Dance and yoga reduced functional abdominal pain in young girls: A randomized controlled trial

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Abstract

Background: Functional abdominal pain disorders (FAPDs) affect children, especially girls, all over the world. The evidence for existing treatments is mixed, and effective accessible treatments are needed. Dance, a rhythmic cardio-respiratory activity, combined with yoga, which enhances relaxation and focus, may provide physiological and psychological benefits that could help to ease pain.

Objectives: The aim of this study was to evaluate the effect of a dance and yoga intervention on maximum abdominal pain in 9- to 13-year-old girls with FAPDs.

Methods: This study was a prospective randomized controlled trial with 121 participants recruited from outpatient clinics as well as the general public. The intervention group participated in dance and yoga twice weekly for 8 months; controls received standard care. Abdominal pain, as scored on the Faces Pain Scale–Revised, was recorded in a pain diary. A linear mixed model was used to estimate the outcomes and effect sizes.

Results: Dance and yoga were superior to standard health care alone, with a medium to high between-group effect size and significantly greater pain reduction ($b = -1.29$, $p = 0.002$) at the end of the intervention.
Introduction

Functional abdominal pain disorders (FAPDs) (Hyams et al., 2016) affect 13.5% of school-aged children globally (Korterink et al., 2015). FAPDs replaced the Rome III term abdominal pain related functional gastrointestinal disorders (AP-FGIDs) in Rome IV and are defined as chronic or recurrent abdominal pain that cannot be attributed to another medical condition (Hyams et al., 2016). FAPDs include Irritable Bowel Syndrome (IBS), functional dyspepsia, abdominal migraine and functional abdominal pain (FAP) – not otherwise specified (Hyams et al., 2016) of which IBS and FAP are in focus in this study. Abdominal pain is associated with depression, anxiety, reduced quality of life (Ayonrinde et al., 2020; Saps et al., 2009) and school absenteeism (Saps et al., 2009). The pathogenesis of FAPDs is complex; biological, psychological and psychosocial factors contribute to the development and maintenance of the disorder, (Jones et al., 2020; Rajindrajith et al., 2018; Van Oudenhove et al., 2016) and the prevalence of FAPDs is higher among girls than among boys (Ayonrinde et al., 2020; Korterink et al., 2015). Suffering from FAPDs is a great burden on these children and their families and often leads to frequent visits to health care services (Hoekman et al., 2015). Abdominal pain in childhood is also a predictor of persistent long-term pain (Walker et al., 2010) and severe mental illness in adulthood (Bohman et al., 2012, 2018; Shelby et al., 2013), and evidence for pharmacological (Martin et al., 2017) and dietary treatments (Newlove-Delgado et al., 2017) for children and adolescents with FAPDs remains insufficient. Studies have shown that psychological treatments such as different types of cognitive behavioural therapy (CBT) and hypnotherapy can reduce pain in children and adolescents with FAPDs in the short term (Abbott et al., 2017; Gupta et al., 2018) but more well-designed studies with new types of interventions are needed (Abbott et al., 2017; Eccleston et al., 2019; Lund et al., 2018; World Health Organization, 2016; 2020).

Yoga has also shown the potential to reduce pain intensity, along with school absenteeism (Brands et al., 2011; Korterink et al., 2016) and IBS-related symptoms, and to improve quality of life and physical functioning in children with FAPDs (S. Evans et al., 2014; Kuttner et al., 2006; Schumann et al., 2016). However, more well-designed studies on yoga are needed in this target group (Schumann et al., 2016). Dance has not previously been studied among children with FAPDs, but a number of meta-analyses and reviews including studies with children and adolescents show that dance can improve both physiological (Fong Yan et al., 2018) and psychological (Burkhardt & Brennan, 2012; Koch et al., 2019; Schwender et al., 2018) health. Moreover, dance is one of the most popular group activities among young girls (O’Neill et al., 2011). A combination of dance and yoga provides dynamic physical activity, relaxation and focus, which we hypothesize may benefit children with FAPDs.

This is the first study, to our knowledge, to use a combined dance/yoga intervention for children with FAPDs. The aim was to compare the effects of an 8-month dance/yoga intervention with standard health care on maximum abdominal pain among 9- to 13-year-old girls with FAPDs.

Methods

2.1 Study design

This study was a prospective randomized controlled trial (RCT), with one intervention group and one control group. The intervention was conducted from September to May in year 2016/2017 at one site (Örebro, Sweden) and 2017/2018 and 2018/2019 at two sites (Örebro and Västerås, Sweden). A full description of the design is published in the study protocol (Philipson et al., 2020).
This study was registered at ClinicalTrials.gov (ID: NCT02920268, Name: Just in TIME - Intervention With Dance and Yoga for Girls With Recurrent Abdominal Pain, Just in TIME) and approved by the Regional Ethical Review Board in Uppsala, Sweden (Dnr 2016/082 1–2).

2.2 | Recruitment and study sample

Girls included in the study were aged 9 to 13 years and diagnosed with FAP or IBS with persistent pain after examination at a paediatric centre. As the Rome III criteria (Rasquin et al., 2006) were still current during the first study inclusion, they were used for IBS and FAP diagnoses throughout. The first year of recruitment included girls aged 9 to 12 years; the range was subsequently extended to 13 years to broaden the study population. Participants were recruited from outpatient clinics at the university hospital paediatrics departments in Örebro, Karlskoga, Lindesberg, and (in the second and third year) Västerås, cities in small regions in the south of Sweden. We recruited participants through information letters sent or given to families with girls in the target age range who had visited the outpatient clinics because of FAP, IBS or constipation. We also recruited from primary health care and a counselling unit for children and adolescents in Örebro and from school health services and the general public (through study information in the media and on websites) in Örebro and Västerås. After their legal guardians provided written consent, the participants met with a paediatrician to verify their diagnostic criteria and confirm the lack of any exclusion criteria. If the participant had met with a paediatrician in the previous 6 months, her diagnosis of FAP and/or IBS was verified in the medical records and complementary tests were performed only if needed. At baseline, the score for the inclusion criterion “persistent pain” was recorded in a pain diary for a week. Girls with FAP and/or IBS who reported 4 or higher on the Faces Pain Scale - Revised (FPS-R) (Hicks et al., 2001; Tomlinson et al., 2010) at least one time during the week were eligible for the study.

The exclusion criteria for the RCT were; (1) contemporaneous celiac or inflammatory bowel disease (IBD); (2) difficulty following oral instructions, such as hearing impairment, mental disability or language difficulty; (3) simultaneous treatment with CBT; and (4) severe depression, for which other treatment was needed. Depression was measured using the Children's Depression Screener (ChilD-S) (Frühe et al., 2012), and girls who scored 13 or higher were offered contact with a psychologist to assess whether they needed further support or could participate in the study. An external statistician performed the randomization at each site, using minimization (Altman & Bland, 2005) based on pain intensity and age at baseline. Because this study included an active intervention, neither participants nor researchers could be blinded to treatment. An external research administrator entered the data for the analyses. The analyses were performed by two of the authors; SH and AP. SH was one of the instructors providing the intervention in Örebro. A full description of the recruitment process and sample is published in the study protocol (Philipson et al., 2020).

2.3 | Sample size

The power calculation before the RCT based on the primary outcome estimated that 75 individuals per arm were necessary to detect clinically significant differences with 80% power (\( \alpha = 0.05 \), two-tailed test) assuming a dropout rate of 20% (Moore et al., 2010). The actual sample included 121 participants (\( n = 64 \) in the intervention group; \( n = 57 \) in the control group).

Before randomization 167 girls were eligible for the study but 46 girls were excluded because of the following reasons; (1) Did not meet the inclusion criteria (\( n = 19 \)) due to medical reasons, no persistent pain or language difficulties. (2) Declined to participate in the study (\( n = 24 \)) due to other free time activities, did not want to take tests and some did not show up at baseline. (3) Other reasons (\( n = 3 \)) one wanted to test another treatment, one was going to surgery for a physical problem and one was under medical investigation for Irritable Bowel Disease (IBD). No one was excluded from the study after the randomization.

Figure 1 shows our CONsolidated Standards of Reporting Trials (CONSORT) diagram illustrating the participant flow through each phase of the study.

2.4 | Intervention

Both groups had access to standard health care such as out-patient visits to the paediatric clinic, school health care and primary care when needed. Participants in the control group were requested to live as usual. All participants were requested to report if they started CBT-treatment during the study, due to the exclusion criteria \( (n = 0) \). For ethical reasons, controls were offered dance and yoga after the 2-year follow-up.

2.4.1 | Dance and yoga

The intervention was called Just in TIME (Try [new activities], Identify [strengthening health factors], Move [your body in physical activity] and Enjoy [the feeling of
movement] to address the importance of early intervention for this target group. The intervention was delivered twice a week for 8 months as an after-school group activity. Each session took 60 min: 30 min of dance practice, 25 min of yoga including relaxation and 5 min of short reflection. The dance was designed as a dynamic, rhythmic cardio-respiratory activity of moderate to vigorous intensity focused on enjoyment and socialization rather than performance. It contained several dance styles such as show jazz, contemporary dance, and street dance and incorporated various themes, performed to popular music. The choreography was usually structured and led by the instructor, but guided improvisation and playful creative movement sessions were also included. The yoga consisted of playful movements and calm physical postures focused on breathing and attention and performed individually, as pairs, and as group exercises (often including storytelling). Each session always included guided relaxation and ended with the girls seated in a circle voluntarily sharing a positive experience from that session. Throughout the intervention period, participants were encouraged to practice their favourite dances, yoga poses or relaxation techniques at home if they wanted to. The intervention was mirrored at both sites and the groups were usually led by four instructors each week, one at a time at each site. In total there were 11 instructors, seven in Västerås and four in Örebro. The intervention was designed by one of the authors (AD), and before it began all instructors received a 2-day course including practical information about the standardized program, dance choreographies, yoga sequences and essential elements of the interventions such as teaching supportively and non-judgmentally. The instructors received a written manual and the course was followed up with three booster sessions to ensure fidelity to the method. The instructors recruited for the study were already educated in teaching dance and yoga and

FIGURE 1 Consort flow chart. ITT, Intention-to-treat; PP, per protocol
had education in health care or pedagogy and previous experience working with children and adolescents. The intervention is described more in detail in the study protocol (Philipson et al., 2020).

### 2.5 Data collection and measures

We collected the data at baseline and 4 months and 8 months later. Questionnaire sessions took place in an auditorium at both sites after school. At each of these, several members of the project team were present to measure heights and weights, provide assistance and answer any questions. Participating girls and their legal guardians each answered different questionnaires. Pain diaries were brought home for assessment and then sent back to the research group in a prepaid envelope. Participants who were unable to attend questionnaire sessions were sent the material by post. To increase the attrition rate and limit losses to follow-up, the research team made a number of active efforts including phone calls, letters and e-mails with reminders. Moreover, members of the research team offered to pick up data material at given places for the participants’ convenience. Also, the control group received a movie ticket after each follow-up to show appreciation for their participation in the study.

The primary outcome measure in this study, maximum abdominal pain, was measured with the validated FPS-R in a pain diary and scored from 0 to 10 (Hicks et al., 2001; Tomlinson et al., 2010). Abdominal pain is the main symptom of FAPDs and is therefore recommended as the primary outcome in clinical trials for paediatric FAPDs (Santucci et al., 2020; Zeevenhooven et al., 2020). FPS-R shows strong psychometric properties in children 4–17 years (Tsze et al., 2013) and is frequently recommended to evaluate acute and chronic pain in children (Birnie et al., 2019; Huguet et al., 2010; McGrath et al., 2008). Tsze et al. (2019) showed that changes in minimal statistical differences with FPS-R can be generalized between different subgroups including the etiology of pain which makes FPS-R a relevant choice since there is no measurement for pain specifically validated for children with FAPDs (Zeevenhooven et al., 2019). When assessing pain in children it is recommended to use a self-reported daily pain diary for 1–2 weeks to increase reliability (Chogle et al., 2012; Saps et al., 2016; Self et al., 2015) and “worst pain” during the day is considered a reliable measure (Atkinson et al., 2010). In this study, the girls were instructed to register their abdominal pain, using FPS-R, three times a day for a week in a pain diary: in the morning, in the evening, and the time point and score for the worst during that day. If at least 4 days were reported with at least one value, the highest reported value for each day was selected, summed and divided with the number of reported days, to obtain a single mean maximum pain score, between 0 and 10, for each individual at each follow-up. All the collected pain diaries met this criterion. This process is in line with a previous study (Naegeli et al., 2018). The mean maximum pain scores were handled as continuous outcome measures in the analysis.

Baseline characteristics were based on data from the questionnaires. The girl’s questionnaires asked for self-reported age, depressive symptoms measured on the Child-S (Frühé et al., 2012) and general health measured with a validated and reliable single self-rating question (Vingilis et al., 2002). The legal guardian’s questionnaires asked about the girls’ menarche, heredity (abdominal issues among parents), parental socioeconomic status (occupation) and country of birth. Finally, accelerometers (GT3X accelerometers, ActiGraph) measured the girls’ physical activity over 1 week, with counts per minutes as the outcome measure (Kowalski et al., 2012).

### 2.6 Statistical analysis

We used IBM SPSS Statistics version 25 and Stata software version 16.0 (StataCorp LP) for the statistical analyses and descriptive statistics to summarize participants’ characteristics. Continuous variables are presented as mean and standard deviation, ordered categorical variables as median and interquartile range (IQR), and binary and categorical variables as frequencies.

According to the study protocol, the primary outcome was to estimate the proportion of girls in each group who had reduced their maximum abdominal pain at 8 months by a minimum clinically statistical difference of two steps or more on FPS-R (Tsze et al., 2019). Only complete cases were used, resulting in different amounts of data at each assessment. Girls who failed to return their pain diaries (see CONSORT flow chart, Figure 1), were handled as missing. At 4 months, 12 pain diaries were missing in the intervention group and 12 in the control group. At 8 months, 11 were missing in the control group and 10 in the intervention group.

We analysed the continuous outcome variables using a linear mixed model, with treatment, time (coded as a categorical variable: 0, 4 or 8), and their interaction included as fixed effects and a random intercept (id) and slope (time) included as random effects with an unstructured covariance structure. Baseline values were incorporated in the model to adjust for imbalances at baseline (despite randomization) and to increase precision by removing between-person variability. Mean differences ($b$) were calculated by the treatment by time interaction term at the 4- and 8-month follow-ups. The control group served as
the reference group for between-group comparisons over time.

All available data for the dependent variable were included since the analysis uses maximum likelihood estimation to make predictions based on the data available, even if data are missing for some time points. Data were assumed to be missing at random. Complete cases were used for all other variables.

We performed both intention-to-treat (ITT) and per protocol (PP) analyses, with the cut-off for the PP group set at participating in at least 50% of the intervention sessions.

All the baseline variables (diagnosis type, age, height, weight class, menarche, depressive symptoms, self-rated health, physical activity, parental abdominal diagnosis and symptoms, parental occupation and country of birth) were tested one by one to find out whether any of them were associated with group, outcome and/or changes in pain levels over time, and could therefore be handled as a confounder. Age, depression, menarche, self-rated health and physical activity were associated with the outcome variable only, and no confounding effect was detected. These variables were tested to find out whether they improved the model fit based on smallest Akaike’s Information Criterion and Bayesian Information Criterion. The final model included only physical activity as a covariate since it significantly affected the outcome and improved the model. Finally, we calculated effect sizes at both the 4- and 8-month follow-ups by dividing the model-based estimates of mean differences by the within-group standard deviation of raw scores that estimates the variability in the outcome measure at baseline, (Feingold, 2009) where 0.20 is considered a small effect, 0.50 a medium effect and 0.80 a large effect (Cohen, 1988). Statistical significance was set at \( p < 0.05 \).

3 | RESULTS

3.1 | Descriptive statistics

A total of 121 participants were included in the ITT analysis and 97 participants in the PP analysis (see CONSORT flow chart, Figure 1). Mean maximum abdominal pain, measured with FPS-R, ranged at baseline from 0.57 to 8.57 in both the ITT sample and PP sample. Characteristics of the study sample at baseline can be found in Table 1.

The dance- and yoga classes were given an average of 50 (48–52) times during the 8-month period depending on recruitment-year and site. The mean attendance for all girls in the intervention group was 63% during the first 4 months and 55% for the entire 8-month intervention.

| TABLE 1 Baseline characteristics |
|----------------------------------|
|                                | Intervention (n = 64) | Control (n = 57) |
| Age at inclusion, mean (SD)     | 10.5 (1.4)            | 10.6 (1.3)       |
| Diagnosis, n (%)                |                      |                  |
| IBS                             | 27 (42.2)            | 20 (35.1)        |
| FAP                             | 37 (57.8)            | 37 (64.9)        |
| Height, centimeters, mean (SD)  | 147.1 (10.1)         | 147.2 (8.7)      |
| Weight class\(^a\), n (%)       |                      |                  |
| Underweight                     | 6 (9.4)              | 4 (7.0)          |
| Normal                          | 40 (62.5)            | 41 (71.9)        |
| Overweight                      | 8 (12.5)             | 5 (8.8)          |
| Obese                           | 7 (10.9)             | 2 (3.5)          |
| Menarche, n (%)                 |                      |                  |
| Yes                             | 5 (7.8)              | 6 (10.5)         |
| No                              | 58 (90.6)            | 51 (89.5)        |
| Child-S, median (IQR)           | 9.0 (5.5)            | 8.0 (5.0)        |
| Self-rated health, median (IQR) | 3.0 (1)              | 3.0 (1)          |
| Physical activity, counts, mean (SD) | 450.3 (118.1)         | 461.9 (160.9)    |
| Parental abdominal diagnosis\(^b\), n (%): | | |
| Yes                             | 6 (9.4)              | 9 (15.8)         |
| No                              | 56 (87.5)            | 48 (84.2)        |
| Parental abdominal symptoms\(^b\), n (%): | | |
| Yes                             | 22 (34.4)            | 16 (28.1)        |
| No                              | 41 (64.1)            | 41 (71.9)        |
| Parental occupation, n (%):     |                      |                  |
| Work or studies\(^c\)           | 54 (84.8)            | 48 (84.2)        |
| Unemployed, sick leave, parental leave\(^b\) | | |
| Sweden                          | 60 (93.8)            | 57 (100.0)       |
| Other country                   | 3 (4.7)              | 0               |

\(^a\)According to body mass index.

\(^b\)At least one parent.

\(^c\)Both parents.

3.2 | Abdominal pain

3.2.1 | Intention-to-treat analysis

The ITT analyses with complete cases showed that 46.3% of the girls in the intervention group and 17.4% of the girls in the control group had reduced their maximum abdominal pain by two steps or more on FPS-R at the 8-months follow-up.
The adjusted linear mixed models showed a reduction in maximum abdominal pain for both groups (Figure 2 and Table 2), with a larger reduction for the intervention group and a significant mean difference between the groups at both the 4-month follow-up ($b = -0.86, p = 0.003$) and the 8-month follow-up ($b = -1.29, p = 0.002$; Table 3). The between-group effect size was small to medium at the 4-month follow-up and medium to large at the 8-month follow-up and (Table 3).

### 3.2.2 Per protocol analysis

The PP analyses of complete cases showed that 55% of the girls in the intervention group reported a two-step or greater reduction in maximum abdominal pain at 8 months.

The adjusted linear mixed models in the PP analysis mirrored the ITT analysis in many ways, showing reduced maximum abdominal pain levels in both groups at both follow-ups (Figure 3 and Table 2), with a significant difference at both time points (Table 3). The between-group effect size was small to medium at the 4-month follow-up and medium to large at the 8-month follow-up (Table 3).

### 4 DISCUSSION

This study compared the effects of an 8-month dance/yoga intervention with standard health care on maximum abdominal pain in 9- to 13-year-old girls with FAPDs. The key finding in the ITT and PP analysis was that dance and yoga were superior to standard health care alone in reducing maximum pain in this group. Small to large between-group effect sizes were found, with statistically significant larger reductions in maximum abdominal pain levels in the intervention group than controls at both the 4- and 8-month follow-ups. These results indicate that a dance/yoga intervention is likely a feasible and beneficial complement to standard health care for 9- to 13-year-old girls with FAPDs. That both groups reduced their maximum abdominal pain during the 8-month intervention might be explained by; the natural course of the disorder, the standard care both groups had access to, participation in a research study or a mix of these components. Pain reduction in the intervention group, however, could also be explained by the several physiological and psychological benefits of dance and yoga, the positive and undemanding group setting and/or positive expectations about the intervention. It is not possible to determine to what extent each of these parts affected outcomes in any of the groups.

Outcomes from the ITT and PP analysis were similar, and the results from the adjusted analysis versus the crude analysis were mixed. The larger difference in pain reduction at 8 months than at 4 months shows that pain continued to be reduced throughout the entire intervention period.

To our knowledge, this is the first study to examine the effects of an intervention using combined dance and yoga for children with FAPDs, but we can compare it with similar interventions using only dance or yoga. While no previous studies used dance for children with FAPDs, an RCT with a similar design to the present study did use dance for adolescent girls with internalizing problems. That study showed enhanced self-rated health (Duberg et al., 2013), enhanced embodied self-trust (Duberg et al., 2016), and reduced emotional and somatic symptoms (Duberg et al., 2020); the reduced somatic symptoms in that study are in

![Figure 2](image-url)  
**Figure 2** Estimated mean maximum abdominal pain scores over time (adjusted), for interventions and controls, according to ITT. Data are means from the linear mixed-effects models. Error bars show confidence intervals.
line with our results. Moreover, several qualitative studies show that dance has the potential to improve various aspects of the self, such as body-image, self-trust, self-expression and self-esteem among children and adolescents (Schwender et al., 2018). Due to the complexity of FAPDs it is likely that this target group would benefit from the strengthening aspects of the self, and this factor might have explanatory value for the current study.

The results of this study are also partly consistent with those of (Korterink et al., 2016) and (Brands et al., 2011).
who studied the use of yoga in children with FAPDs, with similar results as the current study. One study showed reduced pain intensity 12 months after a 10-week yoga intervention (Korterink et al., 2016), and the other found reduced pain intensity and frequency, especially for 8- to 11-year-olds, after 10 yoga lessons (Brands et al., 2011). Other studies of yoga interventions for children with IBS have shown improvements in a number of symptoms (Schumann et al., 2016). In line with (Brands et al., 2011) and (Korterink et al., 2016), we developed a specialized intervention with exercises aimed to appeal to the specific age group.

Which components of the Just in TIME intervention contributed most to the treatment effects could not be determined in this study. However, as we hypothesized, the combination of these activities may have been a strength of this intervention as dance contributed to cardiorespiratory and rhythmic aspects, while yoga contained focus, relaxation and introspection. This is in line with (Alderman et al., 2016) who suggested that the combination of aerobic exercise and focused attention/meditation seemed particularly beneficial in increasing cognitive control and decreasing symptoms of depression and rumination in adults with major depressive disorders, and (Lavadera et al., 2020) who concluded that the same combination led to decreased rumination and perceived stress and increased quality of life among medical students. Children with FAPDs often have poor coping strategies (Abbott et al., 2017), and this intervention may have given the participants new active strategies to cope with and reduce their pain.

The social aspect of the intervention might also have had a considerable impact. The opportunity to meet new friends and to see that other girls suffer from the same symptoms may also have contributed to the positive outcomes. Evans et al. also highlighted in a pilot study that those teens with supportive guardians who were committed to the intervention were more likely to have a positive treatment effect (Subhadra Evans et al., 2018); this may have been another contributing factor in the current study.

This study has some possible limitations that should be considered. We did not evaluate other aspects of abdominal pain such as frequency or duration. However, the measure used, the mean score of maximum pain based on daily assessment for one week, captured both intensity and frequency. Another weakness is the limited knowledge of the control group who was encouraged to live as usual. Despite our extending age range for the sample, recruiting for an extra two years, and adding the Västerås study site, we were unable to reach the intended sample size. Nevertheless, the study outcomes reached the level of significance.

There may be a number of reasons for our difficulty in reaching the desired sample size. The twice weekly after-school intervention was intense, long at 8 months, and demanding for every family. These demands could therefore have limited participation and contributed to a biased distribution in which girls with more engaged legal guardians may have been more likely to participate and to have better attendance. It is also possible that not all eligible girls in the population were reached with the project information. In the first year, participants were recruited mainly from paediatric centres through information letters sent home to families identified as eligible. In the second and third years, as the project became better known, more participants were recruited from the public. To address the small sample size, we added another site in the second year, which not only increased the study population but also
may have enhanced the generalizability of the findings since a multi-centre trial design provides a better basis for the necessary assumptions.

The study also had some strengths worth mentioning. Continuing to consider the small sample size, mixed models such as this seem to require fewer participants to gain the same power as other common analytical methods (Fan, 2003), which is an advantage. Other strengths of linear mixed models are their ability to handle dependence over repeated observations and to account for missing data. In addition to the strengths mentioned above is the RCT design for the study and the high attendance to the dance/yoga intervention.

Since somatic symptoms, especially abdominal pain (Bohman et al., 2012), in children and adolescents can predict severe mental illness in adulthood (Bohman et al., 2012, 2018), this type of intervention may prevent or reduce such long-term outcomes. Further long-term follow-ups are needed to investigate that possibility.

In conclusion, this study shows that a non-pharmacological intervention including combined dance and yoga, focus on enjoyment in a social non-judgmental environment, can be an effective complement to standard health care, for 9- to 13-year old girls with FAPDs. A reduction in pain may decrease the burden of FAPDs for young girls and their families. It would be interesting to compare this dance and yoga intervention with different types of non-pharmacological interventions and also to evaluate this intervention in other populations with FAPDs. In line with other researchers, we conclude that more research is needed in this field to alleviate the suffering and perhaps improve outcomes in this and other patient populations.

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CONFLICTS OF INTEREST
The authors have no conflicts of interest to declare.

AUTHOR CONTRIBUTIONS
Study conception and/or design: AP, LE, ME, UL-F, MM, SS and AD. Recruitment of participants: AP, LE, UL-F, SS and AD. Data collection: AP, LE, UL-F, SH, MM, ES, SS and AD. Statistical analysis and writing of the draft: SH and AP. Interpretation of the data and/or revising the draft critically for important intellectual content: All authors. All authors had access to the study data and took responsibility for the integrity of the data and the accuracy of the data analysis, reviewed and approved the final manuscript.

CLINICAL STUDY REGISTRATION
This study was registered at ClinicalTrials.gov (ID: NCT02920268, Name: Just in TIME - Intervention With Dance and Yoga for Girls With Recurrent Abdominal Pain, Just in TIME).

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REFERENCES
Abbott, R. A., Martin, A. E., Newlove-Delgado, T. V., Bethel, A., Thompson-Coon, J., Whear, R., & Logan, S. (2017). Psychosocial interventions for recurrent abdominal pain in childhood. Cochrane Database of Systematic Reviews, 1, Cd010971. https://doi.org/10.1002/14651858.CD010971.pub2
Alderman, B. L., Olson, R. L., Brush, C. J., & Shors, T. J. (2016). MAP training: Combining meditation and aerobic exercise reduces depression and rumination while enhancing synchronized brain activity. Translational Psychiatry, 6, e726. https://doi.org/10.1038/tp.2015.225
Altman, D. G., & Bland, J. M. (2005). Treatment allocation by minimisation. BMJ, 330, 843. https://doi.org/10.1136/bmj.330.7495.843
Atkinson, T. M., Mendoza, T. R., Sit, L., Passik, S., Scher, H. I., Cleeland, C., & Basch, E. (2010). The brief pain inventory and its "pain at its worst in the last 24 hours" item: Clinical trial endpoint considerations. Pain Medicine, 11, 337–346. https://doi.org/10.1111/j.1526-4637.2009.00774.x
Ayonrinde, O. T., Ayonrinde, O. A., Adams, L. A., Sanfilippo, F. M., O’ Sullivan, T. A., Robinson, M., Oddy, W. H., & Olynyk, J. K. (2020). The relationship between abdominal pain and emotional wellbeing in children and adolescents in the Raine Study. Scientific Reports, 10, 1646. https://doi.org/10.1038/s41598-020-58543-0
Birnie, K. A., Hundert, A. S., Laloo, C., Nguyen, C., & Stinson, J. N. (2019). Recommendations for selection of self-report pain intensity measures in children and adolescents: A systematic review and quality assessment of measurement properties. Pain, 160, 5–18. https://doi.org/10.1097/j.1526-4637.2009.00774.x
Bohman, H., Jonsson, U., Paaren, A., von Knorring, L., Olsson, G., & von Knorring, A. L. (2012). Prognostic significance of functional somatic symptoms in adolescence: A 15-year community-based follow-up study of adolescents with depression compared with healthy peers. BMC Psychiatry, 12, 90. https://doi.org/10.1186/1471-244x-12-90
Bohman, H., Laftman, S. B., Cleland, N., Lundberg, M., Paaren, A., & Jonsson, U. (2018). Somatic symptoms in adolescence as a predictor of severe mental illness in adulthood: A long-term community-based follow-up study. *Child and Adolescent Psychiatry and Mental Health, 12*, 42. https://doi.org/10.1186/s13034-018-0245-0

Brands, M. M., Purperhart, H., & Deckers-Kocken, J. M. (2011). A pilot study of yoga treatment in children with functional abdominal pain and irritable bowel syndrome. *Complementary Therapies in Medicine, 19*, 109–114. https://doi.org/10.1016/j.ctim.2011.05.004

Burkhardt, J., & Brennan, C. (2012). The effects of recreational dance interventions on the health and well-being of children and young people: A systematic review. *Arts & Health, 4*, 148–161. https://doi.org/10.1080/17533015.2012.665810

Chogle, A., Sztainberg, M., Bass, L., Youssef, N. N., Miranda, A., Nurko, S., Hyman, P., Cocjin, J., Di Lorenzo, C., & Saps, M. (2012). Accuracy of pain recall in children. *Journal of Pediatric Gastroenterology and Nutrition, 55*, 288–291. https://doi.org/10.1097/MPG.0b013e31824c0f8a

Cohen, J. (1988). *Statistical power analysis for the behavioral (2nd ed.)* Routledge.

Duberg, A., Hagberg, L., Sunvisson, H., & Moller, M. (2013). Influencing self-rated health among adolescent girls with dance intervention: A randomized controlled trial. *JAMA Pediatrics, 167*, 27–31. https://doi.org/10.1001/jamapediatrics.2013.421

Duberg, A., Jutengren, G., Hagberg, L., & Moller, M. (2020). The effects of a dance intervention on somatic symptoms and emotional distress in adolescent girls: A randomized controlled trial. *Journal of International Medical Research, 48*, 300060520902610. https://doi.org/10.1177/0300060520902610

Duberg, A., Moller, M., & Sunvisson, H. (2016). “I feel free”: Experiences of a dance intervention for adolescent girls with internalizing problems. *International Journal of Qualitative Studies on Health and well-being, 11*, 31946. https://doi.org/10.3402/qhw.v11.31946

Eccleston, C., Fisher, E., Cooper, T. E., Grégoire, M. C., Heathcote, L. C., Krane, L., Lord, S. M., Sethna, N. F., Anderson, A.-K., Anderson, B., Clinch, J., Gray, A. L., Gold, J. I., Howard, R. F., Ljungman, G., Moore, R. A., Schechter, N., Wiffen, P. J., Wilkinson, N. M. R., … Zernikow, B. (2019). Pharmacological interventions for chronic pain in children: An overview of systematic reviews. *Pain, 160*, 1698–1707. https://doi.org/10.1007/j.197-019-01609

Evans, S., Lung, K. C., Seidman, L. C., Sternlieb, B., Zeltzer, L. K., & Tsao, J. C. (2014). Iyengar yoga for adolescents and young adults with irritable bowel syndrome. *Journal of Pediatric Gastroenterology and Nutrition, 59*, 244–253. https://doi.org/10.1097/mpg.000000000000366

Evans, S., Seidman, L. C., Lung, K., Sternlieb, B., & Zeltzer, L. K. (2018). Yoga for teens with irritable bowel syndrome: Results from a mixed-methods pilot study. *Holistic Nursing Practice, 32*, 253–260. https://doi.org/10.1097/HNP.0000000000000288

Fan, X. (2003). Power of latent growth modeling for detecting group differences in linear growth trajectory parameters. *Structural Equation Modeling: A Multidisciplinary Journal, 10*, 380–400. https://doi.org/10.1207/S15328007SEM1003_3

Feingold, A. (2009). Effect sizes for growth-modeling analysis for controlled clinical trials in the same metric as for classical analysis. *Psychological Methods, 14*, 43–53. https://doi.org/10.1037/a0014699

Fong Yan, A., Cobley, S., Chan, C., Pappas, E., Nicholson, L. L., Ward, R. E., Murdoch, R. E., Gu, Y. U., Trevor, B. L., Vassallo, A. J., Wewege, M. A., & Hiller, C. E. (2018). The effectiveness of dance interventions on physical health outcomes compared to other forms of physical activity: A systematic review and meta-analysis. *Sports Medicine, 48*, 933–951. https://doi.org/10.1007/s40279-017-0853-5

Frühe, B., Allgaier, A. K., Pietsch, K., Baethmann, M., Peters, J., Kellnar, S., Heep, A., Burdach, S., von Schweinitz, D., & Schulte-Körne, G. (2012). Children's Depression Screener (Child-S): Development and validation of a depression screening instrument for children in pediatric care. *Child Psychiatry and Human Development, 43*, 137–151. https://doi.org/10.1007/s10578-011-0254-1

Gupta, S., Schaffer, G., & Saps, M. (2018). Pediatric irritable bowel syndrome and other functional abdominal pain disorders: An update of non-pharmacological treatments. *Expert Review of Gastroenterology & Hepatology, 12*, 447–456. https://doi.org/10.1080/17474124.2018.1462699

Hicks, C. L., von Baeyer, C. L., Spafford, P. A., van Korlaar, I., & Goodenough, B. (2001). The faces pain scale-revised: Toward a common metric in pediatric pain measurement. *Pain, 93*, 173–183. https://doi.org/10.1016/s0304-3959(01)00314-1

Hoekman, D. R., Ruten, J. M., Vlieger, A. M., Benninga, M. A., & Dijkgraaf, M. G. (2015). Annual costs of care for pediatric irritable bowel syndrome, functional abdominal pain, and functional abdominal pain syndrome. *Journal of Pediatrics, 167*, 1103–1108.e1102. https://doi.org/10.1016/j.jpeds.2015.07.058

Huguet, A., Stinson, J. N., & McGrath, P. J. (2010). Measurement of self-reported pain intensity in children and adolescents. *Journal of Psychosomatic Research, 68*, 329–336. https://doi.org/10.1016/j.jpsychores.2009.06.003

Hyams, J. S., Di Lorenzo, C., Saps, M., Shulman, R. J., Staiano, A., & van Tilburg, M. (2016). Functional disorders: Children and adolescents. *Gastroenterology, 150*, 1456–1468. https://doi.org/10.1053/j.gastro.2016.02.015

Jones, M. P., Faresjö, Å., Beath, A., Faresjö, T., & Ludvigsson, J. (2020). Abdominal pain in children develops with age and increases with psychosocial factors. *Clinical Gastroenterology and Hepatology, 18*, 360–367.e361. https://doi.org/10.1016/j.jgh.2019.04.036

Koch, S. C., Riege, R. F. F., Tisborn, K., Biondo, J., Martin, L., & Beelmann, A. (2019). Effects of dance movement therapy and dance on health-related psychological outcomes. *A Meta-Analysis Update. Frontiers in Psychology, 10*, https://doi.org/10.3389/fpsyg.2019.01806

Korterink, J. J., Diederik, K., Benninga, M. A., & Tabbers, M. M. (2015). Epidemiology of pediatric functional abdominal pain disorders: A meta-analysis. *PLoS One, 10*, e0126982. https://doi.org/10.1371/journal.pone.0126982

Korterink, J. J., Ockeloen, L. E., Hilbink, M., Benninga, M. A., & Deckers-Kocken, J. M. (2016). Yoga therapy for abdominal pain-related functional gastrointestinal disorders in children: A randomized controlled trial. *Journal of Pediatric Gastroenterology and Nutrition, 63*, 481–487. https://doi.org/10.1097/mpg.00000000000001230

Kowalski, K., Rhodes, R., Naylor, P. J., Tuokko, H., & MacDonald, S. (2012). Direct and indirect measurement of physical
Högström, S., Philipson, A., Ekstav, L., Eriksson, M., Fagerberg, U. L., Falk, E., Möller, M., Sandberg, E., Särnblad, S., & Duberg, A. (2022). Dance and yoga reduced functional abdominal pain in young girls: A randomized controlled trial. European Journal of Pain, 26, 336–348. https://doi.org/10.1002/ejp.1862

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Walker, L. S., Dengler-Crish, C. M., Rippel, S., & Bruehl, S. (2010). Functional abdominal pain in childhood and adolescence increases risk for chronic pain in adulthood. Pain, 150, 568–572. https://doi.org/10.1016/j.pain.2010.06.018

World Health Organization. (2016). Growing up unequal: Gender and socioeconomic differences in young people’s health and well-being. Health policy for children and adolescents, no. 7. Health Behaviour in School-aged Children (HBSC) Study: International Report From The 2013/2014 Survey. Retrieved from http://www.euro.who.int/__data/assets/pdf_file/0003/303438/HSBC-No.7-Growing-up-unequal-FULL-REPORT.pdf

World Health Organization (2020). Guidelines on the management of chronic pain in children. Retrieved from https://www.who.int/publications/i/item/9789240017870

Zeevenhooven, J., Rexwinkel, R., Van Berge Henegouwen, V. W. A., Krishnan, U., Vandenplas, Y., Strisciuglio, C., Staiano, A., Devanarayana, N. M., Rajindrajith, S., Benninga, M. A., & Tabbers, M. M. (2020). A core outcome set for clinical trials in pediatric functional abdominal pain disorders. Journal of Pediatrics, 221, 115–122.e115. https://doi.org/10.1016/j.jpeds.2020.02.032

Zeevenhooven, J., Timp, M. L., Singendonk, M. M. J., Benninga, M. A., & Tabbers, M. M. (2019). Definitions of pediatric functional abdominal pain disorders and outcome measures: A systematic review. Journal of Pediatrics, 212, 52–59.e16. https://doi.org/10.1016/j.jpeds.2019.04.048