% (6.8%–7.9%)** n=566	**3.5% L (2.6%–4.3%)** n=65	**7.7% (6.5%–8.9%)** n=151	**9.2% (7.9%–10.5%)** n=177	**8.9% (7.6%–10.2%)** n=173

H=Group prevalence rate is significantly higher than other groups at p<0.05 level based on non-overlapping 95% CI. L=group prevalence rate is significantly lower than other groups at p<0.05 level based on non-overlapping 95% CI.
DGBI, paediatric disorders of gut–brain interaction.

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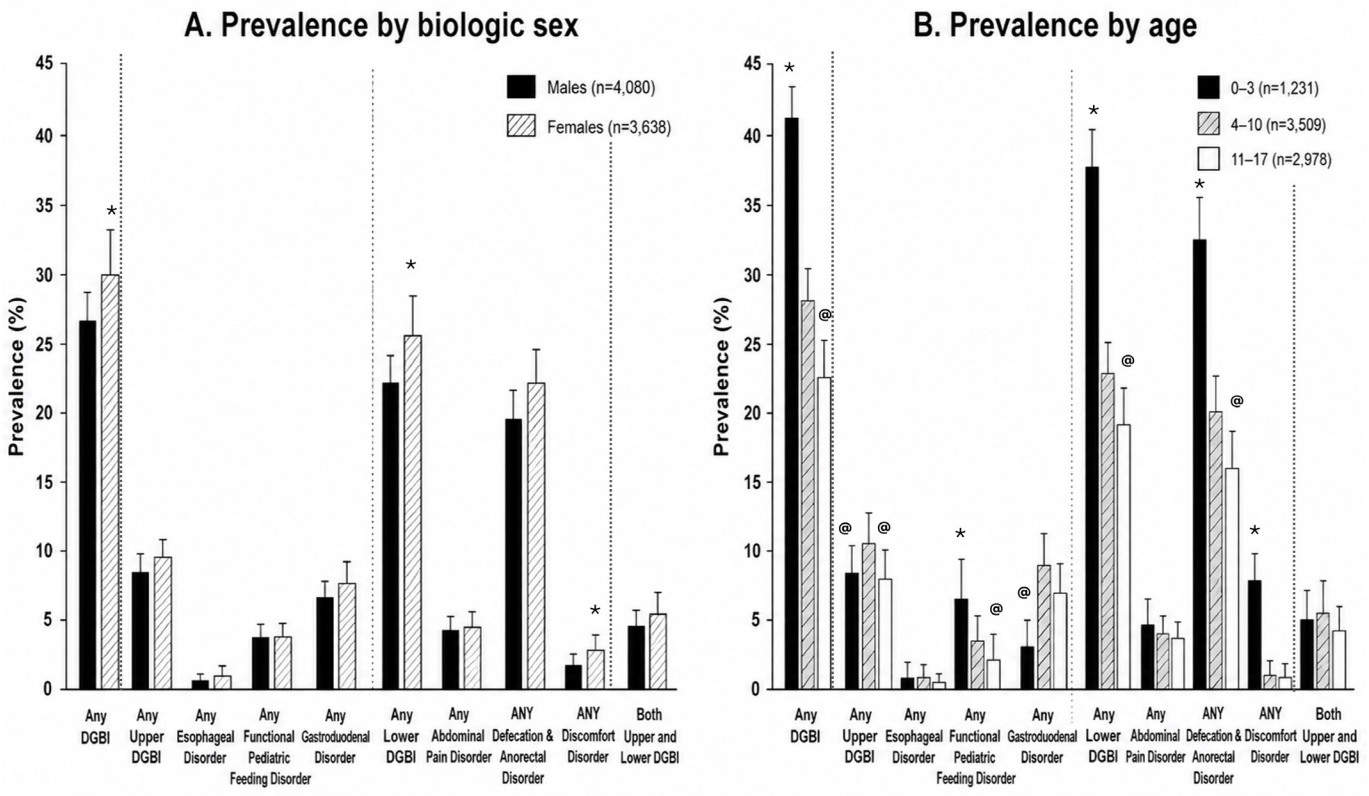

Figure 2 Distribution of DGBI by biological sex and age. (A) Prevalence by biological sex and (B) prevalence by age group. DGBI prevalence was significantly higher in younger children. *Group prevalence rate is significantly higher at p<0.05 level based on non-overlapping 95% CI. @Group prevalence rate is significantly lower at p<0.05 level based on non-overlapping 95% CI. DGBI, paediatric disorders of gut–brain interaction.

years and declined progressively with age (figure 2, and online supplemental table 3).

Discomfort disorders

Functional abdominal bloating affected approximately 1% of children, and infant distress syndrome was the most common discomfort disorder (5.4%) (table 3). Discomfort disorders were most prevalent in China, with similar rates in Italy, Mexico and the USA (table 3, figure 1). Females were more likely than males to meet criteria for a discomfort disorder, primarily because of higher rates of functional abdominal bloating, whereas infant distress syndrome rates were similar between sexes (figure 2, and online supplemental table 3). Functional abdominal bloating was most common in children aged 0–3 years and decreased significantly with age p<0.001 (figure 2, and online supplemental table 3).

Coexisting upper DGBI and lower DGBI

The overall prevalence of coexisting upper and lower DGBI was 4.5% (95% CI 4.1% to 5.0%), with a significantly lower prevalence in China (figure 1). There were no significant differences when comparing children of different ages or biologic sex (figure 2).

Burden of paediatric DGBI

The median global DGBI symptom severity score was 5.0 (IQR=9.0) and ranged from 0 to 120.

Anxiety and depression

Children with DGBI had higher caregiver-reported anxiety and depression than those without DGBI (figure 3). Anxiety and depression differed significantly across DGBI burden categories (χ^2 p=0.001), worse in those with coexisting upper and lower DGBI with strong effect sizes (depression, γ=0.51; anxiety, γ=0.47). DGBI total mean symptom severity scores were significantly higher, with large effect sizes, in children with anxiety (24.3±0.8 vs 8.9±0.1; p<0.001; d=1.35) or depression (27.2±0.9 vs 9.0±0.1; p<0.001; d=1.34) than in those without these symptoms.

Functional disability

Functional impairment was significantly greater in children with DGBI compared with those without DGBI (figure 3). Symptom severity scores also differed significantly according to disability level (none/minimal (9.3±0.1 vs moderate (25.3±1.1) vs severe (19.5±1.6); p<0.01). Functional disability severity differed significantly across DGBI burden categories (χ^2 p=0.001), with a strong effect size (γ=0.45), and was worse in those with coexisting upper and lower DGBI.

Bullying

Children with DGBI were significantly more likely to experience weekly bullying from non-siblings than children without DGBI (p<0.001) (figure 3). Rates were higher in children with upper DGBI as compared with lower DGBI and were highest in those with coexisting upper and lower DGBI. Bullying differed

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Table 3 Global prevalence rates of paediatric lower DGBI using Rome V criteria by Country

Lower DGBI					
Diagnosis	**All n=6123**	**China n=1636**	**Italy n=1601**	**Mexico n=1352**	**USA n=1534**
Abdominal pain disorders (ages 5 and older)					
Abdominal migraine	1.5% (1.2%–1.8%) n=94	1.2% (0.6%–1.7%) n=19	1.1% (0.6%–1.6%) n=17	2.1% (1.3%–2.8%) n=28	2.0% (1.3%–2.7%) n=30
Abdominal pain NOS	0.1% (0.03%–0.2%) n=7	0.2% (0%–0.4%) n=2	0.1% (0%–0.2%) n=1	0.07% (0%–0.2%) n=1	0.2% (0%–0.4%) n=3
Biliary pain syndrome	0%	0%	0%	0%	0%
Centrally mediated abdominal pain syndrome	1.7% (1.4%–2.0%) n=102	1.9% (1.2%–2.6%) n=31	1.3% (0.7%–1.8%) n=20	2.8% (1.9%–3.7%) n=38	0.9% (0.4%–1.3%) n=13
Irritable bowel syndrome (IBS)	1.5% (1.2%=1.8%) n=93	0.8% (0.4%–1.2%) n=13	1.1% (0.6%–1.6%) n=18	1.2% (0.6%–1.8%) n=16	3.0% hour (2.1%–3.9%) n=46
IBS-C	0.5% (0.4%–0.7%) n=39	0.05% (0%–0.2%) n=1	0.4% (0.1%–0.7%) n=8	0.5% (0.2%–0.8%) n=9	1.1% (0.6%–1.5%) n=21
IBS-D	0.2% (0.07%–0.2%) n=12	0.1% (0%–0.3%) n=2	0.1% (0%–0.2%) n=2	0.05% (0%–0.2%) n=1	0.4% (0.09%–0.6%) n=7
IBS-M	0.3% (0.1%–0.4%) n=19	0.2% (0%–0.4%) n=4	0.05% (0%–0.2%) n=1	0.2% (0%–0.3%) n=3	0.6% (0.2%–0.9%) n=11
IBS-U	0.3% (0.2%–0.4%) n=23	0.3% (0.06%–0.6%) n=6	0.4% (0.09%–0.6%) n=7	0.2% (0%–0.3%) n=3	0.4% (0.09%–0.6%) n=7
Any abdominal pain disorder	**4.4% (3.9%–4.9%)** n=264	**3.7% (2.8%–4.6%)** n=59	**3.3% (2.4%–4.2%)** n=53	**5.3% (4.1%–6.4%)** n=71	**5.1% (4.2%–6.4%)** n=81
Defecation and anorectal disorders					
Functional constipation	16.3% (15.4%–17.1%) n=1255	11.6% (10.1%–13.0%) n=218	12.3% (10.9%–13.8%) n=243	24.6% **H** (22.7%–26.5%) n=474	16.5% (14.8%–18.1%) n=320
Functional diarrhoea	1.6% (1.3%–1.9%) n=123	0.1% **L** (0%–0.3%) n=2	1.1% (0.6%–1.5%) n=21	2.7% (2.0%–3.4%) n=52	2.5% (1.8%–3.2%) n=48
Non-retentive faecal incontinence (ages 5 and older)	2.7% (2.3%–3.1%) n=163/6123	1.3% (0.7%–1.8%) n=21/1636	2.4% (1.6%–3.1%) n=38/1601	4.0% (3.0%–5.0%) n=54/1352	3.3% (2.4%–4.2%) n=50/1534
Infant dyschezia (ages 0 to 3)	2.2% (1.4%–3.0%) n=27/1231	2.1% (0.04%–4.1%) n=4/194	2.5% (0.7%–4.3%) n=7/280	1.8% (0.6%–3.0%) n=8/445	2.6% (0.8%–4.3%) n=8/312
Any defecation and anorectal disorder	**20.2% (19.3%–21.0%)** n=1555	**12.9% (11.4%–14.4%)** n=243	**15.4% (13.9%–17.1%)** n=305	**30.3%H (28.3%–32.4%)** n=584	**21.8% (20.0%–23.6%)** n=423
Discomfort disorders					
Functional abdominal bloating	0.9% (0.7%–1.2%) n=73	1.7% (1.1%–2.3%) n=32	1.3% (0.8%–1.8%) n=26	0.4% (0.1%–0.7%) n=8	0.4% (0.09%–0.6%) n=7
Infant distress syndrome (ages 0 to 3)	5.4% (4.2%–6.7%) n=67/1231	3.6% (1.0%–6.3%) n=7/194	3.9% (1.6%–6.2%) n=11/280	5.8% (3.7%–8.0%) n=26/445	7.4% (4.5%–10.3%) n=23/312
Any discomfort disorder	**1.8% (1.5%–2.1%)** n=140	**2.1% (1.4%–2.7%)** n=39	**1.9% (1.3%–2.5%)** n=37	**1.8% (1.2%–2.4%)** n=34	**1.6% (1.0%–2.1%)** n=30

Hgroup prevalence rate is significantly higher than other groups at p<0.05 level based on non-overlapping 95% CI. L=group prevalence rate is significantly lower than other groups at p<0.05 level based on non-overlapping 95% CI.
DGBI, paediatric disorders of gut–brain interaction.

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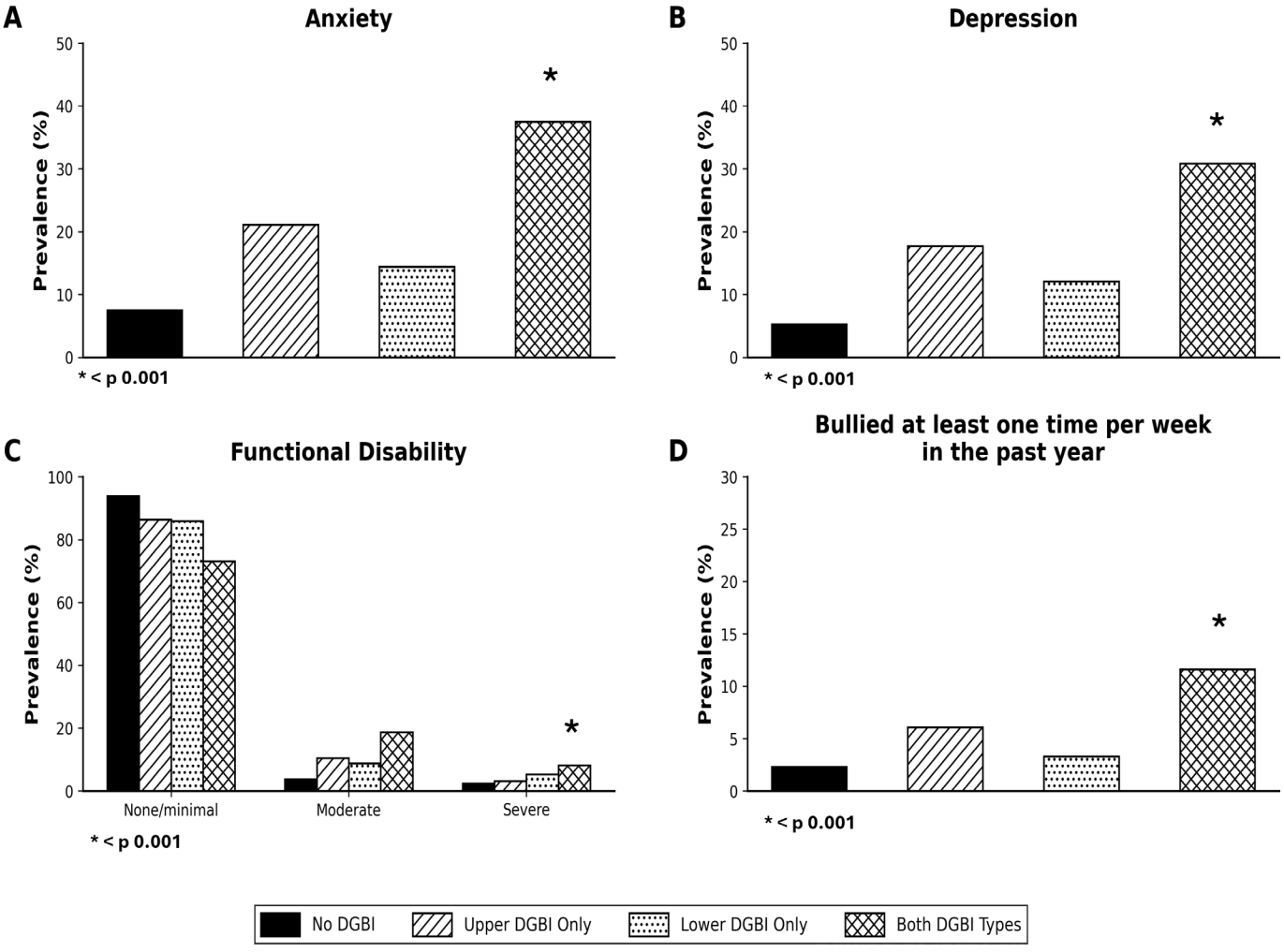

Figure 3 Mental health and functional outcomes by DGBI status. DGBI were significantly associated with anxiety, depression and disability, particularly among children with both upper and lower DGBI; * p<0.001. DGBI, paediatric disorders of gut–brain interaction.

significantly across DGBI burden categories (χ^2 p=0.001), with a moderate effect size (γ=0.39).

Healthcare burden

Children with a DGBI were significantly more likely to have seen a doctor for digestive symptoms, particularly those with coexisting upper and lower DGBI. The time caregivers spent providing or coordinating healthcare is shown in figure 4. There was a significantly greater amount of time spent in those with a DGBI, particularly with coexisting upper DGBI/lower DGBI (p<0.001), with moderate effect sizes for both home care (γ=0.37) and coordinating medical care (γ=0.41).

DISCUSSION

This is the first large global paediatric study aimed at establishing the prevalence and impact of paediatric DGBI in the general population, and the first using the newly revised Rome V Paediatric criteria. We found an overall multinational prevalence of approximately 30%, with a higher prevalence of lower DGBI, with significant differences between countries. The present study is also the first to evaluate the epidemiology of newly introduced disorders, like the oesophageal, functional feeding and new pain disorders, providing important insights into their prevalence, impact and implications for treatment. Furthermore, we found that the presence of DGBI was significantly associated with higher rates of anxiety and depression, increased bullying at school, greater functional disability and healthcare burden. These associations were particularly pronounced in children with coexisting upper and lower DGBI, a finding that has not been previously described.

The overall prevalence of DGBI was broadly consistent with prior Rome IV estimates of 10%–40%. However, our estimates are more robust because this simultaneous, multinational, community-based study included a larger unselected sample across the full paediatric age spectrum, used harmonised methods, incorporated newly defined Rome V diagnoses and assessed comorbidities and healthcare burden.[1–5 9 10 12]

Prevalence estimates for disorders with largely unchanged criteria were similar to prior reports,[1–5] supporting the good performance of the Rome V paediatric questionnaire: constipation 16.3% versus 14.1%–14.9% previously,[12 22] functional dyspepsia 5.5% versus 4.3%–6.0%,[12 22 23] EPS 1.5% versus 1.01%, PDS 4.4% versus 3.6%,[23] abdominal migraine 1.5% as previously reported,[22] infant distress syndrome 5.4% versus 5.2%%[12] and cyclic vomiting syndrome 1.1% versus 2.0%.[12]

In contrast, and as expected, revised diagnostic definitions or newly introduced diagnoses, particularly IBS, AP-NOS and functional diarrhoea, showed important changes in prevalence. IBS prevalence decreased from previously reported rates of 5%–6%[5 23] to 1.5%. This decrease may be explained, in part, by

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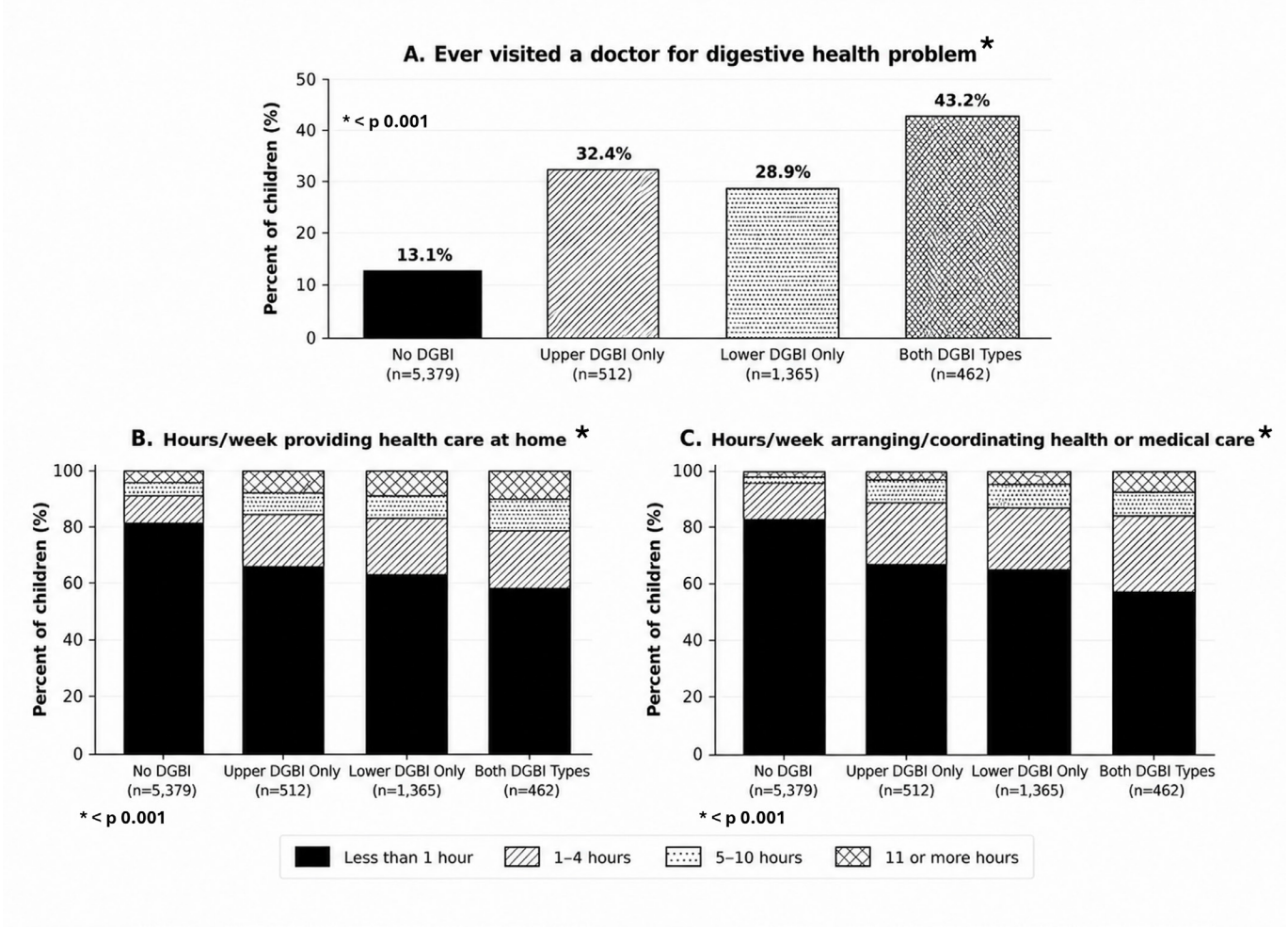

Figure 4 Family burden of paediatric DGBI. Increased healthcare utilisation and greater time spent by families providing care was seen in children with DGBI; * p<0.001. DGBI, paediatric disorders of gut–brain interaction.

the requirement in Rome V that abdominal pain and symptoms should not occur exclusively during menstruation, as this may represent dysmenorrhoea rather than IBS; in our cohort, 20% of females with frequent abdominal pain met this exclusion but would previously have been classified as having IBS. The lower IBS prevalence may also reflect other Rome V changes, including the recognition that some patients previously classified as having IBS may now meet criteria for CAPS, and the requirement that, in children with constipation and abdominal pain, IBS should be diagnosed only when abdominal pain is the predominant symptom.[10 24]

The prevalence of AP-NOS decreased markedly to 0.1%, from previous estimates of 3.1%[12 23] probably secondary to the addition of CAPS.[10] Functional diarrhoea also increased to 1.6%, from previous estimates of 0.01%,[12] confirming that it occurs in children older than 4 years, which may potentially help reduce unnecessary diagnostic testing.[25] The overall prevalence of having at least one DGBI also increased, occurring in up to 28.4% of patients compared with previous estimates of approximately 24% in similar studies. This increase largely reflects better methodology and the inclusion of additional Rome V entities, despite the elimination of infant regurgitation.[6 9]

Rome V introduced new disorders, including FFD, oesophageal disorders, CAPS and biliary pain, broadening the paediatric DGBI spectrum.[9 10] Feeding problems are common in children, but prior studies often grouped structural and functional disorders together.[26 27] Rome V provides greater diagnostic granularity for FFD,[9 28] which have traditionally been classified under broader terms such as avoidant/restrictive food intake disorder or paediatric feeding disorders.[29] In this study, FFD were identified in 3.4% of children; reduced-type hunger dysregulation was the most common disorder, while anticipatory restrictive feeding disorder had a prevalence of 0.7%. Although restrictive eating behaviours are common in childhood, previous prevalence estimates were largely derived from eating disorder clinic populations,[30] so our findings provide one of the first population-based multi-national estimates of FFD and anticipatory restrictive feeding disorders and highlight the importance of improved classification to optimise management and treatment.

Oesophageal disorders were identified, supporting their inclusion within paediatric DGBI, although definitive prevalence is difficult to establish without diagnostic testing. Many children had symptoms possibly consistent with functional heartburn or reflux-negative oesophageal pain disorder, underscoring the need to recognise these conditions and avoid unnecessary acid-suppressive therapy.[31]

Another major Rome V change was the addition of CAPS, reflecting central sensitisation and improving classification of patients previously labelled as AP-NOS.[10] CAPS was identified in 1.7% of children, while AP-NOS prevalence decreased markedly.[12 23] This finding confirms the severity of pain in some

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children and highlights the need for earlier, more intensive interventions, including neuromodulation.[32 33]

Although no comparable paediatric population studies have assessed the new disorders, prevalence was similar to a paediatric study using modified adult Rome IV criteria for functional heartburn, functional dysphagia and biliary pain; however, functional diarrhoea was more common in our cohort, as expected by the expansion in age requirements.[34]

The present study also provides insight into differences in DGBI prevalence by biological sex, age and geographic region. Females had a significantly higher prevalence of gastroduodenal, lower gastrointestinal and discomfort disorders. These differences likely reflect interactions among visceral sensitivity, hormonal factors, gut-brain axis reactivity and psychosocial influences, particularly after puberty.[32] Interestingly, and different from previous studies, the IBS prevalence in the present cohort did not differ significantly between sexes, likely reflecting changes introduced in the Rome V criteria, although IBS-D was less common in females. More in depth studies to understand the relationship between the menstrual cycle and IBS are needed.

Younger children had a significantly higher overall prevalence of DGBI across nearly all categories, particularly feeding, defecation and discomfort disorders. This contrasts with prior reports of similar prevalence across age groups[35 36] and highlights the importance of standardised methodology across the full paediatric age continuum. The higher prevalence in younger children likely reflects developmental vulnerability of the gut–brain axis, ongoing gastrointestinal maturation, acquisition of developmental skills and greater environmental and caregiver influences.[32]

A major strength of this study is its simultaneous conduct in four countries with diverse geographic, cultural and socioeconomic backgrounds, using harmonised Rome V criteria and methodology. We found marked geographic variation in paediatric DGBI prevalence, with the lowest rates in China and the highest in Mexico, while Italy and the USA were similar. A previous study in Mexican school-aged children also reported a high prevalence of DGBI using Rome III criteria,[37] supporting the robustness of our findings. Furthermore, previous studies have also reported lower constipation prevalence in Chinese children,[38] but our findings suggest that this may extend across DGBI more broadly. Lower rates of DGBI in China are likely multifactorial and there may be due to environmental and cultural factors including differences in symptom reporting.[38]

Therefore, the present findings reinforce global variation in paediatric DGBI prevalence[5] and highlight the need to clarify the related factors underlying these differences.[32 37–39] Maternal DGBI may influence paediatric DGBI prevalence and recognition through shared biologic, environmental, psychosocial and reporting pathways. Prior population studies have shown that children are more likely to meet criteria for a DGBI when their mother also has a DGBI[12 39] as observed in the present study. Thus, multiple biologic, environmental, dietary, microbiome, cultural and healthcare-related factors may explain differences between countries.

Parental education and socioeconomic status may also influence paediatric DGBI prevalence and recognition.[40 41] In our cohort, caregiver educational level was higher in China. In fact, some studies have linked lower parental education and socioeconomic disadvantage with functional constipation or abdominal pain disorders, although findings are inconsistent,[41] suggesting that education may interact with diet, toileting practices, health literacy, stress and healthcare-seeking behaviour rather than acting as an isolated determinant. Understanding these factors may provide insights into DGBI pathophysiology and inform prevention strategies, culturally tailored interventions and global management approaches.

Another strength of this study is its assessment of the global impact of paediatric DGBI. Children with DGBI had higher rates of anxiety, depression and functional disability, with the greatest psychosocial burden among those with coexistent upper and lower DGBI. This supports prior evidence that overlapping DGBI are associated with more severe symptoms, greater disability and poorer quality of life[42] and suggests gut–brain axis dysregulation beyond a single gastrointestinal region.[43] These findings highlight the need for targeted multidisciplinary interventions and better support for affected children and families.

Having a child with DGBI significantly affects family functioning, emotional well-being, school attendance, social functioning, finances and caregiver quality of life.[44] Our study quantifies this burden, showing greater healthcare use and caregiving time among families of affected children, particularly those with lower DGBI and coexistent upper and lower DGBI. Physician visits nearly doubled, reaching almost 50% among children with coexistent upper and lower DGBI. These findings highlight the need for greater family support and studies evaluating targeted family interventions.

There are several limitations to the study. First, the Rome V questionnaire has not yet been formally validated against physician-established clinical diagnoses. However, its development closely mirrored that of the Rome IV paediatric questionnaires, which accurately identified DGBI compared with physician assessment,[45] and in addition, the Rome V findings were consistent with prior existing literature.[12 22 23 34] Second, the study relied on caregiver-reported questionnaires completed at home rather than physician interviews. Although this approach reflects real-world symptom reporting and large population-based sampling, it may have introduced reporting and recall bias, as well as cultural differences in symptom interpretation and healthcare-seeking behaviour. However, the use of structured questionnaires, clearly defined recall periods and standardised data collection can help mitigate this bias.[46] Third, surveys were completed only by female caregivers, so male household perspectives were not captured. Although mothers' and fathers' proxy reports are often correlated, they may not be interchangeable, and maternal reports may align more closely with child self-report in some cohorts, but that has not been a universal finding.[47 48] Using only female caregivers might have also added some biases, as females are more likely to have DGBI, which may change their threshold for reporting symptoms. Fourth, patients and caregivers were not involved in the design of the questionnaire, so it is not possible to know if there were any issues regarding perception or comprehension.

Fifth, many of these disorders may require testing to make an exact diagnosis (like the oesophageal and FFD), so the present survey results represent an estimated prevalence based on symptoms.[9] Further studies will be needed to validate these findings as testing may not always be available. Sixth, the cross-sectional design precludes conclusions regarding causality or the natural history of DGBI. Although significant associations were identified with anxiety, depression, bullying, disability and healthcare burden, the temporal relationships between these factors cannot be determined. Longitudinal studies are needed to better understand the symptom evolution and the influence of psychosocial and environmental factors over time. Finally, although the study included countries from multiple world regions, it does not fully represent all geographic, ethnic, socioeconomic and cultural populations. Additional studies from under-represented regions,

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particularly Africa, the Middle East, other parts of Asia and Latin America, are needed to further characterise the global epidemiology of paediatric DGBI.

Despite these limitations, this study represents the first large multinational population-based study of paediatric DGBI using Rome criteria and provides important new insights into their prevalence, distribution, overlap and burden across different regions of the world. Our findings demonstrate the substantial global burden and heterogeneity of Rome V paediatric DGBI across ages, sexes, gastrointestinal regions and countries. Importantly, DGBI affect nearly one-third of children worldwide, show meaningful geographic variation and are associated with significant burden for children, families and healthcare systems. By incorporating newly defined Rome V disorders, this study provides a more comprehensive framework for paediatric DGBI and establishes a foundation for future clinical, translational and public health research.

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Patient and public involvement Patients and/or the public were not involved in the design, conduct, reporting or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involved human participants, but Protocol deemed to be exempt by the IRB at Boston Children's Hospital IRB-P00048891 because the participants were anonymised and unidentifiable. All survey participants completed an electronic informed consent form prior to being presented with the study survey. Participants gave informed consent to participate in the study before taking part.

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Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information.

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