

BMJ Open A randomised, participant- and assessor-blinded, sham-controlled trial investigating acupuncture for disorders of gut–brain interaction in children (P-GAP)

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ABSTRACT

Background Disorders of gut–brain interaction (DGBIs) affect approximately 25% of children worldwide and account for a substantial proportion of paediatric gastroenterology consultations. These conditions are associated with significant morbidity, including chronic pain, school absenteeism, anxiety and reduced quality of life. Current treatment options offer limited efficacy, particularly in paediatric populations. Acupuncture, a widely used complementary therapy, has shown promise in adult DGBIs; however, high-quality evidence in children is lacking. The Paediatric Gut–Brain Acupuncture Protocol aims to evaluate the efficacy and safety of acupuncture in paediatric patients with DGBIs.

Methods and analysis This randomised, participant-blinded and assessor-blinded sham-controlled trial will enrol 96 children aged 8–17 years with a diagnosis of DGBIs defined by Rome IV criteria. Participants will be randomised 1:1 to receive either standardised acupuncture or sham acupuncture one time per week for 8 weeks. The primary outcome is adequate pain relief, defined as $\geq 30\%$ reduction in mean abdominal pain severity on the 11-point Numerical Rating Scale from baseline to follow-up at weeks 12–14. Secondary outcomes include change in mean abdominal pain severity, pain frequency, Rome IV diagnostic status, health-related quality of life, psychological well-being and safety. Outcomes will be assessed at baseline, weeks 4 and 8 during treatment and at post-treatment follow-up at weeks 12–14. Analyses will follow the intention-to-treat principle.

Ethics and dissemination This study has been approved by the Institutional Review Board at Children's Hospital of Orange County. Written informed consent and assent will be obtained from parents/guardians and participants, respectively. Findings will be disseminated through peer-reviewed publications and presentations at scientific conferences.

Trial registration number NCT07435610.

INTRODUCTION

Disorders of gut–brain interactions (DGBIs) are highly prevalent in children, affecting up to 25% of the paediatric population worldwide.¹ In the USA, these conditions account for up to 50% of paediatric gastroenterology

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ The randomised, participant-blinded and assessor-blinded, sham-controlled trial design enables rigorous evaluation of acupuncture in paediatric disorders of gut–brain interaction.
- ⇒ Use of validated paediatric outcome measures enables comprehensive assessment of clinical, functional and psychological outcomes.
- ⇒ The standardised acupuncture protocol enhances reproducibility and internal validity across participants.
- ⇒ The single-centre design may limit generalisability of findings.
- ⇒ Study duration may be insufficient to assess long-term treatment effects.

clinic visits.² DGBIs, which include functional abdominal pain, irritable bowel syndrome (IBS), functional dyspepsia and others, are characterised by chronic gastrointestinal symptoms without identifiable structural or biochemical abnormalities.¹ The pathophysiology of DGBIs is multifactorial, involving altered gut motility, visceral hypersensitivity, immune dysregulation and central nervous system processing of pain.³ Children with DGBIs experience significantly lower quality of life (QoL) compared with both healthy peers and those with organic gastrointestinal disorders.⁴ These conditions are a leading cause of school absenteeism⁴ and frequently persist into adulthood.⁵ In addition to gastrointestinal symptoms, paediatric patients often experience psychological comorbidities such as anxiety and depression, contributing to functional disability and increased healthcare utilisation.^{4,6}

Management of paediatric DGBIs remains challenging because of limited effective treatment options. First-line approaches typically include dietary and lifestyle modifications;

however, many patients continue to experience persistent symptoms.⁷ Pharmacological therapies, including antidepressants, are often used off label and may be associated with adverse effects.⁸ More recently, percutaneous electrical nerve field stimulation has been introduced as a potential therapeutic option and has demonstrated efficacy in modulating autonomic function and reducing visceral hypersensitivity.^{9 10} Recent high-quality systematic reviews have highlighted variability in the quality and certainty of evidence supporting existing treatments.^{7 8 11 12} These findings have informed the development of the first international guidelines for paediatric DGBIs; however, notably, no recommendations could be made regarding alternative or integrative therapies because of the absence of adequately designed studies.^{13–15} Interpretation of paediatric DGBI trials is further limited by inconsistent reporting of care-context factors, including usual care, intercurrent therapies, rescue treatments and healthcare contact intensity, which may affect generalisability and comparability across studies.

Acupuncture, an ancient therapeutic modality rooted in traditional Chinese medicine, is increasingly used in paediatric populations for conditions such as chronic pain and anxiety.¹⁶ Evidence from adult and limited paediatric studies suggests that acupuncture may improve gastrointestinal symptoms and overall well-being.¹⁷ Proposed mechanisms include modulation of central and peripheral nervous system activity, promotion of endogenous neurotransmitter release (eg, endorphins and serotonin), regulation of gastrointestinal motility and attenuation of inflammatory pathways.¹⁸ Additionally, acupuncture may influence the gut–brain axis by reducing stress and anxiety, which are known contributors to DGBIs.¹⁹

Despite these promising findings, high-quality randomised controlled trials evaluating acupuncture in paediatric DGBIs are lacking, particularly those using standardised treatment protocols and rigorous sham controls.²⁰ Prior paediatric DGBI trials are also limited by inconsistent reporting of care-context factors, such as care history before randomisation, intercurrent therapies, usual care, rescue treatments, retention rules and healthcare contact intensity, which may affect generalisability and comparability across studies.²¹ To address this gap, we designed the Paediatric Gut–Brain Acupuncture Protocol (P-GAP), a randomised, participant-blinded and assessor-blinded, sham-controlled clinical trial evaluating the efficacy and safety of a standardised acupuncture intervention in paediatric patients with DGBIs. The primary objective of P-GAP is to determine whether acupuncture reduces pain severity in children aged 8–17 years compared with sham acupuncture following 8 weeks of treatment. Secondary objectives include evaluating changes in mean abdominal pain severity, pain frequency, Rome IV diagnostic status, QoL, functional disability, anxiety and depression, as well as assessing the safety and tolerability of the intervention. This design represents one of the first rigorously controlled evaluations of acupuncture in paediatric DGBIs and aims to

establish a methodological framework for future trials in integrative paediatric gastroenterology.

METHODS AND ANALYSIS

Primary objectives

The primary objective of P-GAP trial is to determine whether standardised acupuncture, compared with sham acupuncture, increases the proportion of paediatric patients with DGBIs achieving clinically meaningful pain relief defined as $\geq 30\%$ reduction in mean abdominal pain severity on the 11-point Numerical Rating Scale (NRS), from baseline to follow-up at weeks 12–14. Secondary objectives include evaluating effects of acupuncture on change in mean abdominal pain severity, pain frequency, Rome IV diagnostic status, health-related QoL and psychological well-being, and the safety of the intervention over the study period.

Trial design

P-GAP is a prospective, randomised, placebo (sham)-controlled, participant-blinded and assessor-blinded superiority trial. The trial evaluates the efficacy and safety of acupuncture in paediatric patients with DGBIs. Participants will be recruited from gastroenterology clinics at Rady Children's Health in Orange County (RCHOC) and randomised 1:1 to standardised acupuncture or sham acupuncture.

The study includes a screening and run-in phase to confirm eligibility and establish baseline symptoms, followed by an 8-week treatment phase with weekly sessions and a post-treatment follow-up to assess efficacy, tolerability and durability of response. This is a participant-blinded and assessor-blinded trial. The acupuncturist and methodologist responsible for central allocation (non-participant-facing) will be unblinded; all other personnel, including outcome assessors and statisticians, will remain blinded. An overview of the trial workflow is provided in figure 1. The protocol was developed in accordance with the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) statement to support transparent reporting of study design and procedures.²²

Study setting and participants

This study will enrol 96 participants aged 8–17 years with functional abdominal pain disorders, including functional abdominal pain–not otherwise specified (FAP-NOS), IBS and abdominal migraine, defined according to Rome IV criteria. Participants will be recruited from Paediatric Gastroenterology clinics at RCHOC and affiliated outpatient sites. Acupuncture treatments will be delivered at an affiliated integrative health facility by licensed practitioners trained in the standardised study protocol.

Inclusion criteria

1. Age 8–17 years

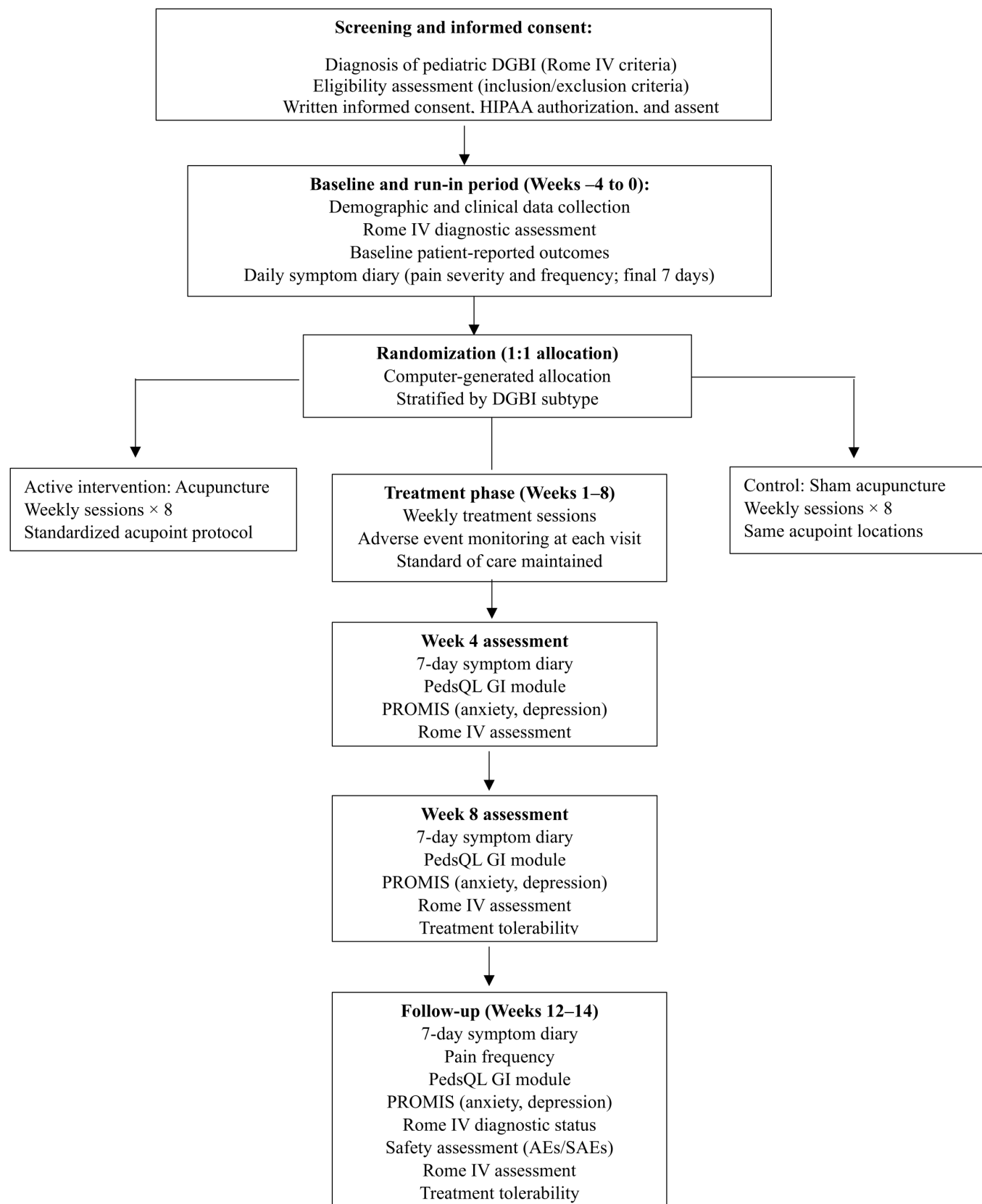


Figure 1 Study design and timeline of the randomised, sham-controlled P-GAP trial in paediatric disorders of gut-brain interaction (DGBIs). Participants undergo screening and baseline assessment, followed by 1:1 randomisation to standardised or sham acupuncture, an 8-week treatment phase with interim assessments (weeks 4 and 8) and post-treatment follow-up. Sham participants are offered crossover to active treatment after follow-up. AEs, adverse events; DGBI, disorders of gut-brain interaction; GI, gastrointestinal; HIPAA, Health Insurance Portability and Accountability Act; PedsQL, Paediatric Quality of Life Inventory; PROMIS, Patient-Reported Outcomes Measurement Information System; SAEs, serious adverse events.

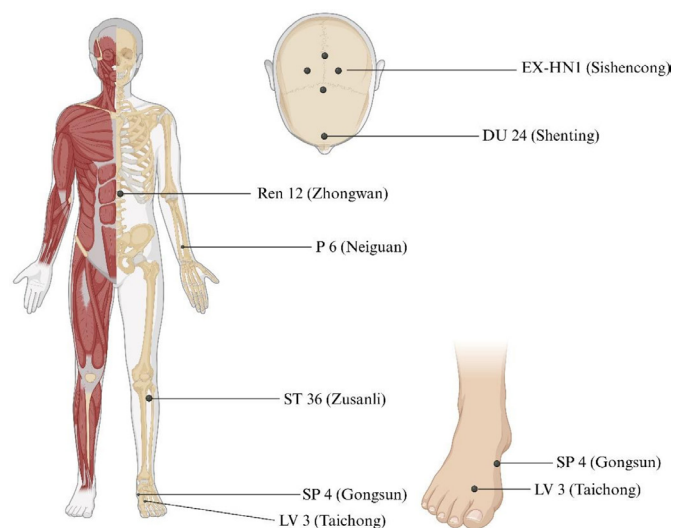


Figure 2 Schematic of acupoint locations. Participants receive either standardised acupuncture or sham acupuncture one time per week for 8 weeks, delivered by licensed acupuncturists trained in the study protocol. Created with BioRender.com. DU, Governor Vessel; EX-HN1, extra point HN1; LV, liver; P, pericardium; SP, spleen; ST, stomach.

2. Diagnosis of FAP-NOS, IBS or abdominal migraine (Rome IV criteria; partial criteria permitted)
3. Stable use (≥ 8 weeks) of antidepressant and/or attention-deficit/hyperactivity disorder medications, if applicable
4. Functional constipation, if present, controlled on maintenance therapy
5. Ability of participant and caregiver to comply with study procedures

Exclusion criteria

1. Prior treatment with IB-Stim, acupuncture or other auricular/percutaneous nerve field stimulation modalities.
2. Diagnosis of functional dyspepsia.
3. Untreated constipation at screening.
4. Use of ketamine, opioids, antibiotics or probiotics within 2 weeks prior to treatment initiation

Interventions

Participants will receive either standardised acupuncture or sham acupuncture one time per week for 8 weeks. All treatments will be delivered by licensed acupuncturists trained in the study protocol at an affiliated integrative health facility. A schematic of acupoint locations and sham device application is shown in [figure 2](#).

Adherence will be defined as completion of at least six of eight treatment sessions. Treatment delivery and attendance will be documented using standardised session logs.

Randomisation and blinding

Participants will be randomised 1:1 to active or sham acupuncture.²³ Randomisation will be performed by a study methodologist using a computer-generated

permuted block scheme, stratified by functional abdominal pain disorder diagnosis including IBS, FAP-NOS and abdominal migraine. Allocation will be concealed, and the methodologist (non-participant-facing) will assign participants centrally following consent/assent. Treatment assignments will be communicated only to the acupuncturist via secure methods. The acupuncturist and the methodologist will be the only unblinded team members; all other personnel (investigators, coordinators, outcome assessors and analysts) will remain blinded.

This is a participant-blinded and assessor-blinded trial. Blinding will be maintained using Park Sham Acupuncture Devices, which mimic needle insertion without skin penetration and are indistinguishable to acupuncture-naïve participants.²⁴ Parents will not be present during treatment sessions, and participants and caregivers will be informed only that two types of acupuncture are being compared. To minimise performance bias related to the unblinded acupuncturist, treatment sessions will be standardised across groups with respect to session duration, treatment environment, procedural steps and practitioner-participant interaction. A standardised script and standardised practitioner language will be used to ensure consistent communication across treatment arms, avoid influencing participant expectations and reduce the risk of unintentional allocation disclosure. At the end of the intervention period, participants will be asked to guess whether they received active acupuncture, sham acupuncture, or were unsure and to rate their confidence in this guess using a 5-point Likert scale. Participants will also be asked whether they perceived needle penetration during treatment. Responses will be summarised by treatment arm and reported with the trial findings. If participant responses indicate reduced blinding credibility, this will be considered when interpreting treatment effects. Where appropriate, exploratory sensitivity analyses will be conducted to assess whether primary outcome findings are consistent after accounting for participants' allocation guesses and confidence ratings.²⁵ Unblinding will occur only if required for participant safety and will be documented. Final unblinding will occur after completion of all follow-up assessments. Participants may be informed of their allocation on request.

Active arm

The active intervention consists of a standardised acupuncture protocol for functional abdominal pain disorders. Seven acupoints will be used consistently across all sessions: ST36 (Zusanli), LV3 (Taichong), REN12 (Zhongwan), PC6 (Neiguan), SP4 (Gongsun), EX-HN1 (Sishencong) and DU24 (Shenting).²⁶ These acupoints were selected based on traditional acupuncture indications, clinical evidence in functional gastrointestinal disorders, preclinical data on stress-related IBS mechanisms and neuroimaging studies suggesting that acupuncture may modulate brain regions involved in pain and emotional processing, consistent with the gut-brain axis pathophysiology of DGBIs.^{27–32} Sterile, single-use needles

will be inserted at predefined depths appropriate for each acupoint and retained for approximately 40 min per session. All procedures will follow the clean needle technique and manufacturer guidelines.³³ Detailed acupoint locations are provided in [figure 2](#).

Sham control arm

The control group will receive non-penetrating stimulation at the same anatomic locations using sterile, single-use Park Sham Acupuncture Devices, which mimic the appearance and tactile sensation of needle insertion without penetrating the skin. These devices have been validated for maintaining participant blinding in acupuncture randomised controlled trials.²⁴

Outcome

Primary outcome

1. Adequate pain relief: the primary outcome is the proportion of participants achieving adequate pain relief, defined as a $\geq 30\%$ reduction from baseline in mean abdominal pain severity on the 11-point NRS from baseline to follow-up at weeks 12–14. This threshold reflects the Rome Foundation's definition of clinically meaningful improvement in paediatric functional abdominal pain disorders.³⁴

Secondary outcomes

1. Pain severity: pain intensity will be measured using the 11-point NRS (0=no pain, 10=worst pain).³⁵ Participants will record daily NRS scores during the baseline run-in period and at weeks 4–5, 8–9 and 12–14. For each timepoint, pain severity will be defined as the means of daily scores recorded over the final 7 days. Change in mean pain severity will be evaluated from baseline to follow-up at weeks 12–14.
2. Pain frequency: participants will record the number of pain episodes using daily symptom diaries.³⁶ Outcomes will be defined as the mean number of episodes recorded over the final 7 days of each assessment period, including baseline and follow-up assessment at weeks 12–14.
3. Rome IV diagnostic classification: DGBI status will be assessed using Rome IV questionnaires at baseline and at weeks 4, 8 and 12–14. Changes in whether participants meet Rome IV criteria for specific DGBIs will be evaluated over time.³⁷
4. Health-related QoL: this will be measured using the Paediatric Quality of Life Inventory (PedsQL) Gastrointestinal Symptoms Module at baseline and at weeks 4, 8 and 12–14.³⁸
5. Psychological well-being: anxiety and depressive symptoms will be measured using the PROMIS Paediatric Anxiety and Depression Scales at baseline and at weeks 4, 8 and 12–14.³⁹
6. Safety and serious adverse events (SAEs): safety will be assessed based on the incidence, severity and relatedness of AEs, classified using the Common Terminology Criteria for Adverse Events (CTCAE v5.0). SAEs will be

reviewed and reported in accordance with institutional requirements.

Study procedures

Recruitment

Participants will be recruited from outpatient clinics at RCHOC, including paediatric gastroenterology and integrative health services. Eligible patients will be identified during routine clinical visits by treating providers based on the study criteria. For participants not under the care of the principal investigator, the initial approach will be by the treating provider or clinic staff. With permission, the research team will follow up to provide study information and complete the consent and assent process. An example participant informed consent form is provided as online supplemental file 1.

A total of 96 participants will be randomised in a 1:1 ratio in this single-centre trial. Recruitment is expected over 18–24 months. The study consists of three phases: a screening and baseline run-in period (weeks –4 to 0), an 8-week treatment phase (weeks 1–8) and a post-treatment follow-up assessment conducted at weeks 12–14. Assessments occur at baseline and at week 4, week 8 and follow-up. The study design is summarised in [figure 1](#).

Screening and baseline run-in period (weeks –4 to 0)

After informed consent, assent (when applicable) and HIPAA authorisation are obtained, participants will undergo screening to confirm eligibility and provide demographic and clinical information. Rome IV diagnostic criteria will be assessed by study clinicians at baseline. Participants will complete a 4-week run-in period during which they continue standard care. During the final 7 days, participants will record daily pain severity and pain frequency and complete the PedsQL Gastrointestinal Symptoms Module and PROMIS Paediatric Anxiety and Depression Scales. This period serves to establish baseline symptom stability prior to randomisation.

Treatment phase (weeks 1–8)

During the week 1 visit, eligibility will be reconfirmed and participants will be randomised (1:1) to active or sham acupuncture. Participants will receive one treatment session per week for 8 weeks. Outcome assessments will be conducted at predefined intervals. Prior to weeks 4 and 8, participants will complete a 7-day symptom diary and validated questionnaires (PedsQL Gastrointestinal Symptoms Module, PROMIS). Rome IV status will be reassessed at these timepoints. AEs will be monitored at each treatment visit.

Follow-up phase (weeks 12–14)

A post-treatment evaluation will be conducted approximately 4 weeks after the final session. Participants will complete 7-day symptom diaries, PedsQL, PROMIS and treatment tolerability assessments. Rome IV diagnostic status and safety outcomes will also be evaluated. This visit may be conducted remotely unless in-person assessment is clinically indicated.

Table 1 Schedule of enrolment, interventions and assessments. Overview of study procedures and outcome assessments across all study phases in accordance with Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) guidelines

Visit windows	Trial period										
	Screening/ enrolment		Post-randomisation								Follow-up
	-30 days to 0	Day 0	Week 1 (±3 days)	Week 2/ day 7 (±3 days)	Week 3/ day 14 (±3 days)	Week 4/ day 21 (±3 days)	Week 5/ day 28 (±3 days)	Week 6/ day 35 (±3 days)	Week 7/ day 42 (±3 days)	Week 8/ day 49 (±3 days)	Week 12/day 77 (-3 days/±14 days)
Enrolment											
Eligibility screen	X										
Informed consent	X										
Medical history	X										
Con/Meds	X										
				X						X	
Vital signs	X										
Randomisation		X									
Intervention/comparator											
Active acupuncture			X							X	
Park sham acupuncture			X							X	
Assessments											
Numerical rating scale daily for 7 days	X					X				X	X
Pain frequency daily for 7 days	X										X
Rome IV Diagnostic Paediatric	X					X				X	X
PROMIS paediatric anxiety and depression scales	X					X				X	X
Paediatric Quality of Life Inventory	X					X				X	X
Treatment tolerability										X	X
Adverse events			X							X	X
Blinding credibility assessment										X	
Con/Meds, Concomitant Medications.											

Schedule of assessments

A detailed schedule of study procedures and assessments is provided in [table 1](#) in accordance with SPIRIT guidelines.²²

Data collection

Following eligibility confirmation and informed consent, study data will be collected using REDCap, a secure electronic data capture system hosted at RCHOC. Data will be entered by trained personnel and supplemented by participant-reported outcomes. Baseline data will include demographic and clinical characteristics, Rome IV diagnostic assessment, concomitant medications and relevant standard-of-care therapies. Concomitant medications

and relevant standard-of-care therapies will be captured at enrolment/screening from the medical record and available clinic documentation, including the standard-of-care clinic note from the visit during which the participant is identified or recruited. Clinically documented changes to medications or standard-of-care therapies during the study period, including initiation of new DGBI-directed therapies, medication discontinuations or clinically meaningful dose changes, will be recorded when reported by participants/caregivers or identified in the medical record. Initiation of new DGBI-directed therapies or major medication changes during the treatment period will be discouraged unless clinically necessary. To

support transparent reporting of care-context factors, the study will document and report care history before randomisation, intercurrent therapies during the study, permitted usual or parallel care, retention and exclusion rules, rescue therapy and healthcare contact intensity.²¹ During predefined periods, participants will complete daily symptom diaries capturing pain severity and pain frequency. Clinical outcomes will be assessed at baseline and at weeks 4, 8 and 12–14 (follow-up) using validated measures, including the PedsQL Gastrointestinal Symptoms Module and PROMIS Paediatric Anxiety and Depression Scales. Rome IV diagnostic status will be reassessed at follow-up. During the treatment phase, participants will attend weekly visits for intervention delivery, where adherence and AEs will be recorded. All study data will be recorded in REDCap and monitored for completeness and accuracy.

Sample size and power

Sample size calculation is often flawed or absent in trials in the field,^{40–41} reducing quality and precision on findings and their ultimate utility.⁴² Sample size was calculated based on the binary primary outcome of adequate pain relief, defined as a $\geq 30\%$ reduction in mean abdominal pain severity on the NRS from baseline to follow-up at weeks 12–14. Based on prior paediatric functional abdominal pain and neuromodulation studies included in key recent publications, a response rate of 30% is assumed in the sham group and 60% in the acupuncture group.¹⁵ Using a two-sided α of 0.05, 80% power and a 1:1 allocation ratio, a total sample size of 96 participants (48 per group) is required to detect this 30-percentage-point difference between groups. The sample size does not include inflation for attrition; dropout rates will be monitored during interim analysis and recruitment may be adjusted if necessary.

Statistical analysis

Baseline demographic and clinical characteristics will be summarised using descriptive statistics. Continuous variables as mean (SD) or median (IQR) and categorical variables as frequencies (%). Primary analyses will follow the intention-to-treat (ITT) principle. The primary outcome, adequate pain relief, will be analysed using logistic regression and reported as ORs with 95% CIs. Secondary outcomes, including change in pain severity, pain frequency, Rome IV diagnostic status, health-related QoL, PedsQL and PROMIS, will be analysed using regression-based approaches. Change in pain severity will be analysed using linear regression adjusted for baseline pain and prespecified covariates including age, sex and disorder subtype. Other continuous secondary outcomes will be analysed using linear regression or mixed-effects models with random intercepts; categorical secondary outcomes will be analysed using logistic regression or χ^2 tests, as appropriate. Changes in concomitant medications or standard-of-care therapies during the study period, including initiation of new DGBI-directed

therapies, medication discontinuations or clinically meaningful dose changes, will be treated as intercurrent events. The primary analysis will use all available outcome data regardless of documented standard-of-care changes. Documented standard-of-care changes will be summarised by treatment arm, and a prespecified sensitivity analysis will adjust for any documented standard-of-care change during the study period to assess the robustness of the primary outcome findings.⁴³ Missing data will be handled using likelihood-based methods under a missing-at-random assumption, with multiple imputation for sensitivity analyses if needed. If responses suggest inadequate blinding, a sensitivity analysis adjusting for participants' perceived treatment allocation will be conducted to assess the robustness of the primary outcome findings. Safety analyses will include all participants receiving at least one treatment. AEs will be summarised by incidence, severity, and relatedness (CTCAE v5.0). An interim analysis will be conducted after 50% follow-up to assess recruitment, retention, placebo response and safety; no formal stopping rules are planned. All tests will be two-sided with $\alpha=0.05$. Secondary analyses are exploratory. Analyses will be conducted in R.⁴⁴

Ethics and dissemination

This protocol was developed in accordance with the revised Standards for Reporting Interventions in Clinical Trials of Acupuncture (STRICTA)⁴⁵ and the recommendations for Interventional Trials (SPIRIT) guidelines.²² The study was approved by the Children's Hospital of Orange County Institutional Review Board (IRB Protocol No. 250226). P-GAP trial will be conducted in accordance with the principles of the Belmont Report, the Declaration of Helsinki and Good Clinical Practice guidelines.⁴⁶ Written informed consent, HIPAA authorisation and, when applicable, child assent will be obtained prior to study procedures. Participant confidentiality will be maintained per HIPAA regulations and institutional policies. All study data will be coded using unique identifiers, with identifiable information stored on secure systems. The principal investigator will oversee study conduct, including protocol adherence, data integrity and participant safety. A formal data and safety monitoring board is not required due to the minimal-risk nature of the intervention. Protocol amendments will require IRB approval and updates to the trial registry as appropriate.

Findings will be disseminated through peer-reviewed publications and scientific conferences. De-identified individual participant data underlying the results reported in the final publication will be made available on reasonable request, where legally and ethically permissible, after completion of the study and publication of the primary results. Requests will be reviewed by the study investigators and may require approval of a proposal and execution of a data use agreement.

The P-GAP trial is registered on ClinicalTrials.gov (NCT07435610). The completed SPIRIT checklist is provided as online supplemental file 2.

Patient and public involvement

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

Trial status

Recruitment began in December 2025, and the first participant was enrolled on 8 January 2026. Recruitment is ongoing, with primary outcome data collection anticipated to be completed by December 2027 and final study completion anticipated by January 2028.

DISCUSSION

Despite affecting up to 25% of children worldwide and driving substantial morbidity and healthcare utilisation, DGBIs remain inadequately treated.¹ Existing pharmacologic, dietary and psychosocial interventions offer variable and often modest benefit, and recent international guidelines were unable to make any recommendations regarding integrative or alternative therapies due to the absence of adequately designed studies.^{7 8} This evidence gap is compounded by important methodological limitations in the existing literature. Trials in paediatric DGBIs have often been constrained by small sample sizes, heterogeneous interventions, inconsistent outcome selection and limited use of rigorous control conditions. These challenges are particularly relevant in studies of non-pharmacologic and integrative interventions, where placebo response rates may be substantial and where absence of sham controls or blinding can make treatment effects difficult to interpret. As a result, the evidence base for alternative therapies in paediatric DGBIs remains limited, despite growing clinical interest in these approaches.¹⁹

Acupuncture is biologically plausible as a therapeutic strategy in this context given its potential effects on pain modulation, autonomic regulation and gut–brain signalling.⁴⁷ Despite increasing integration in adult care, its use in paediatric populations remains limited, with reported utilisation rates ranging from approximately 1.8% to 5.3%.⁴⁷ In addition, high-quality randomised trials of acupuncture in paediatric DGBIs are lacking, and the broader paediatric acupuncture literature remains limited by variation in protocol design and control methodology. Studies of paediatric DGBIs particularly those evaluating psychosocial and integrative therapies have often been constrained by small sample sizes, insufficient consideration of placebo response rates in power calculations and lack of blinding or sham-controlled designs, which are critical in conditions with high placebo effects. From a safety perspective, evidence indicates that no SAEs have been reported, with observed side effects limited to mild, transient symptoms such as localised discomfort, minor bruising, lightheadedness or dizziness. When delivered by trained practitioners, acupuncture demonstrates a favourable safety and tolerability profile in paediatric populations.⁴⁸

The P-GAP trial was designed to rigorously evaluate acupuncture as a targeted intervention for paediatric

DGBIs and address these methodological limitations directly. Key strengths include a randomised, participant-blinded and assessor-blinded sham-controlled design, a standardised acupuncture protocol with predefined acupoints, validated non-penetrating sham devices to preserve blinding and use of clinically meaningful, validated paediatric outcome measures. Importantly, the trial is powered using assumptions that incorporate both expected placebo and treatment response rates, addressing a common limitation in paediatric studies of functional symptoms and complementary therapies. Study design and reporting are informed by SPIRIT,²² Consolidated Standards of Reporting Trials (CONSORT)²³ and STRICTA⁴⁵ guidelines supporting methodological rigour, quality assurance and minimisation of bias.

The P-GAP intervention protocol represents a structured, mechanism-informed approach rather than a traditional regimen. The selected acupoints were chosen to target complementary domains relevant to DGBI pathophysiology, including gastrointestinal motility, autonomic regulation, nausea pathways and central modulation of stress and pain processing. The inclusion of cranial points introduces an intentional central nervous system component, supporting a coordinated gut–brain axis–focused intervention. This integrated design is a key strength of the study and enhances both biological plausibility and reproducibility in future research.

Collectively, these design features such as participant blinding with a validated sham control, predefined response criteria and sample size estimation informed by expected placebo and treatment response rates address several limitations observed in prior paediatric studies of complementary and integrative therapies. If acupuncture demonstrates efficacy, it may offer a safe and well-tolerated adjunctive option within multidisciplinary care models for paediatric DGBIs. More broadly, the standardised protocol and guideline-aligned design may serve as a framework for future comparative and multicentre studies evaluating integrative therapies in children.

Several limitations should be considered. As a single-centre study, generalisability may be limited, and individual variability in symptom presentation and treatment response may not be fully captured despite protocol standardisation. Although the selected outcome measures are validated and clinically meaningful, longer-term follow-up will be required to assess durability of treatment effects. In addition, the use of sham acupuncture at true acupoint locations may not represent completely inert control, as non-penetrating stimulation may still exert physiological or acupressure-related effects, a recognised methodological challenge in acupuncture trial design. Maintaining credible blinding in paediatric acupuncture trials may be challenging because children and adolescents may respond differently to sham needling procedures. Although blinding credibility will be assessed as part of trial feasibility, inadequate blinding could affect interpretation of treatment effects. Future studies should incorporate multicentre designs and extended follow-up to further evaluate the generalisability and comparative

effectiveness of acupuncture in paediatric disorders of gut–brain interaction.

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Contributors AC and RM conceived the study. AC, MG and RM designed the trial. AC, MG and PM contributed to the clinical framework, methodological design and intervention development and revised the manuscript for intellectual content. PM contributed to and led the finalisation of the study protocol. PM drafted the manuscript, which was edited by AC, MG and RM. HJ, JJ, GV and KE contributed to study coordination, protocol development support and manuscript review. TT, AT and JK contributed to clinical implementation and reviewed the manuscript. All authors contributed to the revision of the manuscript and approved the final version. AC is the guarantor of the study. Artificial intelligence (AI) tools (ChatGPT, OpenAI) were used to assist with language editing and improving clarity of the manuscript. The authors reviewed and approved the final content.

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Competing interests Morris Gordon is a member of the BMJ Paediatrics Open editorial board. He had no involvement in the editorial review or decision-making process for this manuscript submitted to BMJ Open. All other authors have no competing interest.

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

Patient consent for publication Not applicable.

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Data availability statement Data are available upon reasonable request. De-identified individual participant data underlying the results reported in the final publication will be made available upon reasonable request, where legally and ethically permissible, after completion of the study and publication of the primary results. Requests will be reviewed by the study investigators and may require approval of a proposal and execution of a data use agreement.

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