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Iyengar Yoga for Adolescents and Young Adults With Irritable Bowel Syndrome

Subhadra Evans, **Kirsten C. Lung**, **Laura C. Seidman**, **Beth Sternlieb**, **Lonnie K. Zeltzer**, and **Jennie C.I. Tsao**
Pediatric Pain Program, University of California, Los Angeles.

Abstract

Objectives—Irritable bowel syndrome (IBS) is a chronic, disabling condition that greatly compromises patient functioning. The aim of this study was to assess the impact of a 6-week twice per week Iyengar yoga (IY) program on IBS symptoms in adolescents and young adults (YA) with IBS compared with a usual-care waitlist control group.

Methods—Assessments of symptoms, global improvement, pain, health-related quality of life, psychological distress, functional disability, fatigue, and sleep were collected pre- and posttreatment. Weekly ratings of pain, IBS symptoms, and global improvement were also recorded until 2-month follow-up. A total of 51 participants completed the intervention (yoga = 29; usual-care waitlist = 22).

Results—Baseline attrition was 24%. On average, the yoga group attended 75% of classes. Analyses were divided by age group. Relative to controls, adolescents (14–17 years) assigned to yoga reported significantly improved physical functioning, whereas YA (18–26 years) assigned to yoga reported significantly improved IBS symptoms, global improvement, disability, psychological distress, sleep quality, and fatigue. Although abdominal pain intensity was statistically unchanged, 44% of adolescents and 46% of YA reported a minimally clinically significant reduction in pain following yoga, and one-third of YA reported clinically significant levels of global symptom improvement. Analysis of the uncontrolled effects and maintenance of treatment effects for adolescents revealed global improvement immediately post-yoga that was not maintained at follow-up. For YA, global improvement, worst pain, constipation, and nausea were significantly improved postyoga, but only global improvement, worst pain, and nausea maintained at the 2-month follow-up.

Conclusions—The findings suggest that a brief IY intervention is a feasible and safe adjunctive treatment for young people with IBS, leading to benefits in a number of IBS-specific and general functioning domains for YA. The age-specific results suggest that yoga interventions may be most fruitful when developmentally tailored.

Address correspondence and reprint requests to Subhadra Evans, PhD, Pediatric Pain Program, Department of Pediatrics, David Geffen School of Medicine at UCLA, MDCC 22-464, 10833 Le Conte Ave, Los Angeles, CA 90024 (suevans@mednet.ucla.edu).

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Keywords

adolescents; irritable bowel syndrome; yoga; young adults

Irritable bowel syndrome (IBS) is a common, complex disorder characterized by abdominal pain and altered bowel habits. IBS and related functional bowel disorders are a common cause of illness-related absenteeism, second only to the common cold (1), and substantially affect quality of life (2).

Although IBS is typically diagnosed in adulthood, symptoms often present in childhood and adolescence (3). Quality of life is greatly compromised in young patients. Children and adolescents with IBS are more likely to miss school, refrain from normative activities, require care, and exhibit psychological difficulties compared with healthy children (4,5). It is likely that IBS takes a particular toll on the academic and social functioning of adolescents and young adults (YA), during a period when dating, social acceptance, and academic performance become paramount concerns. Fear of pain and/or diarrhea may severely limit the adolescent and YA patient's willingness to attend school and social outings. Such fear further exacerbates symptoms, and over time, IBS symptoms and fear of pain can evolve into a vicious cycle in a young person (6).

IBS remains difficult to treat and mind-body approaches, such as yoga, hold promise in addressing the symptom and quality-of-life concerns of IBS patients (6). Yoga consists of *asanas* (body postures) as well as *pranayama* (proscribed breathing patterns) and meditation, which together have the potential to impact patient's physical and psychological health. Given that patients with IBS are at relative risk for mood disorders, anxiety, and neuroticism (7), yoga could ameliorate psychological distress in patients, with further downstream effects on pain.

Yoga is commonly practiced to reduce stress and pain (8). Despite its widespread acceptance among patients with IBS (9), there is a dearth of randomized controlled trials (RCTs) on the specific effects of yoga for chronic pain conditions, particularly among young patients. Only a handful of studies have focused on the use of yoga for IBS, demonstrating evidence in reducing IBS symptoms (10,11), at least on par with pharmacological treatment (12); however, these studies are limited in various ways, including small sample sizes, use of an exclusively male sample (despite IBS disproportionately affecting women) (11), and an unclear yoga protocol (12).

For the purpose of the present study, we focus on Iyengar yoga (IY), a tradition that may be particularly suited to treating chronic medical conditions (13). Sequences are tailored in a prescription-like manner for specific problems; teachers receive extensive training in anatomy, physiology, and safety; and the use of props reduces potential for strain or fear of injury. Emphasis on alignment is unique, and it is believed that maintaining poses with an effort toward understanding alignment strengthens muscles, organs, and joints, and develops mindfulness of poor posture and habituation to normative bodily sensations (14).

The main aim of the study was to assess the impact of a 6-week IY intervention on the primary outcome of IBS symptoms, in a sample of 14- to 26-year-old adolescents and YA with IBS to that of a usual-care waitlist control group within a randomization group assignment. Adolescence and early adulthood were chosen as the target age range owing to the significant impact of IBS on personal functioning during this life stage. The secondary aim was to examine treatment effects and maintenance of treatment gains on all of the participants who received the IY intervention (ie, combining the immediate and waitlisted yoga groups) on data from a weekly monitoring report of global improvement and IBS symptoms—including pain, constipation, diarrhea, and nausea—before, during, and after treatment. An additional aim was to test the effects of developmental stage on IY outcomes by analyzing data separately for adolescents (14–17 years) and YA (18–26 years).

METHODS

Study Design

Upon entry, participants were randomized to receive either immediate yoga (yoga group) or usual-care waitlist (control group) in a 1:1 ratio. The control group continued with usual care under the supervision of their primary physician or gastroenterologist for the duration of the study, and received yoga after the completion of the waitlist period. Thus, participants in the yoga group were assessed at 3 time points: baseline, posttreatment, and 2-month follow-up. The control group was assessed at 4 time points: baseline, postwaitlist (yoga group's posttreatment), posttreatment, and 2-month follow-up.

Inclusion Criteria—The inclusion criteria for the study were male and female participants ages 14 to 26 years with a diagnosis of having either recurrent abdominal pain, or IBS using Rome III pediatric criteria for patients ages 14 to 17 years, and Rome III adult criteria for 18- to 26-year-olds; ability to provide written informed assent or consent and to comply with the requirements of the study protocol; and ability to speak and understand English. Participants were excluded if they were pregnant; experienced any injury, disease, metabolic dysfunction, physical examination finding, or clinical laboratory finding that had the potential to affect the interpretation of the results or render the patient at risk for participating in the intervention; unable to comply with study and follow-up procedures; had previous practice of yoga within the last 3 months; unable to speak and understand English; or planned to begin a new treatment within 2 weeks of the IY program. Full approval for this study was received from the institutional review board of the University of California, Los Angeles.

Treatment Conditions

IY—The intervention consisted of 6 weeks of classes held twice per week. The classes were 1.5 hours in duration (total dose 18 hours). A make up class was available. Classes had a maximum of 6 students, led by an experienced IY teacher and assisted by a junior teacher. To standardize delivery, a working list of poses (Table 1) was developed with a senior teacher who served as an advisor to the study. Classes were held in the UCLA Pediatric Pain Program Yoga Studio, which is equipped with standard IY equipment, including ropes fastened securely to the walls, blankets, bolsters, and blocks.

A range of yoga postures were taught to students, including reclining postures, standing postures, forward bends, supported inversions, backbends, and seated postures. The postures were taught with props. Classes were sequenced over time, and as students developed skills, more challenging postures were introduced. To ensure that employed participants and full-time students had access, classes were held during a weekday evening and on a weekend afternoon. Homework was suggested, but not required, and interested participants were invited to take props home for the duration of the intervention.

Study personnel reviewed adherence to the protocol of key poses at regular intervals throughout the study. There were no deviations from the manualized yoga protocol, beyond those allowed to account for individual differences in comorbidities or injuries.

Usual-Care Waitlist Control Group—This condition controlled for the effects of routine care of patients treated for IBS. All of the participants continued with usual care under the supervision of their primary care physician or gastroenterologist. Although the control group did not account for the social, attention, or expectation aspects of IY, a usual-care control group is appropriate when examining a novel treatment in an untested population. Control participants were contacted weekly by a research assistant, who administered a weekly monitoring form (WMF; see Measures). Upon completion of the waitlist period, the control group participants were offered the yoga intervention.

Recruitment and Assessment

Recruitment for the study occurred between October 2009 and May 2013, with recruitment continuing during yoga class cohorts. The primary recruitment strategy included advertisements in gastroenterology offices and local community bulletin boards, support group newsletters and events, physician referrals of patients, postings in university and local community bathrooms, and online sources (eg, Craigslist, the ClinicalTrials.gov Web site). Participants who lived >25 miles away from the yoga studio where classes were administered were offered $10 toward each session attended to cover gas expenses.

Eligibility was determined during a screening session via telephone with a qualified research assistant, and interested patients were informed that they would be randomized into either a yoga or a waitlist group. Before the baseline assessment, patients were randomized in blocks. A research staff member who was not otherwise involved in the study used the research randomizer program as a means to generate random numbers for patient assignment to the intervention or waitlist group. Principal investigators were blinded to participant randomization during the study process.

The average wait time between screening date and baseline assessments was 2 months, and participants were scheduled for a baseline assessment approximately 2 weeks before the start of yoga classes. All of the eligible participants were e-mailed a link to complete a battery of questionnaires (detailed below) at the baseline, upon completion of the yoga intervention, and at 2-month follow-up. In addition, weekly functioning data were collected from the participants. The WMFs were administered once per week for 2 weeks preceding the start of the intervention to determine baseline functioning, once per week throughout the duration of the intervention and again at 2-month follow-up. A link to an online version of

the monitoring form was e-mailed weekly to participants, and followed up with reminder e-mails to ensure timely completion.

Participants

One hundred twenty-nine participants were originally screened for study eligibility. As shown in Figure 1, of the 129 participants who were assessed for eligibility, 13 were excluded based on eligibility criteria. An additional 40 declined to participate, with the most common reason involving availability. Seventysix patients were willing to participate and were randomized to either the yoga or waitlist control group (Fig. 1). Of the 39 participants randomized to the yoga group, 34 were girls and 5 were boys; of the 37 randomized to the control group, 26 were girls and 11 were boys. There were no significant differences in the female-to-male ratio between the groups.

Of the 76 participants who were randomized, 4 dropped out of the yoga group (all girls) and 14 from the control group (9 girls, 5 boys) before beginning the study. The overall baseline attrition was thus 24% (10% for the yoga group and 38% for the waitlist group). A further 6 participants withdrew from the yoga group after completing the baseline assessments and a further 1 participant withdrew from the waitlist after completing the baseline assessments, leaving 29 completers in the yoga group and 22 completers in the waitlist group. Overall postrandomization attrition was, thus, 12% (17% for the yoga group and 4% for the waitlist group). There were no significant age or disease characteristic differences between those who dropped out of the study and those who completed. Equal numbers of adolescents (14–17 years) and YA (18–26 years) in each group withdrew.

The RCT results are based on the 51 participants who completed baseline and postassessments (yoga 29, control 22). Within the yoga group, there were 18 adolescents (14–17 years) and 11 YA (18–26 years). In the waitlist control group, there were 12 adolescents and 10 YA. Results regarding the maintenance of treatment benefits are based on the 51 yoga completers (from both yoga and waitlist groups).

All but 1 participant had a diagnosis of IBS according to Rome III criteria, with the remaining participant experiencing recurrent abdominal pain with continual pain and loss of daily functioning for 8 years. Participants received a diagnosis from their primary care doctor or gastroenterologist (in a number of cases, this diagnosis was confirmed by the study pediatrician). Twenty-four participants reported comorbid chronic conditions, with the most common being chronic headaches (n = 6). Other comorbid conditions reported include fibromyalgia, depression, anxiety, arthritis, and asthma. Nineteen individuals reported taking antidepressants. Nine reported taking proton-pump inhibitors, 4 were taking analgesics, and 5 reported using laxatives. Three participants noted taking melatonin. Additional demographic and clinical information is presented in Table 2.

Measures

Our selection of outcomes is consistent with the Pediatric Initiative on Methods, Measurement and Pain Assessment in Clinical Trials (PedIMMPACT) and the Initiative on Methods, Measurement and Pain Assessment in Clinical Trials (IMMPACT) guidelines on assessments in clinical trials of chronic pain (15,16).

Global Improvement was assessed with the *Global Improvement Scale* (GIS). This scale asks participants "Compared to the way you felt before you entered the study, have your IBS symptoms over the past 7 days been from (1) = substantially worse, to (7) = substantially improved?" Global improvement is noted for patients endorsing moderately or substantially improved status. The scale shows adequate reliability and validity (17).

Abdominal Pain Intensity was assessed with a *Numeric Rating Scale* (NRS), by asking participants how much their stomach usually hurt in the last week, from 0 (no pain) to 10 (most pain possible). Abdominal pain is frequently assessed with an NRS in clinical trials of IBS.

IBS Symptoms were measured using the abdominal symptoms subscale of the Child Somatization Inventory (CSI) (18–21). Items from the abdominal symptoms subscale include abdominal pain, nausea, diarrhea, constipation, feeling bloated, and feeling sick during the last 2 weeks using a 5-point scale (*not at all* to *a whole lot*) (22). We did not include pain because of our use of an NRS to assess pain (see above). Although the CSI is not typically used with YA, the items match those in most IBS questionnaires used with adults, and 1 set of questions across participants allowed for similar IBS symptom comparisons across age.

Health-Related Quality of Life was assessed with the *Health-Related Quality of Life—Short Form-36* (*SF-36*) (23). Consistent with PedIMMPACT and IMMPACT guidelines, the physical functioning subscale was used (15,16). The SF-36 performs well in terms of reliability, validity, and lightness of respondent/administrative burden (24). Higher scores indicate better functioning.

Functional Disability Index (*FDI*) (20) is a 15-item measure assessing perceived difficulty in physical and psychosocial functioning in the last 2 weeks because of physical health. Items are rated on a 5-point scale (*no trouble* to *impossible*).

Psychological Distress was evaluated using the *Brief Symptom Inventory 18* (BSI-18) (25). Respondents rate how often they have experienced anxiety, somatization, and depressive symptoms within the last 7 days on a 5-point scale ranging from *not at all* to *extremely*. The BSI-18 has shown adequate to good internal consistency (α range = 0.74–0.89) and validity (25).

Functional Assessment of Chronic Illness Therapy Fatigue Subscale (FACIT-Fatigue) (26) includes 13 items that assess physical and functional consequences of fatigue. Scores range from 0 to 52 on a reverse 4-point Likert scale, with higher scores indicating less fatigue.

The Pittsburgh Sleep Quality Index assesses sleep quality during the previous month (27). The Pittsburgh Sleep Quality Index comprises 7 components scored from 0 (best) to 3 (worst). The subjective sleep quality component was used, with lower scores indicating less sleep problems.

Weekly Monitoring Form (WMF) assessed participants' weekly global improvement as well as weekly worst pain, constipation, nausea, and diarrhea using a 0 to 10 NRS. For example,

patients were asked to rate their worst pain during the last week from 0 (no pain) to 10 (worst pain imaginable). Participants were also asked to report any adverse events during the classes, any changes in medication, extent of home practice of yoga, and level of physical activity.

Statistical Analyses

Sample Size Calculation—The primary point of comparison between the 2 groups was a reduction in IBS severity (measured by the gastrointestinal subscale of the CSI). We used the method of deriving a sample size by specifying an effect size based on a minimally important clinical difference (MICD). In the case of IBS symptoms, an MICD of 50 for the IBS severity scoring system was used to calculate power (28) because no MICD was available for the CSI.

The standard deviation has been estimated to be 42 for a comparable group of subjects (28). A correlation of 0.5 is assumed between baseline and follow-up scores for individuals. These specifications were used to calculate an effect size for a power analysis, which computes as a Pearson correlation of 0.5115 for the 2 groups and an associated R^2 of 0.2616. Selecting a difference in 2 independent means and calculating the sample size needed for a Type I error rate of $\alpha = 0.05$, statistical power of 0.80 (the Type II error rate, $1 - \beta$), and an effect size of $d = 1.19$, the sample size required to show a statistically significant effect was estimated at 26 per group. Assuming a 20% attrition rate, 32 subjects per group would need to be recruited.

Data Analyses—We analyzed the data in a per-protocol manner owing to the preliminary nature of the study, the small sample size, and the risk of an intent-to-treat analysis resulting in Type II error (29). To ensure that randomization produced equivalent groups, *t* tests and χ^2 tests compared the yoga and control groups on demographic and baseline clinical variables. The data were analyzed for skewness and to ensure that data met assumptions for parametric tests. We performed per-protocol analyses, including only those participants who completed both pre- and postintervention assessments. A minimum α level of 0.05 was used to determine statistical significance.

Inferential analysis took place in 2 stages. We first conducted analysis of treatment effects in the controlled trial data (pre- to posttreatment in the yoga versus waitlist groups on the primary and secondary outcomes). Posttreatment group effects were analyzed using analysis of covariance (ANCOVA) controlling for baseline scores. The groups' baseline scores on the individual outcome measures were included to ensure that baseline measure differences between the groups were accounted for. Any significant differences on disease characteristics between the groups were also included as covariates. For the GIS, χ^2 analysis was used to compare the yoga and control groups' global improvement of symptoms following the yoga group's posttreatment assessment (corresponding with the control group's postwaiting period). Clinical significance was calculated for global improvement. As recommended by IMMPACT guidelines, the percentage of patients reporting global improvement (ratings above "slight improvement") was calculated. Clinical significance was also calculated for abdominal pain. Consistent with standards for minimally clinically

significant differences (MCSDs), a raw change of −1 point on the NRS is considered clinically meaningful for adolescents (30). The standard for adults, a raw change of −1.74 points on the NRS (31), was used for the YA group.

Second, we analyzed uncontrolled effects and treatment gains on all of the participants who began treatment (ie, yoga and waitlist groups combined, n = 51) using mixed-model analysis. We used post–waiting list assessments as pretreatment assessments for waiting list participants. Linear mixed models were performed to assess significant linear trends over time for global improvement and IBS symptoms before, during, and after treatment. Tests evaluated differences from baseline to 2-month follow-up to evaluate maintenance of treatment gains. Mixed models can handle missing data and do not require that such data points be excluded or estimated. Random intercepts were included in the models, with time as the independent factor. Separate analyses were conducted for each of the measures. Inferential statistics and modeling was accomplished with SPSS version 19.0 (IBM SPSS Statistics, Armonk, NY).

An additional aim of the study was to examine the effects of developmental stage on yoga impact. Thus, analyses were conducted separately for the 30 adolescents (14–17 years) and 21 YA (18–26 years).

RESULTS

Preliminary Analyses

Demographic information for participants is presented in Table 2. Initial tests revealed no baseline difference between the yoga and control groups on demographic and clinical variables, including age, duration of IBS, bodily pain, sex, race, and ethnicity. The data met normality assumptions and ANCOVAs examining group differences at postintervention controlling for baseline scores were performed.

Controlled Trial

Results from ANCOVA analyses evaluating posttreatment group differences on outcomes for each age group are displayed in Tables 3 and 4. For adolescents, there was 1 significant difference between the yoga and control groups: SF-36 physical functioning, with the yoga group reporting higher physical functioning than the control group. In contrast, YA in the yoga group reported multiple significant improvements compared with the control group, including IBS symptoms, functional disability, psychological distress, sleep quality, and fatigue. There were no statistically significant differences on abdominal pain or physical functioning. As detailed below, χ^2 tests for the GIS also revealed that the YA yoga group reported significantly greater improvement compared with controls.

Clinical Significance—Results from χ^2 analyses evaluating global improvement in symptoms are displayed in Figure 2A and B. In YA only, the yoga group was significantly more likely to endorse items related to improvement than were controls ($\chi^2 = 11.13$, $P = 0.03$). In the yoga group, 5 participants (45%) reported slight improvement, and 3 (27%) reported moderate improvement. Thus, according to IMMPACT guidelines, approximately one-third of participants in the yoga group reported clinically significant improvement in

IBS symptoms. Of note, none of the yoga group reported substantial improvement and 1 yoga participant actually reported being substantially worse postintervention. Although χ^2 analyses for the adolescents were not significant ($\chi^2 = 6.18$, $P = 0.19$), 6 in the yoga group (33%) reported moderate improvement. For abdominal pain, 44% of adolescents experienced a reduction of at least 1 point on the NRS, which is an MCSD, and 46% of YA experienced a reduction of at least 1.74 points on the NRS, an MCSD.

Uncontrolled Effects and Maintenance of Treatment Response

Figure 3A and B depict the WMF data across baseline, treatment, and follow-up. The baseline was created from averaging responses from the 2 weeks preceding yoga, which occurred at the beginning of the study for the yoga group and after the waitlist period for the waitlist group, weeks 1 to 6 of the yoga intervention, and then 2 months following completion of yoga for both groups.

Mixed-model tests of fixed effects for the adolescent group revealed that over time, yoga led to significant improvements in global improvement ($F(177) = 2.18$, $P = 0.03$) with scores improving relative to baseline at the fourth week of yoga ($t(176) = 1.97$, $P = 0.05$) until the end of the intervention. Scores at the 2-month follow-up were not significantly different to baseline indicating no maintenance of improvement. There were no significant reductions in abdominal pain, constipation, diarrhea, or nausea.

Mixed-model tests of fixed effects for the YA group revealed that over time, yoga led to significant improvements in global improvement ($F(113) = 3.37$, $P = 0.00$) with scores improving relative to baseline from the second week of yoga ($t(113) = 3.10$, $P = 0.00$) that maintained across the intervention and at the 2-month follow-up ($t(115) = 3.64$, $P = 0.00$). Worst pain was significantly reduced over time ($F(112) = 2.16$, $P = 0.04$); improvement in worst pain began at week 4 ($t(111) = -2.68$, $P = 0.01$), was not significantly different from baseline at weeks 5 and 6, but did differ significantly from baseline directly after the yoga intervention ($t(115) = -2.66$, $P = 0.01$) and at the 2-month follow-up ($t(113) = -3.05$, $P = 0.00$). There was a significant time effect for constipation ($F(112) = 2.52$, $P = 0.02$), which began during the final week of the intervention $t(112) = -3.66$, $P = 0.00$) and trended toward significance at the 2-month follow-up ($t(112) = -1.79$, $P = 0.07$). There was a significant time effect for nausea ($F(112) = 2.12$, $P = 0.04$) that was significantly reduced compared with baseline starting the second week of classes $t(112) = -2.10$, $P = 0.04$) and maintained at the 2-month follow-up ($t(112) = -2.22$, $P = 0.03$). There were no significant time effects for diarrhea in the YA group.

Yoga Practice

The average number of classes attended in the yoga group was 9.3, and 35% completed the full course of yoga (12 classes). The average number of classes attended in the waitlist group was 8.8, and 9% completed the full course of yoga. There were no attendance differences between the age groups (9.8 classes for the adolescents and 8.8 for the YA). Forty-three participants reported practicing at home: 25 in the yoga group (adolescent 14, YA 11)) and 18 in the waitlist group (adolescent 12, YA 6). Duration of home sessions ranged from 5 to 60 minutes for the entire intervention (mean 4 min/week). At the 2-month

follow-up, 5 participants still reported practicing yoga during the previous week, either in a class setting or at home.

We examined correlations between yoga practice (total hours of yoga classes; total minutes of home practice) and outcomes for each age group. There were no significant correlations between any of the yoga practice and outcome variables for adolescents. For YA, a significant relation emerged between IBS symptoms and number of hours of yoga classes ($r = -0.55$, $P = 0.02$); and BSI-global severity and number of hours of yoga classes ($r = -0.54$, $P = 0.025$). There were no significant correlations for amount of home practice.

Adverse Events

One yoga-related adverse event occurred. The case involved a participant slipping out of a rope while in headstand and hitting his knee. Following the incident, the participant reported that his knee was not problematic, and he went on to complete the yoga intervention. The event was self-limited and deemed by the investigators and data safety monitoring board to not be serious.

DISCUSSION

The yoga intervention significantly improved physical functioning in adolescents, and IBS symptoms, global improvement, psychological distress, functional disability, fatigue, and sleep quality in YA relative to waitlist controls. Average abdominal pain intensity in adolescents and YA remained statistically unchanged; however, approximately half of adolescents and YA experienced a clinically significant reduction in abdominal pain. On the whole, our findings indicate developmental differentiation in response to our IY protocol with YA benefitting more than adolescents.

Analyses examining maintenance of treatment effects on IBS symptoms were also conducted separately for each age group. Combining the yoga and waitlist yoga groups allowed for increased power to examine the impact of IY over time for each age group. For adolescents, the combined group (yoga and waitlisted yoga) showed improvement in functioning over time for global improvement of symptoms, which was not maintained at the 2-month follow-up. The YA combined group showed improvements over time for global improvement of symptoms as well as IBS-specific symptoms, including worst pain, constipation, and nausea. Global improvement of symptoms, worst pain and nausea were still significantly improved relative to baseline at the 2-month follow-up.

In addition to demonstrating improvement in outcomes, the yoga intervention was safe. Adverse events were minimal, with only 1 self-limiting event related to yoga, and the participant continuing the IY intervention until completion. Participant attendance was somewhat limited. Average attendance for the groups was 9 of 12 classes and only 35% and 9% of the yoga and waitlisted yoga groups, respectively, completed the entire yoga protocol. Our findings regarding dose of IY and outcomes were not especially revealing, which is likely because of the relatively low number of participants who completed the entire complement of classes. There were no significant correlations between yoga practice and outcome variables for adolescents. For YA, number of hours of yoga classes across the

intervention was significantly related to reduced IBS symptoms and psychological distress, but home practice did not relate to outcomes. It is likely that the lack of significant correlations for home practice was because of low rates of practice. In the present study, home practice was suggested but not required. Approximately 20% of participants did not engage in any home practice, and for those who did, sessions were extremely limited (mean practice 4 min/week). Future research should prescribe home practice in a more systematic manner and test dose-response relations to determine maximal benefit as a function of class and home-practice time.

The results contribute to the literature showing that yoga is a relatively safe and feasible intervention for young people with IBS. Our results are also consistent with previous research supporting the use of yoga to improve IBS symptoms and function in young patients. In a recent single-arm pilot study of yoga for 20 children ages 8 to 18 years with IBS or functional abdominal pain (FAP), improvement in pain and quality-of-life outcomes were noted (10). An earlier, randomized waitlist trial with 25 adolescents ages 11 to 18 years with IBS that used a predominantly home-practice model of yoga demonstrated significantly less disability, anxiety, and problem coping in the yoga group compared with a waitlist control group, but no postintervention gastrointestinal differences between the groups. Our study expands upon these findings by including a larger sample size and a manualized, and thus replicable, yoga intervention. Although the findings were not as promising for adolescents compared with YA, our data indicate that a twice per week group yoga intervention leads to improvements in a number of IBS-specific and general functioning domains for YA. The WMF data showed that IBS symptoms were impacted midway through the intervention, and that global improvement, worst pain, and nausea continued to be significantly improved relative to baseline at the 2-month follow-up among YA.

Our yoga intervention did not appear to benefit patients of all ages with IBS equally. Our disparate age-related findings are not likely because of underlying recruitment, demographic, or practice differences between the age groups because similar attrition rates, demographics, clinical data, and adherence were evident across participants. A number of explanations are possible, including the distinct living situations of the groups. In order for children and adolescents to attend classes, motivation must be present in both the child and at least 1 parent, unlike a relatively independent YA population. The presence of the parent may also have been problematic for adolescents. Although we were careful to ensure parents were not present during classes (they were provided with refreshments at a nearby café), it is possible that the journey to and from classes resulted in increased strain on adolescent participants, many of whom had to travel an hour each way by car with their parent. We did not assess parent–child relationship quality, but it is conceivable that such long, frequent journeys may have provided an unintended opportunity for discord in already fractious dyads.

Adolescents with IBS may be particularly difficult patients to motivate and treat. Ours are not the only age-specific effects of yoga for IBS favoring a nonadolescent group. In a single-arm pilot study of yoga for children with IBS and FAP, longer-lasting effects were noted for 8- to 11-year-olds than for 12- to 18-year-olds (10). The yoga protocol used within this prior study was different from ours. It is possible that ours was more appropriate for YA, whereas

the previous IBS/FAP intervention was more appropriate for younger children. Our study involved a classic IY protocol, which requires a certain level of serious practice and attention to alignment, whereas the previous pilot included “specialized yoga exercises for children,” which may have differentially captured the attention and interest of younger children. Together, these findings suggest that a one-size-fits-all approach does not work for patients with IBS across development. Indeed, separate interventions for children, adolescents and YA may be warranted. At the least, yoga studies that include children should examine results separately by age group.

Limitations of our study are common to many nonpharmacological trials for chronic pain, and include inability to blind participants to their treatment assignment, lack of an active control group, and differential attrition between the groups. Differential attrition rates are perhaps one of the most substantial issues with this and other mind-body trials for pain. At baseline, approximately 4 times as many participants in the waitlist withdrew from the study compared with the yoga group. It is likely that the high rate of attrition was because of disappointment on the part of the control group when they understood that they would be required to wait for yoga. At 2 months, the average wait time between screening and first assessment was, unfortunately, long for all of the participants, and many waitlist participants may have felt unable to wait further before being offered yoga. It is also possible that unassessed psychological factors, which led to the large percentage of control participants withdrawing, ultimately rendered the groups unequal. This uneven attrition highlights the need for control conditions within yoga intervention studies to be attractive and motivating to participants. A further limitation is the lack of an active control group; it is not possible to determine whether the benefits seen in the yoga group were a result of the yoga intervention or to nonspecific effects such as group membership; however, a lack of consensus over an ideal yoga control group dominates the literature and our intention at this early stage of research was to ascertain whether yoga is a feasible, safe, and efficacious approach.

Young patients with IBS are in particular need of complementary interventions to treat symptoms and reduce disability. For a group that is expected to actively participate in social, work, and family life for many years to come, a behavioral intervention that can be incorporated into individual lifestyles and that targets physical and psychological health is critical to functioning. Not only does yoga share many of the benefits of traditional exercise but yoga is also likely to confer psychological benefits, as evidenced by the observed reduction in psychological distress among YA patients. Patients with FAP are at long-term risk for anxiety disorders, even when abdominal pain resolves (32). Yoga may emerge as an important intervention in preventing longer-term sequelae of psychological distress.

The results of the present study indicate that yoga is a valuable treatment tool for easing symptoms, improving quality of life and reducing distress in YA. Further research should explore interventions tailored in a developmentally sensitive manner to specific age groups. For example, it is possible that incorporating parents or other family members into the intervention would increase motivation and benefit in adolescents. A family-based yoga program may also improve family relationships, and alleviate the stress of some of the adolescent–parent dyads we observed. Because our weekly monitoring reports demonstrate trends for adolescents improving over time, it may also be the case that adolescents require a

longer intervention than YA to improve symptoms. Studies should also confirm the most effective intensity and dose of yoga treatment for IBS (33). It is possible that additional strategies, such as setting required homework sessions and providing support for completion of homework, would encourage completion of the yoga protocol, augment the benefits of yoga, and support the continued practice of yoga after the study's completion.

The findings of this RCT provide promising support for the safety, feasibility, and efficacy of traditional IY for YA with IBS. Our 6-week, twice-weekly intervention significantly improved physical functioning in adolescents and IBS symptoms, global improvement, psychological distress, disability, fatigue, and sleep quality in YA relative to waitlist controls. Moreover, the weekly monitoring data revealed statistically significant global improvement of symptoms for both adolescents and YA, as well as improvements in worst pain, constipation, and nausea that were maintained at the 2-month follow-up for YA. The findings suggest that developmentally tailored yoga treatments may best serve the therapeutic needs of patients with IBS.

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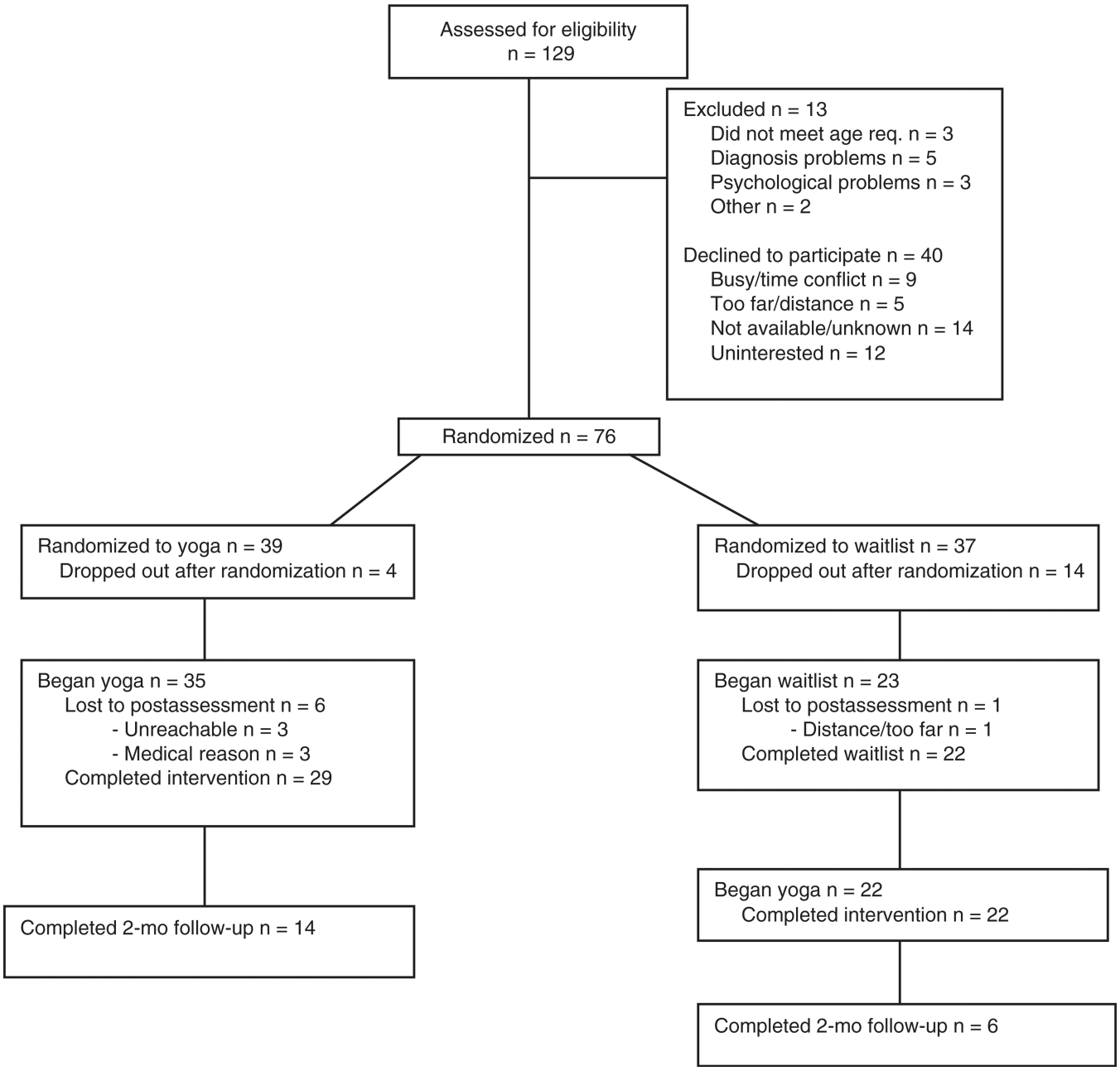

FIGURE 1.
Study participant flowchart.

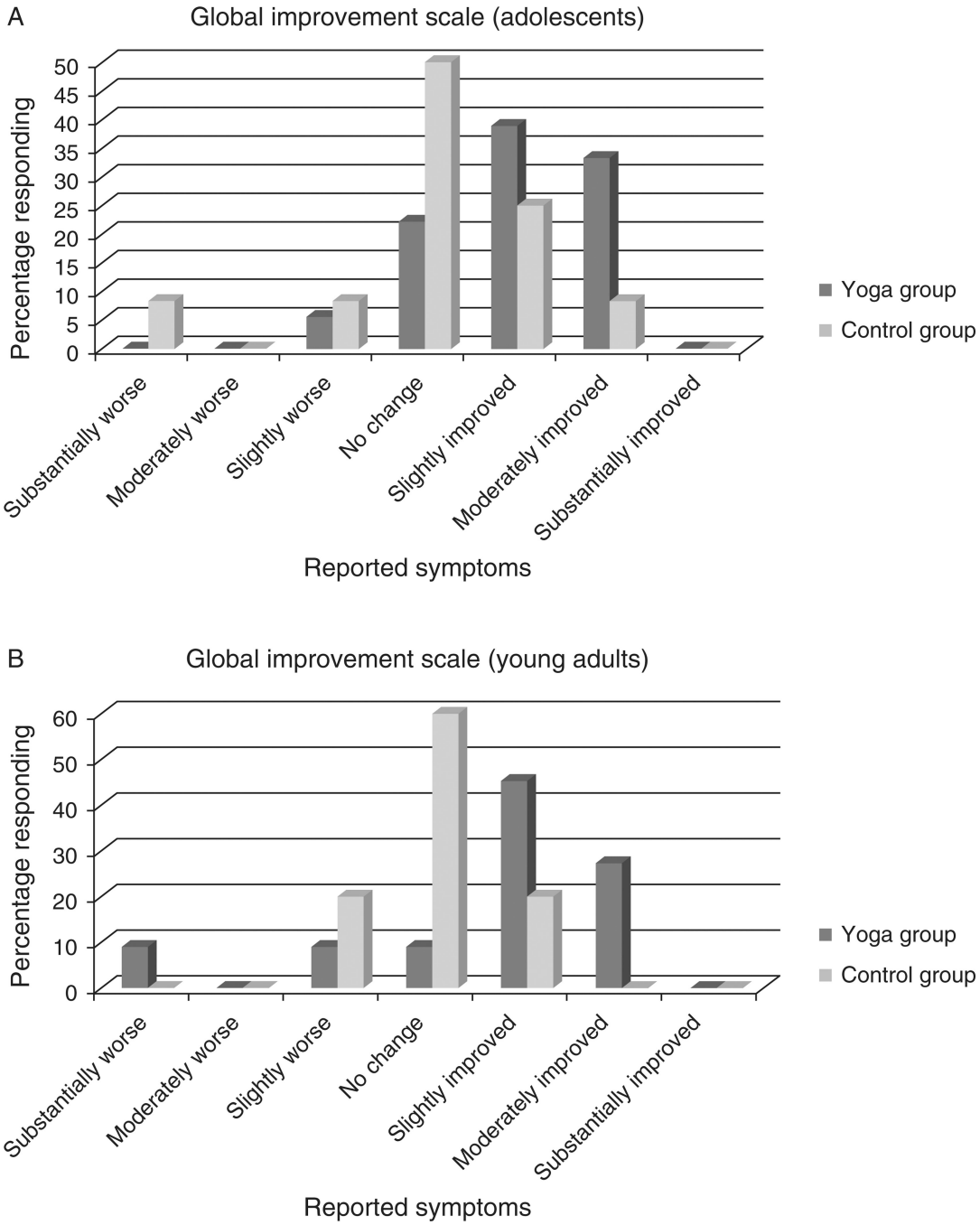

FIGURE 2.

A, Adolescents: percentage of each group responding to the GIS categories. B, YA: percentage of each group responding to the GIS categories. GIS = Global Improvement Scale; YA = young adults.

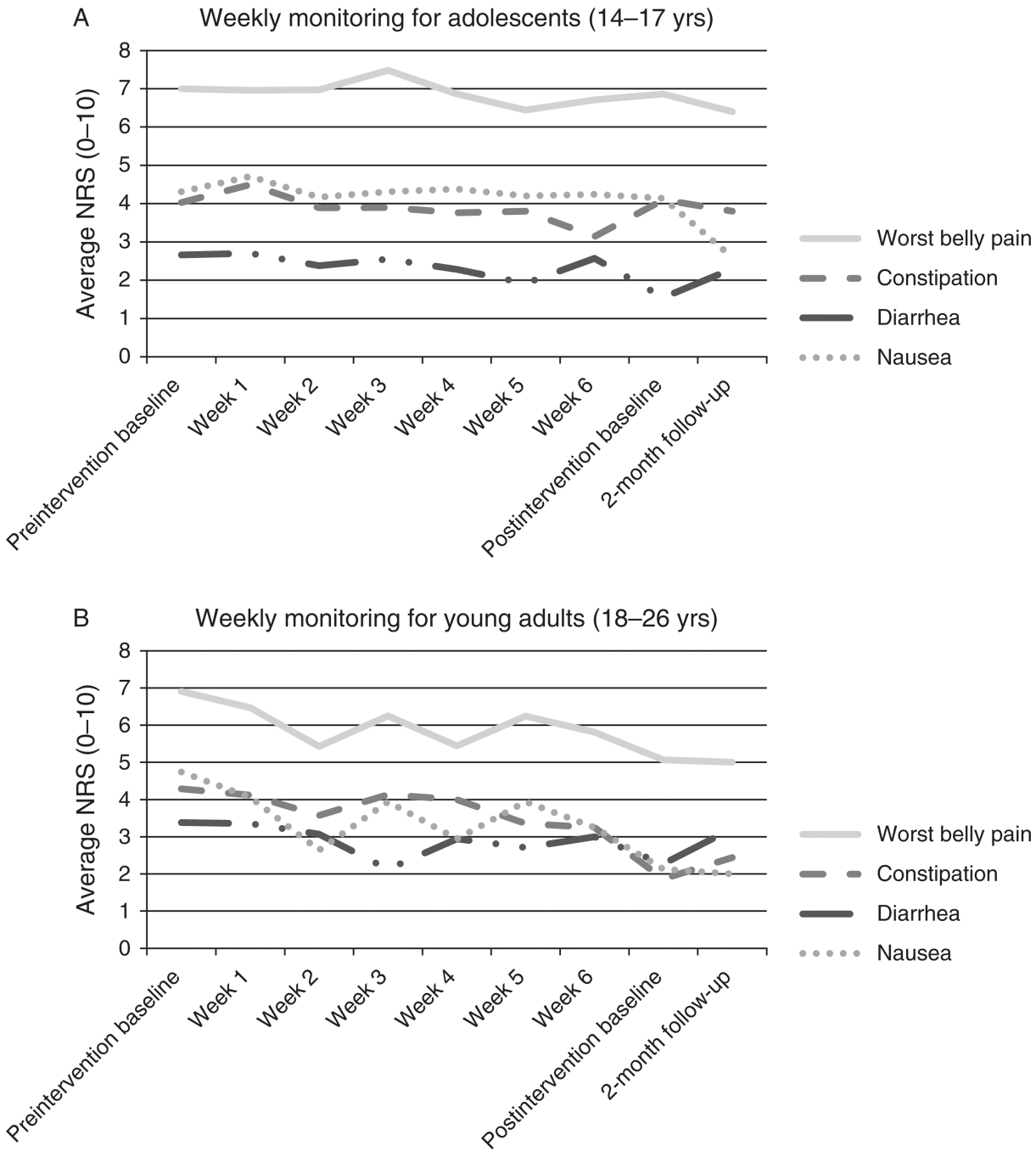

FIGURE 3.

A, Adolescents: weekly monitoring of belly pain, constipation, diarrhea, and nausea (pre-, during, and post-yoga) for the combined yoga and waitlist groups. B, YA: weekly monitoring of belly pain, constipation, diarrhea, and nausea (pre-, during, and post yoga) for the combined yoga and waitlist groups. YA = young adults.

TABLE 1

Key yoga postures for irritable bowel syndrome

Sanskrit name	Description
Reclining postures	
Supta Baddha Konasana	Reclining fixed angle posture
Supta Virasana	Reclining hero posture
Supta Padangusthasana	Reclining leg, foot, and toe stretch
Supta Swastikasana	Reclined cross posture
Standing postures	
Ardha Chandrasana with chair, or as needed	Half-moon posture
Prasarita Padottanasana	Wide-legged standing forward bend
Forward bends	
Janu Sirsasana	Head on knee posture
Inversions	
Adhomukha Svanasana with ropes	Downward facing dog posture
Salamba Sarvangasana and variations	Shoulder stand
Rope Sirsasana	Headstand at the rope wall
Setubhanda Sarvangasana on cross bolsters	Full bridge posture
Setubhanda Sarvangasana on bench	Full bridge posture
Viparita Karani	Inverted lake posture
Handstand	Handstand
Pincha Mayurasana	Forearm balance
Chair Halsana	Plow posture
Backbends	
Viparita Dandasana	Inverted staff posture
Purvottanasana on chairs	Upward plank posture
Seated postures	
Upavista Konasana	Seated wide angle posture

A more detailed list of poses and sequences is available from the corresponding author, upon request.

TABLE 2

Yoga and control group characteristics

Characteristic	Total sample (n = 51) n (%)/mean (SD)	Yoga group (n = 29) n (%)/mean (SD)	Control group (n = 22) n (%)/mean (SD)
Female (%)	43 (84.3)	27 (93.1)	16 (72.7)
Age, y	19.0 (3.9)	19.0 (3.7)	19.0 (4.2)
Years since diagnosis	2.7 (2.9)	3.3 (3.5)	2.1 (1.9)
Ethnicity (%)			
Hispanic	10 (19.6)	5 (17.2)	5 (22.7)
Non-Hispanic	41 (80.4)	24 (82.8)	17 (77.3)
Race (%)			
White	36 (72.0)	21 (72.4)	15 (71.4)
Multiracial	9 (18.0)	5 (17.2)	4 (19.0)
Asian	2 (4.0)	1 (3.4)	1 (4.8)
African American	3 (6.0)	2 (6.9)	1 (4.8)
Education (%)			
Some high school	10 (19.6)	6 (20.7)	4 (18.2)
High school	6 (11.8)	2 (6.9)	4 (18.2)
Some college completed	5 (9.8)	4 (13.8)	1 (4.5)
Associate’s degree	2 (3.9)	2 (6.9)	0 (0.0)
Bachelor’s degree	7 (13.7)	2 (6.9)	5 (22.7)
Master’s degree	1 (2.0)	1 (3.4)	0 (0.0)
Master’s degree or higher	1 (2.0)	1 (3.4)	0 (0.0)

TABLE 3

Estimated marginal means, change scores (95% confidence intervals), and ANCOVAs for yoga and waitlist adolescents

	Yoga		Waitlist				
	EMM	**Change (95% CI)**	**EMM**	**Change (95% CI)**	***F*(1,27)**	***P***	**Effect size (η^2_p)**
Abdominal Pain NRS	4.42	−0.62 (−1.28 to 0.04)	5.19	−0.15 (−1.01 to 0.71)	2.27	0.15	0.087
CSI-Gastrointestinal scale	10.36	0.00 (−1.48 to 1.48)	9.88	−0.69 (−2.44 to 1.05)	0.15	0.70	0.005
BSI-18 Global Severity	16.64	−2.18 (−7.27 to 2.92)	16.01	−1.85 (−7.67 to 3.98)	0.04	0.85	0.001
FDI	17.52	0.83 (−2.53 to 4.19)	15.21	−1.62 (−5.57 to 2.34)	0.79	0.38	0.028
SF-36 Physical Functioning	74.69	6.67 (2.87 to 10.47)	67.35	0.00 (−4.47 to 4.47)	9.46	0.01	0.252
PSQI Sleep Quality	1.34	0.06 (−0.37 to 0.48)	1.54	0.00 (−0.51 to 0.51)	0.46	0.50	0.016
FACIT: Fatigue	28.95	2.44 (−1.28 to 6.17)	25.15	−0.54 (−4.92 to 3.85)	1.94	0.18	0.065

ANCOVA = analysis of covariance; η^2_p = Partial Eta-Squared (group); BSI-18 = Brief Symptom Inventory, 18-item version; CI = confidence interval; CSI = Children's Somatization Inventory; EMM = estimated marginal mean; FACIT = Functional Assessment of Chronic Illness Therapy; FDI = Functional Disability Inventory; NRS = Numeric Rating Scale; PSQI = Pittsburgh Sleep Quality Index.

TABLE 4

Estimated marginal means, change scores (95% confidence intervals), and ANCOVAs for yoga and waitlist YA

	Yoga		Waitlist				
	EMM	**Change (95% CI)**	**EMM**	**Change (95% CI)**	***F*(1,19)**	***P***	**Effect size (η^2_p)**
Abdominal Pain NRS	3.66	−1.27 (−2.59 to 0.04)	4.85	−0.50 (−2.04 to 1.04)	2.26	0.15	0.124
CSI-Gastrointestinal scale	10.97	−2.27 (−3.80 to −0.75)	13.48	0.44 (−1.24 to 2.13)	5.68	0.03	0.250
BSI-18 Global Severity	13.06	−3.82 (−7.65 to 0.02)	18.93	3.00 (−1.24 to 7.24)	5.03	0.04	0.228
FDI	11.40	−1.73 (−3.85 to 0.39)	13.95	1.78 (−0.57 to 4.12)	5.06	0.04	0.230
SF-36 Physical Functioning	84.41	2.73 (−2.69 to 8.15)	80.73	0.00 (−5.99 to 5.99)	2.43	0.14	0.125
PSQI Sleep Quality	1.35	−0.36 (−0.71 to −0.02)	1.80	0.11 (−0.27 to 0.50)	6.16	0.02	0.266
FACIT: Fatigue	30.57	2.91 (−0.85 to 6.67)	25.87	−3.67 (−7.82 to 0.49)	4.29	0.05	0.202

ANCOVA = analysis of covariance; η^2_p = Partial Eta-Squared (group); BSI-18 = Brief Symptom Inventory, 18-item version; CI = confidence interval; CSI = Children's Somatization Inventory; EMM = estimated marginal mean; FACIT = Functional Assessment of Chronic Illness Therapy; FDI = Functional Disability Inventory; NRS = Numeric Rating Scale; PSQI = Pittsburgh Sleep Quality Index; YA = young adults.