The Clinical Journal of Pain Publish Ahead of Print
DOI:10.1097/AJP.0000000000000490

A Mindfulness Program Adapted for Adolescents with Chronic Pain: Feasibility, Acceptability and Initial Outcomes

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Disclosure of funding: This research was supported by a Pain Seed Grant from the Hospital for Sick Children's Pain Centre to D. Ruskin.

Abstract

Objectives: Pediatric chronic pain is a major health issue which can lead to significant interference in daily functioning. Mindfulness-based interventions (MBI's), which emphasize acceptance rather than control of pain, have gained increasing attention as a viable treatment option among adults with chronic pain. The effectiveness of MBIs for chronic pain in pediatric populations remains largely unknown. This prospective pre-post interventional study was conducted to examine the feasibility, acceptability and initial effectiveness of an 8-week group MBI for adolescents (MBI-A) with chronic pain.

Methods: Self-report measures assessing pain characteristics, anxiety, depression, disability, pain catastrophizing, perceived social support, mindfulness, and pain acceptance were administered at baseline, post-intervention, and at a 3-month follow-up. In addition, session data was collected to assess each session's impact on patients' coping with pain and stress, body awareness, and sense of feeling less alone.

Results: Forty-two consecutive patients in a tertiary care chronic pain clinic met eligibility criteria to participate in the MBI-A group. Of these, 21 participated. A treatment completion rate of 90.5% was observed. Between session mindfulness practice was reported by 77% of participants. Participants were highly satisfied with the MBI-A and all participants reported they would recommend the group to a friend. Improvements in pain acceptance were observed between baseline and the three-month follow-up, in domains of pain willingness and activity engagement. Session data revealed improved body awareness and improved ability to cope with stress across sessions.

Discussion: The MBI-A is a feasible, well-received intervention for adolescents with chronic pain conditions. Findings support the need for further investigation of the efficacy of MBI-A through randomized-controlled trials.

1. Introduction

Pediatric chronic pain affects between 11-38% of children [1] and is associated with impairments across numerous domains (e.g., physical, emotional, school attendance). [2,3] Chronic pain treatments focus on increasing function through the integration of pharmacological, physical and psychological modalities.[4] Often, despite our best efforts, pain persists [5,6] necessitating interventions that improve tolerance of symptoms and reduce pain-related distress.

Recently, mindfulness based interventions (MBIs) have emerged as a promising intervention for this purpose given their emphasis on improved tolerance of uncomfortable physical and emotional experiences. Mindfulness is a form of awareness that involves 'paying attention, on purpose, in the present moment, and nonjudgmentally'. [7,8] Individuals with chronic pain are taught to *approach* rather than avoid painful sensations and to assume a dispassionate attitude towards catastrophic cognitions ("I can't stand it") and emotions (anxiety, frustration) that often accompany and exacerbate pain. [9] Additional strategies such as thought diffusion, present moment awareness, and acceptance are also taught. [9] Over time, participants learn that while pain may be unavoidable, suffering and distress are optional. [10]

Meta-analytic reviews [11,12] of MBI's for adults with chronic pain report effect sizes in the small to medium range for reductions in pain intensity and depression/ anxiety and in the medium to large range for improvements in pain acceptance/interference. Recent research has shown that an 8 week MBI performed as well as cognitive behavioural therapy (an established psychosocial treatment for individuals with chronic pain[13]) in effecting meaningful and sustained reductions in disability and pain bothersomeness as compared to usual care in adults with chronic low back pain. [14]

In contrast, the pediatric literature is mainly composed of studies investigating MBI's for non-clinical populations (e.g., school children [15–17]), although studies are emerging for pediatric clinical populations (e.g., externalizing disorders, [18] substance use, [19] psychiatric conditions [20]). A recent meta-analysis showed that MBI's are three times more impactful for clinical versus non-clinical pediatric populations (*del* = 0.5 vs 0.197). [21]

To date, investigations of MBIs for pediatric chronic pain are limited and results are mixed. Hesse et al.[22] demonstrated improved depression (p = .009) and parent-reported quality of life (p = 0.49) but no changes in pain (p = .589) in 20 children with recurrent headaches after completing an eight week MBI program. A recent study comparing an MBI to a wait list control in adolescents with chronic pain failed to find differences between groups on emotional distress, quality of life, or pain perception but detected post mindfulness session reductions in salivary cortisol. [23] An RCT attempted to compare an MBI to a psychoeducation group among children with chronic pain but the trial could not be effectively evaluated given only six treatment completers. [24]

Acceptance and Commitment therapy (ACT), which incorporates mindfulness strategies and are considered a similar therapeutic approach given a focus on acceptance rather than control of discomfort, also show value for adolescents with chronic pain. For example, an RCT revealed that ACT was superior to multidisciplinary pain treatment on many outcomes including pain disability, fear of pain and health related quality of life [25] while another study, with a pre-post uncontrolled design, showed that an ACT intervention delivered to severely disabled adolescents with chronic pain resulted in reduced disability and improved psychological state and school attendance. [26] ACT therapies, however, differ from mindfulness in placing emphasis on commitment to behavior change in order to realize valued life goals.

Given limited published information on mindfulness interventions for adolescents with complex chronic pain conditions, our primary goal in this study was to determine the feasibility and acceptability of an MBI group intervention program adapted for adolescents with chronic pain (MBI-A). [27] Adolescents were selected as our target group recognizing the importance of this developmental period for expanding self-regulatory pain and emotion coping skills while reducing the risk for psychopathology associated with adolescence. [28] A second goal was to assess changes in secondary outcomes (i.e., pain acceptance, mood/anxiety, pain catastrophizing, and mindfulness) immediately following the MBI-A intervention and at three month follow-up. Based on the success of MBIs in adult chronic pain populations and benefits of mindfulness for adolescents, it was anticipated that the MBI-A would improve secondary outcomes. Consistent with prior MBI research [11,29,30] and given the focus of this intervention on acceptance rather than control of symptoms, we did not expect changes in pain intensity. Exploratory goals were to determine relationships between participants' levels of mindfulness and pain acceptance, weekly minutes of mindfulness practice and baseline characteristics that conceptually could influence their readiness for a mindfulness- acceptance based approach including pain chronicity (e.g., pain duration, disability level) and pain catastrophizing.

2. Materials and Methods

1. Participants

Participants were recruited from consecutive referrals to a major pediatric tertiary care multidisciplinary chronic pain clinic. Individuals were considered eligible if they were between the ages of 12 and 18 and diagnosed with a chronic pain condition. Patients with a severe cognitive impairment that would impede ability to participate in the group were excluded from participating in the study.

2.2 Measures

Primary outcomes of this study focused on feasibility and acceptability of the MBI-A program. In keeping with evaluation criteria employed in other studies assessing the feasibility of interventions, [31] we evaluated the current program using the following criteria: a) recruitment and retention, b) treatment acceptability, and c) treatment timing. *Recruitment and retention* was measured by (i) accrual and dropout rates, (ii) attendance and punctuality records (defined as treatment completers when the participant arrived on time and attended six of eight sessions), and proportion of completed questionnaires (defined as 100% when all measures completed immediately and three months post intervention). *Treatment acceptability* was measured by (i) participation in group activities (defined as treatment accepters when the participant completed all group exercises and activities for a minimum of six of eight sessions), (ii) compliance with the home practice (defined as 'having practiced' when participant listed minutes of practice on weekly mindfulness meditation logs) and (iii) satisfaction with the intervention, as measured by a satisfaction questionnaire administered following the intervention. *Treatment timing* was measured by (i) comparing group recruitment and retention between both groups (Fall versus Spring).

Secondary outcomes to evaluate the impact of the MBI-A included pain-related domains (e.g., pain intensity, functional impairment, pain catastrophizing, pain acceptance), emotional factors (anxiety and depression), mindfulness and social support. Specific measures are listed below.

2.2.1. Adolescent Health Information Form

The Adolescent Health Information Form (AHIF) was developed for the purposes of this investigation. The AHIF was administered at baseline to gather the following demographic and health information: gender, age, pain diagnosis, duration of pain, presence of a comorbid health condition or mental health condition, and current treatment regime.

2.2.2. Pain Characteristics Questionnaire

Developed for the purposes of this investigation, the 5-item pain characteristics questionnaire (PCQ) queried the nature, frequency, and location of participants' pain. Using a 0 to 10 numeric rating scale, participants provided ratings of their current, average, best, and worst level of pain over the past week, and rated the degree to which their pain "bugged" them over the past week.

2.2.3 Functional Disability Index

The Functional Disability Index (FDI [32]) is a self-report measure assessing activity limitations in pediatric populations with health conditions. Using a four-point Likert-style scale, respondents answer 15 items assessing their psychosocial and physical functioning over the past two weeks. Responses on items are summed and higher scores are indicative of greater disability. The FDI is well validated across a number of pediatric health conditions. In pediatric pain populations, FDI scores are a strong predictor of pain, school-related disability, and somatic and depressive symptoms.[33] In the initial psychometric evaluation of the FDI in a pediatric pain sample, internal consistency ranged from .86 to .91. [33] Test-retest reliability of the measure over a 2-week period was .74 and over a 3-month period was .48. In the current sample at T1, excellent internal consistency was observed on the FDI, $\alpha = .91$.

2.2.4 Multidimensional Anxiety Scale for Children

The Multidimensional Anxiety Scale for Children (MASC [34]) assesses common symptoms of anxiety in children and adolescents. Respondents provide ratings to 39 items using a four-point Likert-style scale (0 = "never true about me," 3 = "often true about me"). A number of subscales scores can be derived from the MASC (e.g., physical anxiety, harm avoidance, social anxiety, and separation anxiety); however, for the current investigation, only the MASC total score (i.e., sum of all items), converted to *T* scores, was used. Items are summed and higher total scores on the MASC are indicative of greater symptoms of anxiety. The MASC has demonstrated good reliability and validity in community [35] and clinical adolescent populations [(e.g.,34,36)] and good test-retest reliability over 3-week and 3-month intervals. [34] In the current investigation at T1, $\alpha = .86$.

2.2.5 Columbia Depression Scale

The Columbia Depression Scale (CDS, previously the Columbia DISC Depression Scale [37]) is a 22-item yes/no questionnaire derived from the Major Depression Module of the Diagnostic Interview Scale for Children-IV (DISC-IV [37]). The CDS is developed for youth ages 11 and over. A total score is calculated and higher scores on this measure are indicative of more symptoms of depression. The depression module of the DISC-IV has excellent test-retest reliability in a clinical sample. [37] Several self-report measures, such as the CDS, have been derived from stem questions of the DISC-IV modules with strong psychometric properties reported. [38,39] In the current sample at T1, $\alpha = .83$.

2.2.6 Pain Catastrophizing Scale

The Pain Catastrophizing Scale (PCS [40]) is a 13-item scale that measures the degree to which individuals hold negative mental sets surrounding actual or anticipated painful experiences. The PCS evaluates three facets of catastrophizing – rumination, magnification, and helplessness – using a five-point Likert-style scale (0 = "not at all"; 4 = "all the time"). Responses on each item are summed to calculate a total score where higher scores suggest more catastrophizing about pain. The PCS is moderately positively correlated with negative affect and negatively correlated with positive affect, although is overall more strongly correlated with perception of pain severity and pain interferences.[41] Consequently, the PCS measures facets of the pain experience that is related but not redundant with other measures of pain and affect. The PCS has been extensively used in populations with and without pain conditions [42,43] and has well established internal consistency across a number of samples. Coefficient alpha in the initial validation of the PCS was .87. [40] Over six-week and 10-week periods, test-retest reliability in undergraduate students was .75 and .70, respectively.[40]

A child version of the PCS (PCS-C) has been developed for use in children aged eight to 16 years.[44] This measure is very similar to the PCS, with minor changes in the wording of questions and simplified response options. Unfortunately, the PCS and not the PCS-C was the primary measure of catastrophizing used in the pain clinic over the course of the study. However, given the similarity in the measures, it is believed that the PCS remains a good measure of catastrophizing in the adolescent age group. Moreover, strong internal consistent was found in the current sample at T1, $\alpha = .95$.

2.2.7

2.2 7 Child and Adolescent Mindfulness Measure

The Child and Adolescent Mindfulness Measure (CAMM [45]) is a 25-item measure of mindfulness skills in youth. It examines adolescents' ability to observe and accept internal experiences without judging them, and act with awareness, using a five-point Likert-style scale (0= "never true"; 4 = "always true"). Higher scores on the CAMM indicate higher levels of mindfulness and acceptance. [45] Evaluations of convergent validity for the CAMM suggest the measure is negatively correlated with measures of thought suppression and psychological inflexibility, and positively correlated with quality of life.[45] The CAMM has strong internal consistency, α = 95. Psychometric properties of the CAMM have primarily been examined in non-clinical populations;[45,46] however, in one investigation of adolescents with cancer, Cronbach's alpha was .76.[47] In the current sample at T1, internal consistency was low, α = .40.

2.2.8 Chronic Pain Acceptance Questionnaire-Revised

The Chronic Pain Acceptance Questionnaire-Revised (CPAQ-R [48]) is a 20-item self-report measure of acceptance of chronic pain. Items are answered using a 7-point Likert-style scale (0= "never true", 6= "always true"), yielding a total score, an Activity Engagement subscale score (i.e., engaging in life activities despite pain) and a Pain Willingness subscale score (i.e., recognizing that avoidance and control are frequently unhelpful when managing chronic pain)[48]. Higher scores are indicative of more pain acceptance. The reliability and validity of the CPAQ in adult chronic pain populations has been supported by a number of investigations.[48–50] Acceptable to good internal consistency on the CPAQ-R (α = .82 for Activity Engagement and α = .78 for the Pain Willingness) has been observed among adults in an interdisciplinary pain management program.[48] Both the Activity Engagement and Pain Willingness subscales are predictive of pain-related disability and distress.[48]

An adolescent version of the CPAQ-R has been developed (CPAQ-A[51]). At the time of implementing the MBI-A, the CPAQ-R was the primary measure of pain acceptance used. Unfortunately, awareness that an adolescent version of this scale existed did not occur until after initiating the current investigation. Consequently, a decision was made to continue using the CPAQ-R for consistency across participants. Nevertheless, in the current sample at T1, excellent internal consistency was observed on the full scale (α = .90), and good internal consistency was observed on the Activity Engagement (α = .88) and Pain Willingness (α = .81) subscales. Given these reliability scores, as well as similarities between the CPAQ-R and CPAQ-A, it is reasonable to expect that the CPAQ-R is adequately measuring participant's pain acceptance.

2.2.9 Multidimensional Scale of Perceived Social Support

The Multidimensional Scale of Perceived Social Support (MSPSS [52]) is a 12-item measure of perceived social support from family, friends, and significant others. Responses are provided using a seven-point Likert-style scale (1 = "very strongly disagree, 7 = "very strongly agree") and yield a total score, and a Family, Friends, and Significant Others subscale score. Higher scores are indicative of higher perceived social support. The MSPSS has been examined across a number of samples, including adolescents and adults.[53] The construct validity of the three subscales has been well supported [52–55] and the measure has been significantly negatively correlated with depression and anxiety.[52] In the initial development of the MSPSS among adults, acceptable internal consistency for the full scale (α = .78) and good to excellent internal consistency scores across the three subscales (Family α = .91; Friends α = 89; Significant Others α = .91) was reported. Subsequent investigations among community adolescents point to strong reliability of the full scale (α = .84-93) and subscales (α = .81-.92).[53,54,56] In the current sample at T1, α = .92 for the full scale and α = .95, α = .90, and α = .91 for the Significant Others,

Friends, and Family subscales, respectively.

2.2.10 Post-Session Questionnaire

The Post-Session Questionnaire was developed for the purposes of this investigation and was administered following each session across the eight-week program. Participants indicated daily minutes of mindfulness practice over the past week and also provided a rating from zero to 10 (0 = "not at all true"; 10 = "completely true") of the degree to which the session helped them 1) learn ways to cope with their pain, 2) learn ways to cope with their stress, 3) be more aware of their body, and 4) feel less alone. Minutes of practice across each day were tallied to calculate a weekly total. When a participant did not note any minutes of practice next to a day of the week but had completed the remainder of the Post-Session Questionnaire, the participant was calculated as having practiced zero minutes for that day.

2.2.11 Satisfaction Questionnaire

The Satisfaction Questionnaire is a measure developed for this study to obtain feedback from participants regarding their experience in the group. Participants rated from zero to 10 (0= "not at all satisfied"; 10= "the most satisfied ever") the degree to which the group helped them cope with pain, stress, and their sense of feeling alone. Participants also indicate (yes/no) whether they would recommend the group to a friend.

2.3 Intervention

Standard adult MBIs consist of eight week, two hour sessions and homework for 45 minutes a day, six days a week. Based on recommendations from several of the MBI studies with adolescents described above, [57,58] the adult chronic pain MBI program was modified to include reduced expectations for daily practice and a greater focus on experiential activities to illustrate mindfulness concepts. [57,59] Modifications were included to make MBI concepts more

developmentally appropriate. For example, while Jon Kabat-Zinn's traditional definition for mindfulness was presented,[8] more accessible terminology was presented such as "trust the process" and "patience" along with more traditional terminology such as "non-judgement" and "compassion." Experiential exercises were also used to illustrate concepts. For example, finger traps were passed around to participants to illustrate the concept of pain x resistance = suffering and "dilute the yuck" was used as a short hand for directing present moment awareness to pleasant along with unpleasant aspects of our experience. A parenting component was also included (not described in this article) to recognize that parents assist in reinforcing children's coping strategies. In contrast to the one study on MBI for adolescents with headache which minimally tailored typical MBI programming to address headache pain, [22] the MBI-A was purposefully adapted to address pain (e.g., approaching versus avoiding pain in body scan / ice cube meditation and metaphors to illustrate pain acceptance) (see Ruskin et al. for full MBI-A modifications and session by session content [27]). Sessions were led by two facilitators (DR, KW) who are completing MBI training through a University Mindfulness Meditation Certificate Course, and maintain personal meditation practices.

The MBI-A intervention ran after school for weekly two hour sessions over the course of eight weeks. Sessions focus on skill building and incorporate mindfulness meditations, exercises, and activities adapted specifically for pediatric chronic pain. Topics include: mind-body connection, the effects of stress on pain, living in the present moment, focused awareness, responding versus reacting to pain and/or difficult situations, approaching and co-existing with chronic pain, non-judgment, gratitude, kindness and compassion towards self and others. The group also encourages a regular daily meditation practice. At the beginning of the intervention, parents of study participants participate in a onetime workshop teaching the mindfulness skills

their children are learning, so they can reinforce these skills at home. Specific mindfulness skills introduced to parents included the concept of "responding versus reacting", using the STOP meditation practice (Stop, Take a breath, Observe one's experience, and Proceed with one's response[60]) to practice responding versus reacting during interactions with their teens, along with an exercise of parents using their values to guide interactions with their teens.

Attention was brought to treatment fidelity during the administration of the MBI-A groups. This occurred through the use of a structured session guide that was consistently implemented in the Fall and Spring groups. The same facilitators were also responsible for leading both groups.

2.4 Procedure

Following ethical approval being granted by the Research Ethics Board at the Hospital for Sick Children, patients at this hospital's chronic pain clinic with scheduled follow-up appointments were approached to participate in the study. Eligible patients were provided a letter outlining the purposes of the study and nature of the MBI-A group. All patients were subsequently contacted by the Research Project Coordinator (RPC) by phone or in person during their scheduled appointment so that additional information could be provided to interested participants. Once a patient agreed to participate in the study, informed consent was obtained. One week prior to starting the MBI-A group, participants completed baseline (T1) measures (i.e., PCQ, FDI, MASC, CDS, PCS, MSPSS, CAMM, CPAQ-R). Post-group measures (T2) were completed immediately after the final session, and follow-up measures (T3) were completed three months following the final session. All questionnaires were distributed via email using the REDCap platform [61] and participants received a $10.00 (CAD) gift card for completion of T2 and T3 measures, respectively.

Throughout the course of the eight weeks, participants completed the Post-Session Questionnaire at the end of every MBI-A session. At the final session, participants completed the Satisfaction Questionnaire. Participants (n = 18) also attended a focus group after completion of the group in which feedback about the MBI-A and suggestions for improvement were obtained (comments on feasibility are included in this paper, other qualitative data from focus groups is being prepared for summary in a separate paper). Of note, participants engaged in other treatments as usual during the study period including pharmacological, physical therapies and adjunctive counselling.

2.5 Analytic and Statistical Approach

Prior to undertaking the analyses, the two treatment groups (i.e., Spring and Fall) were compared on demographic and baseline clinical characteristics using *t*-tests and chi-square analyses. Although differences were not anticipated across group as content and facilitators were the same for both groups, equivalency was evaluated to confirm that groups could be combined for subsequent analyses. Groups did not differ in terms of age, $t(19) = .88$, $p = .39$, pain duration, $t(19) = 1.46$, $p=.16$, or pain diagnosis, χ^2 $(2,n=21) = .29$, $p = .86$. Groups also did not differ in terms of sex, χ^2 $(1,n=21) = .002$, $p = .96$; however, the majority of participants (95%) were female, with only one male participating across the two groups. Given that no significant differences were observed at T1 on any secondary outcome measures or on baseline demographic/clinical characteristics, groups were combined for subsequent analyses.

Primary feasibility outcomes including recruitment, retention and acceptability were examined using descriptive statistics. [62] Changes in secondary outcomes across the study's time points were examined using repeated measures analysis of variance (ANOVA). This approach was selected given that only minor issues with normality were observed for a small number of

measures (i.e., CPAQ-R, MSPSS and CDS), and that ANOVAs are generally robust against normality violations. [63] Repeated measures ANOVAs with post-hoc pairwise comparisons adjusted for multiple comparisons using Bonferroni's correction were conducted to compare T1, T2, and T3 scores on physical and emotional symptoms, pain catastrophizing, mindfulness, pain acceptance, and perceived social support. Changes in coping with pain, coping with stress, body awareness, and loneliness across earlier (session one) versus later (session seven) were evaluated using paired-samples *t*-tests. Lastly, exploratory analyses were conducted with study variables across time points using Pearson correlational analyses.

3. Results

3.1 Demographic Characteristics

A total of 21 individuals aged 12 to 18 participated across the two groups. Ten participants completed the Fall group and the remaining 11 participants completed the Spring group. Demographic characteristics and pain-related characteristics of the full sample are summarized in Table 1. The average disability score at T1 across participants was 23.57 (*SD* = 11.47) out of a total score of 60 on the FDI, suggesting that participants were experiencing a moderate level of disability pre-treatment, consistent with typical disability levels of adolescents presenting to chronic pain clinics. [32]

3.2 Primary Outcomes

3.3.1 Recruitment and Retention

Participation in the group was offered to 42 consecutive clinic patients (93% female) who met eligibility criteria. Of patients offered the group, 50% agreed to participate; 10 out of 21 in the Fall and 11 of 21 in the Spring. Scheduling conflicts and inability to contact patients who initially expressed interest were the two most frequent reasons for not participating in the group.

Treatment completers where defined, a priori, as patients who attended ≥ six of the eight sessions. None of the participants enrolled in the group dropped out prior to completion; however, two participants were identified as treatment non-completers, with both attending only five of eight sessions. Of the remaining participants, 32% completed all eight sessions (*n*=8), 20% attended seven sessions (*n*=5), and 24% attended six sessions (*n*=6). No difference in attendance was observed based on treatment timing (Fall *M* = 6.70, *SD* = 1.16; Spring *M* = 7.09, *SD* = .94, *t*(19) = -.85, *p* = .41). Review of punctuality records indicated that all group attendees arrived on time for sessions. Consensus from focus groups indicated that timing of offering the group after school worked well; however, because participants enjoyed the regularity of meeting together for mindfulness practice, they suggested either extending sessions to 10 or offering a 'mindfulness graduate' course that would enable continued group practice and connection.

With respect to completion of outcomes measures, 100% of participants completed T1 measures. Ninety-five percent of participants (*n*=20) completed T2 measures, and 81% of participants (*n*=17) completed T3 measures. Frequency of completing measures did not differ based on treatment timing (Fall or Spring) at any time point (T1, 100% completion in each group; T2, *t(*19) = .95, *p* = .35, T3, *t*(19) = -1.20, *p* = .24).

3.3.2 Treatment Acceptability

All participants who were present at sessions participated in session activities. On average, participants self-report practice of 59.03 minutes per week (median = 53.9 minutes, *SD* = 62.60, range = 0-246 minutes). Four participants reported no minutes of practice over the course of the 8 weeks. Minutes of practice significantly differed between the Fall (*M* = 21.48, SD = 35.20*)* and the Spring (*M* = 89.76, SD = 64.39) group, *t*(18) =-2.84, *p* = .01. All participants who reported no minutes of practice over the 8 weeks participated in the Fall session.

The average satisfaction rating across both groups was 8.29/10 (range = 7-10, *SD* = 1.28). No significant differences were observed in satisfaction ratings based on treatment timing, $t(17) = -1.22$, $p = .24$. All participants reported they would recommend the group to a friend.

3.4 Secondary Outcomes

3.4.1 Treatment outcomes

Changes in physical and emotional symptoms, pain catastrophizing, mindfulness, pain acceptance, and perceived social support were examined across the three time points. Means and effect sizes are summarized in Table 2. Significant improvements across time were observed for the CPAQ-R. Conversely, scores significantly increased over time on the FDI.

3.4.2 Session Outcomes

Session data assessed the degree to which participants perceived MBI-A sessions to improve their coping with pain, coping with stress, body awareness, and feeling less alone. Average participant ratings across each of the four areas were compared between earlier sessions (session one) to later sessions (session seven; session eight could not be used due to a measure administration error in which the Post-Session Questionnaire was not administered in session eight for group two). Paired-samples *t*-tests comparing mean session ratings between session one and session seven in each of the four areas revealed statistically significant improvements over time in the areas of coping with stress, session 1 $M = 4.79$ (3.49), session 7 $M = 7.86$ (1.79), $t(13) = -3.68$, $p < .01$, and body awareness, session 1 $M = 7.77$ (1.74), session 7 $M = 8.84$ (1.34), $t(12) = -2.42$, $p = .03$. No significant changes were observed for coping with pain, $t(14) = -1.50$, $p = .16$, or feeling less alone, $t(12) = -.16$, $p = .88$. High average participant ratings were observed across sessions one to seven (see Figure 1).

3.5 Exploratory Analyses

The relationship between patient baseline clinical variables and mindfulness and acceptance outcomes was examined through correlational analyses. Participation variables (minutes of practice, number of sessions attended) were also examined. At baseline, lower levels of mindfulness were associated with longer pain durations (r = -.60, p = .004) and higher levels of disability (r = -.48, p = .03). However, these associations were not seen at T2 or T3. *R*-to-*z* transformations showed that these associations were significantly stronger at T1 than at T3, z = -2.13, p = .03 for mindfulness and pain duration and were significantly stronger at T1 than at T2 for mindfulness and disability, z = -.201, p = .04.

Relationships were seen between pain acceptance and several study variables. First, higher pain catastrophizing at T1 was correlated with lower pain acceptance across all times points (T1, r = -.64, p < .01, T2, r = -.51, p = .03, T3, r = -.70, p < .01) and lower mindfulness at T1, r = -.57, p < .01. In contrast, higher pain acceptance at T2 and T3 was correlated with greater perceived support from family at T1 (r = .59, p = .01, r = .56, p = .02, respectively). Further, greater perceived social support from friends at T1 was correlated with more activity engagement, a component of pain acceptance, at T2, r = .48, p = .04. Lastly, more reported minutes of practice was correlated with greater mindfulness immediately following the MBI-A at T2, r = .47, p = .04, and number of sessions attended was associated with higher levels of activity engagement immediately following the intervention at T2, r = .51, p = .03. Correlation coefficients are summarized in Table 3.

3. Discussion

This study is one of the first to demonstrate the feasibility, acceptability, and initial outcomes of a mindfulness based intervention adapted for adolescents with complex chronic pain

conditions. Findings demonstrate feasibility of the MBI-A as evidenced by a 90.5 % treatment completion rate, no drop outs, and good completion of outcome measures (100% completion at T1, 95% at T2 and 81% at T3). Prior MBI studies for pediatric chronic pain were largely unsuccessful in obtaining follow-up outcome data. A strength of this study is the collection of three-month follow-up outcomes on the majority of participants, enabling evaluation of the effectiveness of the MBI-A at multiple time points. Success in obtaining good outcome completion rates may reflect a combination of satisfaction with the intervention, honorariums for completion of study measures and online administration of measures. [64] Acceptability of the MBI-A was seen through good satisfaction ratings (*M* = 8.29/10), completion of session activities (90.5%), and compliance with home practice (*M* = ~60 min per week). All group participants indicated they would recommend the group to a friend. Approximately half of the adolescents approached for the study participated in the MBI-A, suggesting that adolescents are open and willing to try this type of intervention. However, given that scheduling conflicts were the primary reason for being unable to attend, other aspects of MBI-A implementation should be considered, such as providing more choice of session days/times or having the option of joining remotely via telemedicine as has been done by others. [65]

The retention rate for the MBI-A is superior to other MBIs for adolescents with chronic pain [22,24] possibly because session content was developed in iterations over the years based on feedback from adolescent chronic pain patients who requested that content be tailored for chronic pain. [27] Incorporating feedback from adolescent pain patients into development of MBI content has been advised by others who had difficulty retaining adolescent chronic pain participants in MBIs.[24]

Pain acceptance significantly increased over the course of the MBI-A which is congruent with this intervention's focus on acceptance of pain, through use of mindfulness strategies. Pain acceptance has emerged as a strong predictor of outcome in pediatric chronic pain research, predicting level of disability over and above pain intensity, depression, anxiety and self-efficacy[51] and accounting for changes in outcome following treatment. [26,66] In the current study, significant changes were seen in both global pain acceptance and its components - pain willingness (i.e., recognizing that avoidance and control strategies are frequently unhelpful when managing chronic pain) and activity engagement (i.e., engaging in life activities despite pain) . These improvements were seen between baseline to three month follow-up, suggesting that changes in pain acceptance may become more pronounced as participants practice MBI skills beyond the eight week group. A recent meta-analysis of acceptance and MBIs for adults with chronic pain showed a similar finding – effect sizes for improvements in pain acceptance increased by almost 60% 3-4 months following completion of the intervention.[11] This is in keeping with the notion that mindfulness is a skill that develops with practice. [67]

In this study, small sample size precluded examination of whether certain baseline characteristics (e.g., pain duration, disability, distress) predicted pain acceptance and mindfulness outcomes following the intervention. However, exploratory correlations revealed baseline pain catastrophizing to be a significant correlate of lower pain acceptance across all time points. Prior research, mainly from ACT treatment studies, has shown similar inverse relationships between pain acceptance and pain catastrophizing [26,68] and identify both constructs as important mechanisms with unique contributions to behaviour change among chronic pain patients. [69] Given that pain catastrophizing is a well-known risk factor for ongoing chronic pain and disability, [70,71] future studies should consider inclusion of catastrophizing as an outcome.

For example, might it be possible that higher pain catastrophizing prior to beginning an MBI may hinder participants from developing pain acceptance? As suggested by Schütze, [72] consideration can be given to including more decentering and detachment strategies (e.g., "thoughts are not facts"; "I am not my thoughts") into session content such as in Mindfulness Based Cognitive Therapy programs to reduce the *ruminative* aspect of catastrophizing, which accounts for the greatest proportion of variance in the catastrophizing construct. [42] Cognitive diffusion strategies ("I am noticing that I am having the thought that…") taught in Acceptance and Commitment Therapy can also be considered as a method to change how individuals relate to their catastrophic thoughts.

Exploratory correlations also revealed that while longer pain durations and higher disability were significantly correlated with lower level of mindfulness at baseline, these relationships weakened following completion of the MBI-A. Conclusions that the MBI-A group led to these changes cannot be made without a controlled study design

Contrary to hypotheses, expected improvements were not seen in outcomes on the T2 or T3 measures of mindfulness, emotional factors, or social support. In general, prior research has shown MBIs to improve emotional factors among adolescents [22,59] though findings are inconsistent on changes in mindfulness. [57,73,74] While it is possible that the MBI-A simply was not effective in improving these factors, several explanations for a lack of change can be considered including: 1) floor effects (i.e., as compared to other studies that detected pre-post changes on emotional outcomes, [59,74] participants in the MBI-A were not very stressed to begin with (scores for anxiety and depression were within normal range), making it more difficult to detect pre-post changes; 2), as suggested by Lagor et al., [57,75] participants may become increasingly aware of how mind*less* they are as they practice present moment awareness skills

during the MBI-A, resulting in little change in their mindfulness score. In addition, poor internal consistency of ratings on the mindfulness questionnaire at baseline may have contributed to lack of findings. Session data showed significant improvements in participants' body awareness and their ability to cope with stress over the course of the MBI-A. Thus, session data (which specifically assessed key content areas of the MBI-A) may detect changes over the course of the intervention that may not be evident on questionnaires designed to assess clinical levels of mood/anxiety. Veehof's and colleagues' [11] recent review of acceptance and MBIs for chronic pain suggests a similar strategy of collecting data throughout the intervention to better capture important outcomes.

It is noted that disability scores increased over the course of the baseline to follow-up period. Several explanations for this finding are offered. It is possible that participants socialized outside of the group sessions and may have reinforced disability behaviours. It is also possible that increases in disability scores may reflect timing of the end of each intervention group and follow-up period, which coincided with a time of peak school stress (end of semester when cumulative exams are provided for Fall group and beginning of school year when stress increases for Spring Group). In the absence of a control group, it cannot be determined whether the increase in disability levels can be attributed to the MBI-A treatment or whether scores of controls would have also increased in response to these putative stressors. In addition, while scores did increase, they remain within the clinical classification of moderate disability (13-29).

3.1 Limitations and Future Directions

Several limitations of this study warrant discussion. First, the uncontrolled pre-post study design did not permit determination of whether changes in outcomes were due to the MBI-A or to other aspects of the adolescent's experience such as elements of their health care treatments

which were not measured (e.g., medications, physiotherapy) or to feeling 'less alone' (rated highly across sessions by participants) due to meeting weekly with other adolescents who have pain. A randomized control design, with an active comparison group to control for social support and tracking of other multi-disciplinary pain management interventions in which participants engage is an ideal next step to further assess MBI-A benefits. Second, while our sample was representative of typical referrals to a pediatric chronic pain clinic (e.g., presenting with a variety of chronic pain conditions – the majority which were musculoskeletal and neuropathic, average pain durations of over three years and moderate pain intensity and disability levels [76]), only three males were eligible for the study during the recruitment period (despite liberal inclusion criteria) with one male participating. While females are known to outnumber males in terms of prevalence rates for chronic pain, [1] the uncharacteristically low number of eligible males in this study may have reflected a lull in male referrals during the recruitment period. Regardless, this limits the generalizability of results to mainly females. Future studies, with larger sample sizes and ideally recruiting from several different pediatric chronic pain clinics, can increase generalizability and help determine whether a gender-based difference in interest in a mindfulness intervention exists for adolescents with chronic pain. Third, although efforts were made to reduce demand characteristics associated with participants completing post-session questionnaires (e.g., ID numbers were used, facilitators were preoccupied tidying the treatment room while participants completed questionnaires), participants may nevertheless have felt pressured to respond positively on these measures. Future studies may wish to administer similar post-session questionnaires in a more anonymized fashion (e.g. participants complete scales online the following day with data sent back to the research coordinator). Finally, several unvalidated scales (e.g., post session questionnaires, satisfaction scale) were administered.

While attention was brought to treatment fidelity during the administration of the MBI-A groups (a structured session guide led to consistency of content across Fall and Spring groups and facilitators remained the same across groups), a measure of treatment fidelity was not included. As recommended by others, [11] future studies should include such a metric.

This investigation relied solely on adolescents' self-report. Hesse and colleagues [22] noted additional changes in outcomes as a result of their MBI in children with headaches through the use of parent proxy reports. The inclusion of parental proxy in future investigations may provide additional clarification of the effectiveness of MBI-A. As part of determining feasibility of the MBI, we evaluated whether outcome questionnaires employed in this study adequately tapped selected domains (for example, several questions regarding 'significant other' on the social support measure may have been less relevant for this younger teen cohort). Since this study began in 2013, several new outcome measures have emerged or come to our attention that appear to better tap domains such as mindfulness (see Comprehensive Inventory of Mindfulness Experiences [CHIME] scale [77]) and social support (see Revised UCLA Loneliness scale [78,79] and PROMIS social support scales [76]) for this age group. These scales are recommended for consideration in similar future research.

3.2 Conclusions

This study found that the MBI-A is a feasible and acceptable intervention for adolescents with chronic pain. Session content was specifically tailored for adolescents with chronic pain and may have resulted in good satisfaction and retention. Congruent with the intervention's focus on acceptance of discomfort (emotional or physical), participants showed improvements in their pain acceptance from baseline to three months post-intervention. Adolescents also improved in body awareness and coping with stress over the course of the intervention. Pain catastrophizing

emerged as a correlate of pain acceptance and should be considered as an outcome to be measured in future MBI research with this population. Randomized controlled trials with active control conditions that control for social support and adequate sample size are required to determine effectiveness of the MBI-A on outcomes.

Acknowledgements

This research was supported by a Pain Seed Grant from the Hospital for Sick Children's Pain Centre to D. Ruskin.

Conflict of Interest Statement:

The authors have no conflicts of interest to declare.

References

1. King S, Chambers CT, Huguet A, et al. The epidemiology of chronic pain in children and adolescents revisited: A systematic review. *Pain* 2011;152:2729–2738.
2. Eccleston C, Crombez G, Scotford A, et al. Adolescent chronic pain: Patterns and predictors of emotional distress in adolescents with chronic pain and their parents. *Pain* 2004;108:221–229.
3. Eccleston C, Wastell S, Crombez G, et al. Adolescent social development and chronic pain. *Eur. J. Pain* 2008;12:765–774.
4. Turk DC, Wilson HD, Cahana A. Treatment of chronic non-cancer pain. *Lancet* 2011;377:2226–2235.
5. Huguet A, Miró J. The severity of chronic pediatric pain: An epidemiological study. *J. Pain* 2008;9:226–236.
6. Perquin CW, Hunfeld JAM, Hazebroek-Kampschreur AAJM, et al. The natural course of chronic benign pain in childhood and adolescence: A two-year population-based follow-up study. *Eur. J. Pain* 2003;7:551–559.
7. Kabat-Zinn J. *Wherever you go, there you are: Mindfulness meditation in everyday life*. New York: Hyperion; 1994.
8. Kabat-Zinn J. *Full Catastrophe Living: Using the Wisdom of Your Body and Mind to Face Stress, Pain and Illness*. New York: Hyperion Books; 1990.
9. Baer RA. Mindfulness training as a clinical intervention: A conceptual and empirical review. *Clin. Psychol. Sci. Pract* 2003;10:125–143.
10. Kabat-Zinn J, Lipworth L, Burney R. The clinical use of mindfulness meditation for the self-regulation of chronic pain. *J. Behav. Med* 1985;8:163–190.

11. Veehof MM, Trompetter HR, Bohlmeijer ET, et al. Acceptance- and mindfulness-based interventions for the treatment of chronic pain: a meta-analytic review. *Cogn. Behav. Ther* 2016;45:5–31.

12. Bawa FLM, Mercer SW, Atherton RJ, et al. Does mindfulness improve outcomes in patients with chronic pain? Systematic review and meta-analysis. *Br. J. Gen. Pract* 2015;65:e387-400.

13. Ehde DM, Dillworth TM, Turner JA. Cognitive-behavioral therapy for individuals with chronic pain: Efficacy, innovations, and directions for research. *Am. Psychol* 2014;69:153–166.

14. Cherkin DC, Sherman KJ, Balderson BH, et al. Effect of mindfulness-based stress reduction vs cognitive behavioral therapy or usual care on back pain and functional limitations in adults with chronic low back pain. *JAMA* 2016;315:1240.

15. Atkinson MJ, Wade TD. Mindfulness-based prevention for eating disorders: A school-based cluster randomized controlled study. *Int. J. Eat. Disord* 2015;48:1024–1037.

16. Zenner C, Herrnleben-Kurz S, Walach H. Mindfulness-based interventions in schools-A systematic review and meta-analysis. *Front. Psychol* 2014;5:1–20.

17. Weijer-Bergsma E van de, Langenberg G, Brandsma R, et al. The Effectiveness of a School-Based Mindfulness Training as a Program to Prevent Stress in Elementary School Children. *Mindfulness* 2014;5:238–248.

18. Haydicky J, Shecter C, Wiener J, et al. Evaluation of MBCT for adolescents with ADHD and their parents: Impact on individual and family functioning. *J. Child Fam. Stud* 2013:1–19.

19. Himelstein S, Saul S, Garcia-Romeu A. Does mindfulness meditation increase effectiveness of substance abuse treatment with incarcerated youth? A pilot randomized controlled trial. *Mindfulness* 2015;6:1472–1480.

20. Tan LB. A critical review of adolescent mindfulness-based programmes. *Clin. Child Psychol. Psychiatry* 2015;21:193-207.

21. Zoogman S, Goldberg SB, Hoyt WT, et al. Mindfulness interventions with youth: A meta-analysis. *Mindfulness* 2015;6:290–302.

22. Hesse T, Holmes LG, Kennedy-Overfelt V, et al. Mindfulness-based intervention for adolescents with recurrent headaches: A pilot feasibility study. *Evidence-Based Complement. Altern. Med* 2015;2015:1–9.

23. Chadi N, McMahon A, Vadnais M, et al. Mindfulness-based intervention for female adolescents with chronic pain: A pilot randomized trial. *J. Can. Acad. Child Adolesc. Psychiatry* 2016;25:159–168.

24. Jastrowski Mano KE, Salamon KS, Hainsworth KR, et al. A randomized, controlled pilot study of mindfulness-based stress reduction for pediatric chronic pain. *Altern. Ther. Health Med* 19:8–14.

25. Wicksell RK, Melin L, Lekander M, et al. Evaluating the effectiveness of exposure and acceptance strategies to improve functioning and quality of life in longstanding pediatric pain--a randomized controlled trial. *Pain* 2009;141:248–57.

26. Gauntlett-Gilbert J, Connell H, Clinch J, et al. Acceptance and values-based treatment of adolescents with chronic pain: Outcomes and their relationship to acceptance. *J. Pediatr. Psychol* 2013;38:72–81.

27. Ruskin D, Ahola Kohut S, Stinson J. The development of a mindfulness-based stress reduction group for adolescents with chronic pain. *J Pain Manag* 2015;7:301–312.

28. Merikangas KR, He J, Burstein M, et al. Lifetime prevalence of mental disorders in U.S. adolescents: Results from the National Comorbidity Survey Replication–Adolescent Supplement (NCS-A). *J. Am. Acad. Child Adolesc. Psychiatry* 2010;49:980–989.

29. Song Y, Lu H, Chen H, et al. Mindfulness intervention in the management of chronic pain and psychological comorbidity: A meta-analysis. *Int. J. Nurs. Sci* 2014;1:215–223.

30. Rajguru P, Kolber MJ, Garcia AN, et al. Use of mindfulness meditation in the management of chronic pain: A systematic review of randomized controlled trials. *Am. J. Lifestyle Med* 2015;9:176–184.

31. Kazak AE, Simms S, Alderfer MA, et al. Feasibility and preliminary outcomes from a pilot study of a brief psychological intervention for families of children newly diagnosed with cancer. *J. Pediatr. Psychol* 2005;30:644–655.

32. Walker LS, Greene JW. The Functional Disability Inventory: Measuring a neglected dimension of child health status. *J. Pediatr. Psychol* 1991;16:39–58.

33. Claar RL, Walker LS. Functional assessment of pediatric pain patients: Psychometric properties of the Functional Disability Inventory. *Pain* 2006;121:77–84.

34. March JS, Parker JDA, Sullivan K, et al. The Multidimensional Anxiety Scale for Children (MASC): Factor structure, reliability, and validity. *J. Am. Acad. Child Adolesc. Psychiatry* 1997;36:554–565.

35. Baldwin JS, Dadds MR. Reliability and validity of parent and child versions of the Multidimensional Anxiety Scale for Children in community samples. *J. Am. Acad. Child Adolesc. Psychiatry* 2007;46:252–260.

36. Osman A, Williams JE, Espenschade K, et al. Further evidence of the reliability and validity of the Multidimensional Anxiety Scale for Children (MASC) in psychiatric inpatient samples. *J. Psychopathol. Behav. Assess* 2009;31:202–214.

37. Shaffer D, Fisher P, Lucas CP, et al. NIMH Diagnostic Interview Schedule for Children Version IV (NIMH DISC-IV): Description, differences from previous versions, and reliability of some common diagnoses. *J. Am. Acad. Child Adolesc. Psychiatry* 2000;39:28–38.

38. Lucas CP, Zhang H, Fisher PW, et al. The DISC Predictive Scales (DPS): Efficiently screening for diagnoses. *J. Am. Acad. Child Adolesc. Psychiatry* 2001;40:443–449.

39. Shaffer D, Scott M, Wilcox H, et al. The Columbia Suicide Screen: Validity and reliability of a screen for youth suicide and depression. *J. Am. Acad. Child Adolesc. Psychiatry* 2004;43:71–79.

40. Sullivan MJL, Bishop SR, Pivik J. The Pain Catastrophizing Scale: Development and validation. *Psychol. Assess* 1995;7:524–532.

41. Osman A, Barrios FX, Kopper BA, et al. Factor structure, reliability, and validity of the Pain Catastrophizing Scale. *J. Behav. Med* 1997;20:589–605.

42. Sullivan MJ., Stanish W, Waite H, et al. Catastrophizing, pain, and disability in patients with soft-tissue injuries. *Pain* 1998;77:253–260.

43. Edwards RR, Haythornthwaite JA, Sullivan MJ, et al. Catastrophizing as a mediator of sex differences in pain: Differential effects for daily pain versus laboratory-induced pain. *Pain* 2004;111:335–341.

44. Crombez G, Bijttebier P, Eccleston C, et al. The child version of the Pain Catastrophizing Scale (PCS-C): A preliminary validation. *Pain* 2003;104:639–646.

45. Greco LA, Baer RA, Smith GT. Assessing mindfulness in children and adolescents: development and validation of the Child and Adolescent Mindfulness Measure (CAMM). *Psychol. Assess* 2011;23:606–614.

46. Kuby AK, McLean N, Allen K. Validation of the Child and Adolescent Mindfulness Measure (CAMM) with non-clinical adolescents. *Mindfulness* 2015;6:1448–1455.

47. Malboeuf-Hurtubise C, Achille M, Muise L, et al. A mindfulness-based meditation pilot study: Lessons learned on acceptability and feasibility in adolescents with cancer. *J. Child Fam. Stud* 2016;25:1168–1177.

48. McCracken LM, Vowles KE, Eccleston C. Acceptance of chronic pain: Component analysis and a revised assessment method. *Pain* 2004;107:159–166.

49. McCracken LM. Learning to live with the pain: acceptance of pain predicts adjustment in persons with chronic pain. *Pain* 1998;74:21–7.

50. McCracken LM, Vowles KE. Acceptance and commitment therapy and mindfulness for chronic pain. *Am. Psychol* 2014;69:178–187.

51. Wallace DP, Harbeck-Weber C, Whiteside SPH, et al. Adolescent acceptance of pain: Confirmatory factor analysis and further validation of the Chronic Pain Acceptance Questionnaire, Adolescent Version. *J. Pain* 2011;12:591–599.

52. Zimet GD, Dahlem NW, Zimet SG, et al. The Multidimensional Scale of Perceived Social Support. *J. Pers. Assess* 1988;52:30–41.

53. Zimet GD, Powell SS, Farley GK, et al. Psychometric characteristics of the Multidimensional Scale of Perceived Social Support. *J. Pers. Assess* 1990;55:610–617.

54. Canty-Mitchell J, Zimet GD. Psychometric properties of the Multidimensional Scale of Perceived Social Support in urban adolescents. *Am. J. Community Psychol* 2000;28:391–

400.

55. Cheng S-T, Chan ACM. The Multidimensional Scale of Perceived Social Support: Dimensionality and Age and Gender Differences in Adolescents. *Pers. Individ. Dif* 2004;37:1359–1369.

56. Bruwer B, Emsley R, Kidd M, et al. Psychometric properties of the Multidimensional Scale of Perceived Social Support in youth. *Compr. Psychiatry* 2008;49:195–201.

57. Lagor AF, Williams DJ, Lerner JB, et al. Lessons learned from a mindfulness-based intervention with chronically ill youth. *Clin. Pract. Pediatr. Psychol* 2013;1:146–158.

58. Thompson M, Gauntlett-Gilbert J. Mindfulness with children and adolescents: Effective clinical application. *Clin. Child Psychol. Psychiatry* 2008;13:395–407.

59. Biegel GM, Brown KW, Shapiro SL, et al. Mindfulness-based stress reduction for the treatment of adolescent psychiatric outpatients: A randomized clinical trial. *J. Consult. Clin. Psychol* 2009;77:855–866.

60. Stahl B, Goldstein E, Kabat-Zinn J. *A Mindfulness-Based Stress Reduction Workbook*. Oakland, CA: New Harbinger Publications, Inc.; 2010.

61. Harris PA, Taylor R, Thielke R, et al. Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. *J. Biomed. Inform* 2009;42:377–381.

62. Tickle-Degnen L. Nuts and bolts of conducting feasibility studies. *Am. J. Occup. Ther* 2013;67:171–176.

63. Field A. *Discovering Statistics using IBM SPSS Statistics*. 4th ed. London: Sage Publications; 2013.

64. Marcano Belisario JS, Jamsek J, Huckvale K, et al. Comparison of self-administered survey questionnaire responses collected using mobile apps versus other methods. In: Marcano Belisario JS, ed. *Cochrane Database of Systematic Reviews*. Chichester, UK: John Wiley & Sons, Ltd; 2015.

65. Gardner-Nix J, Barbati J, Grummitt J, et al. Exploring the effectiveness of a mindfulness-based chronic pain management course delivered simultaneously to on-site and off-site patients using telemedicine. *Mindfulness* 2014;5:223–231.

66. Weiss KE, Hahn A, Wallace DP, et al. Acceptance of pain: Associations with depression, catastrophizing, and functional disability among children and adolescents in an interdisciplinary chronic pain rehabilitation program. *J. Pediatr. Psychol* 2013;38:756–765.

67. Bishop SR. Mindfulness: A proposed operational definition. *Clin. Psychol. Sci. Pract* 2004;11:230–241.

68. Elvery N, Jensen MP, Ehde DM, et al. Pain catastrophizing, mindfulness and pain acceptance. *Clin. J. Pain* 2016:1.

69. Vowles KE, McCracken LM, Eccleston C. Processes of change in treatment for chronic pain: the contributions of pain, acceptance, and catastrophizing. *Eur. J. Pain* 2007;11:779–87.

70. Tran ST, Jastrowski Mano KE, Hainsworth KR, et al. Distinct influences of anxiety and pain catastrophizing on functional outcomes in children and adolescents with chronic pain. *J. Pediatr. Psychol* 2015;40:744–755.

71. Severeijns R, Vlaeyen JWS, Hout MA van den, et al. Pain catastrophizing predicts pain intensity, disability, and psychological distress independent of the level of physical

impairment. *Clin. J. Pain* 2001;17:165–172.

72. Schütze R. Re-thinking over-thinking pain: What can metacognition add to our understanding of pain catastrophising? *Clin. Psychol* 2016;20:147–153.

73. Tan L, Martin G. Taming the adolescent mind: A randomised controlled trial examining clinical efficacy of an adolescent mindfulness-based group programme. *Child Adolesc. Ment. Health* 2015;20:49–55.

74. Ames CS, Richardson J, Payne S, et al. Mindfulness-based cognitive therapy for depression in adolescents. *Child Adolesc. Ment. Health* 2014;19:74–78.

75. McCracken LM, Gauntlett-Gilbert J, Vowles KE. The role of mindfulness in a contextual cognitive-behavioral analysis of chronic pain-related suffering and disability. *Pain* 2007;131:63–9.

76. DeWalt DA, Thissen D, Stucky BD, et al. PROMIS Pediatric Peer Relationships Scale: Development of a peer relationships item bank as part of social health measurement. *Heal. Psychol* 2013;32:1093–1103.

77. Bergomi C, Tschacher W, Kupper Z. Measuring mindfulness: First steps towards the development of a comprehensive mindfulness scale. *Mindfulness* 2013;4:18–32.

78. Russell D, Peplau LA, Cutrona CE. The revised UCLA Loneliness Scale: Concurrent and discriminant validity evidence. *J. Pers. Soc. Psychol* 1980;39:472–80.

79. Russell DW. UCLA Loneliness Scale (Version 3): Reliability, validity, and factor structure. *J. Pers. Assess* 1996;66:20–40.

Figure 1.

Average Session Ratings on Coping with Pain, Coping with Stress, Body Awareness, and Feeling Less Alone.

Note. Higher scores indicative of better outcomes (i.e., better coping with pain, better coping with stress, more body awareness, and improvements in feeling less alone).

Means for each session were calculated based on participants who attended that particular session and therefore may differ from means reported in text, which were calculated based on pairwise comparisons between sessions 1 and 7, which includes data only from participants who were present at **both** sessions 1 and 7.

* $p < .05$ between session 1 and session 7

Table 1 *Participant Demographics at Baseline* (n = 21)

Demographic Characteristic	Statistic
Age, $M \pm$ SD, (range)	15.52 ± 1.37, (12-18)
Sex, *n*	
Male	1
Female	20
Pain Duration in Months, $M \pm$ SD, (range)	41.76 ± 34.30, (10-120)
Average Pain Intensity (past week), $M \pm$ SD, (range)	5.5±2.01, (.5-8.5)
Pain Diagnosis, *n*(%)	
Musculoskeletal	14 (67%)
Neuropathic	4 (19%)
Headaches	2 (9%)
Abdominal	1 (5%)

Table 2. Outcome measures across three time points

Measure	N±	Possible Range	*M*(*SD*) Pre	Post	3 months	*F*	*p*	ES*(d)
Functional Disability Index	18	0-60	22.67 (11.15)	26.69 (13.27)	26.39 (12.98)	3.28	.05	-.31
Multidimensional Anxiety Scale for Children – Total Score *t*-score	16	0-100	52.69 (9.21)	56.68 (8.88)	54.19 (9.17)	1.63	.21	-.16
Columbia Depression Scale	15	0-21	9.53 (4.79)	10.41 (4.43)	9.60 (5.55)	.70	.51	-.01
Pain Catastrophizing Scale	16	0-52	25.31 (12.58)	25.62 (13.92)	25.43 (13.67)	.01	.99	-.01
Child Acceptance and Mindfulness Measure	16	0-100	53.88 (6.49)	50.45 (7.18)	52.94 (8.52)	2.24	.12	-.12
Chronic Pain Acceptance Questionnaire-Revised								
Activity Engagement Subscale Score	16	0-66	36.06† (11.85)	39.13 (11.57)	41.00† (8.81)	3.50	.04	.47
Pain Willingness Subscale Score	16	0-54	20.94† (9.81)	24.13 (8.03)	26.44† (10.70)	4.61	.02	.54
Total Score	16	0-120	57.00† (20.31)	63.25 (17.82)	67.44† (17.68)	6.11	.01	.55
Multidimensional Scale of Perceived Social Support	15	7-84	67.07 (13.67)	68.80 (13.65)	69.60 (12.00)	1.46	.25	.20
Current Pain	9	0-10	5.11 (2.47)	5.33 (1.66)	5.50 (1.92)	.42	.67	-.18

Note. All scores reported are raw scores other than the Multidimensional Anxiety Scale for Children – Total Score, which is a T-score (mean=50 and SD =10). Higher scores on the Child Acceptance and Mindfulness Measure, the Chronic Pain Acceptance Questionnaire, and the Multidimensional Scale of Perceived Social Support are indicative of more positive outcomes, while lower scores on the remaining measures are indicative of more positive outcomes.
±N is varied by analysis based on data available for all three time points.
*cohen's *d* calculated comparing pre to 3 months post. A positive cohen's *d* represents changes in the expected direction (i.e., improvements).
† Denotes significant difference between time points, $p < .05$

Table 3 Exploratory Correlations between Baseline Variables and Mindfulness and Acceptance Post-Intervention and at Follow-up

	Mindfulness			Activity Engagement			Pain Willingness			Global Pain Acceptance		
T1 Variables and Attendance/Practice	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
Pain Duration	-.60**	-.43	.06	.04	-.21	.11	.13	.01	-.10	.09	-.17	-.01
Disability	-.48*	.15	.10	-.41	-.31	-.43	-.01	-.07	-.22	-.25	-.20	-.36
Anxiety	-.27	-.22	-.19	-.42	-.03	-.07	-.12	-.15	-.04	-.32	-.04	-.06
Pain Catastrophizing	-.57**	-.31	-.30	-.66*	-.42	-.75**	-.47*	-.53*	-.50*	-.64**	-.51*	-.70**
Depression	-.49*	-.34	-.28	-.42	-.26	-.46	-.11	-.18	-.25	-.31	-.22	-.40
Perceived Social Support – Family	.28	.09	.35	.38	.65**	.66**	.19	.41	.35	.32	.59**	.56*
Perceived Social Support – Friends	.28	.14	.40	.38	.48*	.48	.19	.30	-.08	.32	.42	.20
Perceived Social Support – Significant other	.08	.02	.38	.15	.38	.17	.09	.19	.05	.13	.31	.12
Number of sessions attended	.35	.21	-.02	.02	.51*	.05	.02	.03	.37	.02	.40	.26
Average minutes	-.07	.47*	.29	-.19	-.24	-.36	-.20	-.24	-.26	-.22	-.24	-.35

Note. T1 = Baseline; T2 = Post-intervention; T3 = 3 month follow-up; Mindfulness = Children and Adolescents Mindfulness Measure Score; Activity Engagement = Chronic Pain Acceptance Questionnaire- Revised Activity Engagement Subscale Score; Pain Willingness = Chronic Pain Acceptance Questionnaire- Revised Pain Willingness Subscale Score; CPAQ-R Total = Chronic Pain Acceptance Questionnaire- Revised Total Score; Disability = Functional Disability Index Score; Anxiety = Multidimensional Anxiety Scale for Children Total Score; Pain Catastrophizing = Pain Catastrophizing Scale Score; Depression = Columbia Depression Scale Score; Perceived Social Support = Multidimensional Scale of Perceived Social Support Score.

*$p < .05$

**$p < .01$

Figure 1