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Feasibility and Acceptance Testing of a Mobile Application Providing Psychosocial Support for Parents of Children and Adolescents With Chronic Pain: Results of a Nonrandomized Trial

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Abstract

Objective To conduct a single-arm pilot study assessing the feasibility and acceptability of a 30-day parent-focused mindfulness and psychosocial support mobile app intervention for parents of children with chronic pain. **Methods** Thirty parents completed the intervention, which included a mindfulness curriculum, peer support videos, and written psychoeducational content. Twelve healthcare providers also assessed the app and provided feedback. Feasibility was assessed by server-side documented usage on ≥50% of the days in the intervention period and completion of ≥70% of the mindfulness content. Parent and provider acceptance were assessed by ≥70% of participants rating each acceptance test question as ≥5 on a 7-point Likert scale. Parents completed measures of solicitousness, stress, mindful parenting, and resilience prior to and following the intervention. **Results** Feasibility results were mixed: parents completed mindfulness content on an average of 11.2 days during the intervention period, slightly under the pre-established criterion. However, parents completed an average of 72.1% of the content, which met feasibility criterion. Acceptance criteria were met for the majority of parent acceptance test questions and all of the provider acceptance test questions. Exploratory analyses of the psychosocial measures revealed significant decreases in parental solicitous behavior and perceived stress, and a significant increase in mindful parenting. **Conclusions** The current study extends the emerging body of research on mindfulness-based interventions for parents of children with chronic illness and suggests that it may be acceptable to deliver this content through a mobile device. Future research is needed to assess the intervention's efficacy compared to standard of care.

Key words: chronic and recurrent pain; parents; parent stress; psychosocial functioning.

Introduction

Chronic pain—pain that persists three months or longer (Treede et al., 2015)—is conservatively estimated to affect 20–35% of children and adolescents globally making it a common distressing experience (King et al., 2011; Stanford, Chambers, Biesanz, & Chen, 2008). Parents of children with chronic pain often feel distraught and helpless watching their children suffer (Noel, Beals-Erickson, Law, Alberts, & Palermo,

2016; Palermo & Eccleston, 2009). Subsequently, parental responses to their child's pain can significantly affect the child's pain experiences and behaviors. In addition, high levels of parental stress can also negatively impact a child's pain-related functional impairment (Chow, Otis, & Simons, 2016), which can further affect parental response to their children's suffering. However, parental coping and stress management are often not addressed in interventions for children with chronic pain (Palermo, Eccleston, Lewandowski, Williams, & Morley, 2010; Palermo, Valrie, & Karlson, 2014).

One promising approach for helping adults manage the stress of parenting a child with a chronic health condition may be mindfulness-based interventions (MBIs). MBIs tend to demonstrate relief for symptoms related to anxiety, depression, and stress in adults (Hofmann & Gómez, 2017; Khoury, Sharma, Rush, & Fournier, 2015). Emerging research suggests that these approaches can also be helpful for parents. Mindful parenting approaches have been shown to reduce distress in parents of children with emotional and behavioral challenges (Bogels, Lehtonen, & Restifo, 2010; Cachia, Anderson, & Moore, 2016) and children with chronic illness (Minor, Carlson, Mackenzie, Zernicke, & Jones, 2006).

Despite the evidence that psychosocial interventions for parents can reduce parental distress related to parenting a child with a chronic illness, significant barriers remain. Access to parent interventions is typically only available in selected urban areas or medical centers (Palermo, Wilson, Peters, Lewandowski, & Somhegyi, 2009; Peng et al., 2007). Furthermore, lack of parental engagement with the ongoing practice of the relaxation and mindfulness skills provided through the intervention can reduce longer-term program effectiveness (Rosenzweig et al., 2010). Although modern technology has inspired digital health tools and resources, evidence-based therapeutic technology programs for caregivers are not widely available (Palermo et al., 2010). In spite of a myriad of mobile apps for mindfulness and stress reduction, there are few that specifically address parenting stress, and even fewer that address helping parents coping with a child in pain. These barriers indicate the need for additional innovative strategies to increase availability of and promote parental engagement with these types of interventions.

The aim of the current study was to conduct a single-arm pilot study to assess the feasibility and acceptability of a 30-day parent-focused mobile app intervention, *Mindfulness for Resilience in Illness: Support for Parents* (MRI: Parents). The feasibility and acceptability of MRI: Parents was assessed via: (1) parent self-reported acceptance; (2) parents' use of the program; and (3) acceptance testing with healthcare providers. We also explored changes in psychosocial outcomes of solicitousness, stress, mindfulness in parenting, and resilience following the 30-day intervention. We hypothesized that MRI: Parents would be feasible, as demonstrated by sample averages of server-side documented usage on $\geq$50% of the days in the intervention period and completion of $\geq$70% of the mindfulness content, and acceptable, as demonstrated by $\geq$70% of parent and provider participants' rating of each evaluation question as $\geq$5 on the 7-point Likert scale. Assessment of psychosocial outcomes was exploratory and therefore no a priori hypotheses were established.

Methods

Participants

Participants were 30 parents of children being treated for chronic pain at tertiary chronic pain clinics and 12 healthcare providers (Julious, 2005) who provided treatment for children and adolescents with chronic pain. (See Table I for demographic data and providers' specialties.) The number of parents was chosen to ensure that we received feedback from parents of children with a range of pain diagnoses. Thirty of 34 parents (88%) screened and enrolled in the study completed the "onboarding" process (app download and orientation, described below), yielding a dropout rate of 12%. We conservatively estimated dropout rate based on the initial enrolled sample of 34, with special consideration given to describing the reasons for dropout and how that might guide future implementation of app evaluation studies. However, quantitative results are based on the 30 parent participants who actually completed the onboarding process and had access to the app content (Turner & Hingle, 2017; Wen, Sweeney, Welton, Trockel, & Katznelson, 2017). Twelve of 15 invited providers enrolled and completed review of the app yielding an 80% provider participation rate. See Figure 1 for a flow chart depicting study enrollment.

Parent participant eligibility criteria included: (1) parenting a child or adolescent 8–18 years of age with noncancer chronic pain, (2) daily use of a mobile device (i.e., smartphone or tablet), and (3) ability to speak and understand English. Assessment of noncancer chronic pain was made by the physician at the time of recruitment based on the onset of the child's pain as at least three months prior (Treede et al., 2015) and the child's negative medical history for any type of cancer. Provider eligibility criteria included: (1) at least 5 years' experience treating children and adolescents with chronic pain, and (2) ability to speak and understand English. Parent participants completed online informed consent, and provider

Table I. *Demographic Data*

	Parents enrolled ($N = 34$)	Parents onboarded ($N = 30$)	Providers ($N = 12$)
Sex			
Male	2 (5.9%)	1 (3.3%)	1 (8.3%)
Female	32 (94.1%)	29 (96.7%)	11 (91.7%)
Age	49.1 (6.2)[a]	49.5 (6.2)	
Ethnicity			
Hispanic/Latino	2 (5.9%)	2 (6.7%)	1 (8.3%)
Not Hispanic/Latino	31 (91.2%)	28 (93.3%)	11 (91.7%)
Unknown	1 (2.9%)	0	0
Race			
White	29 (85.3%)	27 (90.0%)	12 (100.0%)
African-American	2 (5.9%)	1 (3.3%)	0
Asian	1 (2.9%)	1 (3.3%)	0
Multi-Racial	1 (2.9%)	1 (3.3%)	0
Unknown	1 (2.9%)	0	0
Child's Sex			
Male	10 (29.4%)	10 (33.3%)	
Female	24 (70.6%)	20 (66.7%)	
Child's Age	14.8 (2.0)	14.8 (2.1)	
Child's Pain Problems[b]			
Fibromyalgia, centralized/widespread body pain	14 (41.2%)	12 (40.0%)	
Arthritis (all types), joint pain	9 (26.5%)	8 (26.7%)	
CRPS	7 (20.6%)	7 (23.3%)	
Musculoskeletal pain (shoulder, back, foot, hands, legs, chest)	6 (17.6%)	6 (20.0%)	
Headaches	5 (14.7%)	5 (16.7%)	
Irritable bowel syndrome, recurrent/ functional abdominal pain	4 (11.8%)	2 (6.7%)	
CRMO	2 (5.9%)	2 (6.7%)	
EDS	2 (5.9%)	1 (3.3%)	
Provider Specialties			
Pediatric Pain Physician or Nurse (MD, NP, RN)			4 (33.3%)
Pediatric Pain Psychologist			3 (25.0%)
CAM Provider[c]			5 (41.7%)

Note. Data presented as N (%) for categorical variables or mean (*SD*) for continuous variables. CRPS = Complex Regional Pain Syndrome; CRMO = Chronic Recurrent Multifocal Osteomyelitis; EDS = Ehlers-Danlos Syndrome; CAM = Complementary and Alternative Medicine.

[a]$N = 32$.

[b]Pain problems sum to more than 100% due to multiple pain diagnoses.

[c]Includes relaxation and therapeutic massage, physical/aqua therapy, craniosacral therapy, and biofeedback practitioners.

participants were emailed an approved study information sheet. This study was approved by the UCLA Institutional Review Board and registered on ClinicalTrials.gov (NCT03356275). Each participating parent and provider received a $100 Amazon.com gift card.

Intervention Content

The app targeted four main parental needs: (1) self-care; (2) mindfulness and relaxation exercises; (3) peer support and advice; and (4) support from health experts. The 4-week mindfulness program was delivered through an existing mindfulness mobile app (Whil: Wellbeing and Mindfulness by Whil Concepts, Inc.). The mobile application was a customized version of the existing app and was available via Apple iOS App Store and Android Google Play Store. Participants logged in to the app using custom, nonidentifying credentials created for this study. This automatically opened the customized version of the app, which was not available to the general public. Modifications included the creation of four primary features: (1) a 4-week mindfulness curriculum consisting of 20 audio recordings selected by our team of four psychologists (SRM, LAP, TMC, and ED), one pediatric pain physician (LKZ), and one social worker (MWT) from the Whil library (created by Whil's team of physicians, psychologists, and mindfulness experts). Audio mindfulness recordings ranged in length from 2 to 10 min (average 5.1 min); (2) new weekly 1- to 2-min videos created by our team for this program featuring a clinical psychologist (TMC) introducing and summarizing the weekly theme; (3) parent peer support videos; and (4) a series of brief psychoeducational articles to fit the 4 weeks of curriculum. The weekly themes were: (1) Build Up Your Resilience; (2) Find

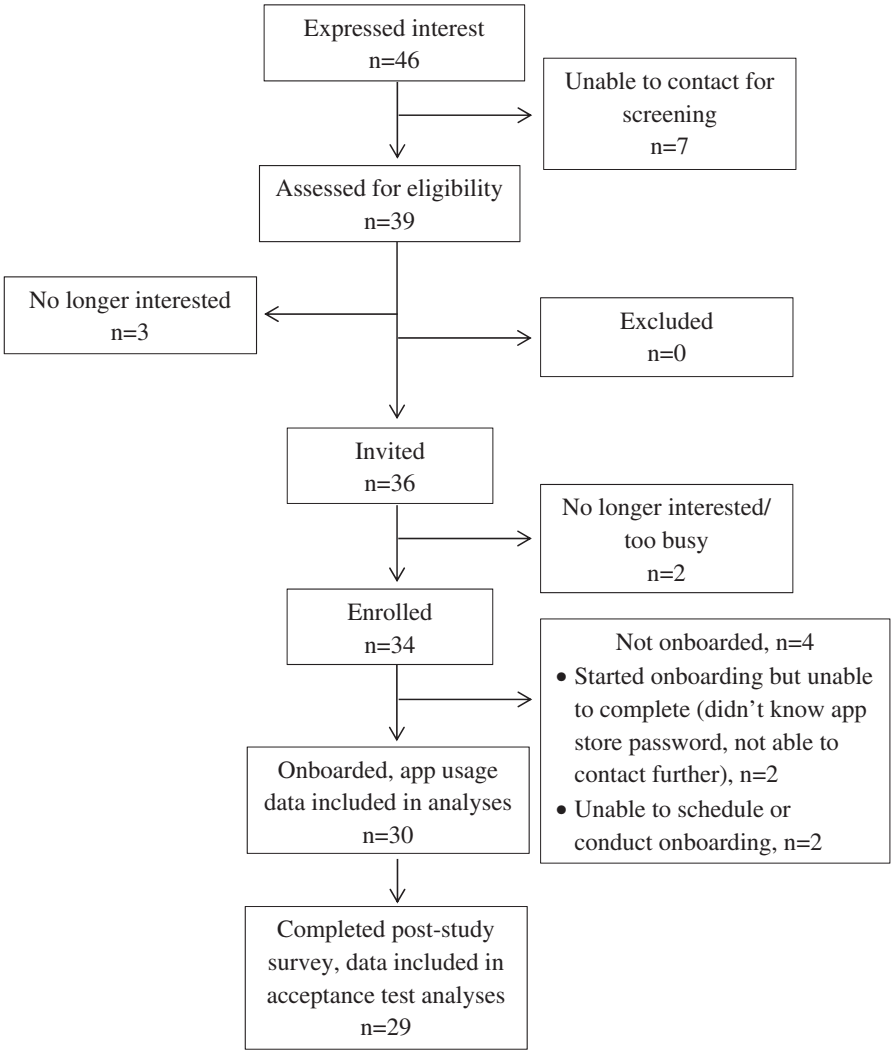

Figure 1. CONSORT-style depiction of parent participant enrollment flow.

Your Center; (3) Communicate and Connect; and (4) Practice Empathy and Self-Compassion. See Supplementary online materials for a detailed overview of intervention content.

Peer support was offered in the form of videos featuring parents of current and former patients (two mothers, one father, and one mother-father pair). These brief video clips ranged in length from 1 to 4 min and each focused on the weekly themes of the intervention. Our team wrote the question prompts, conducted the filmed interviews with parents, and selected the video excerpts to be used. Four psychoeducational articles were written by our team to supplement the weekly curriculum. All clips and articles were available throughout the intervention. See the Supplementary online content for the full list of peer videos and articles. Children received treatment as usual during the study period (we did not provide any intervention to the children).

Procedure

Parent Participants

Parent participants were recruited at the time of their child's appointment from a convenience sample at two urban tertiary chronic pain clinics serving a broad geographic region encompassing southern and central California. Parents of children within the target age range were approached by a member of the research team and given a flyer and verbal description of the study. Recruitment was also conducted through emails from LKZ to parents of past clinic patients. During an initial eligibility screening, a trained research coordinator provided a brief overview of study procedures and screened participants for eligibility. Eligible individuals were emailed a link to a secure online website containing the study information sheet. After completing the online consent, participants completed four brief psychosocial measures online.

After study enrollment, participants were scheduled for a 15-min onboarding orientation phone call.

During this phone call, participants received instructions on how to download the app and sign in. Participants then watched a 7-min orientation video that explained app functioning, features, and expectations of participants during study participation.

Weekly text message reminders were sent to encourage participants to use the app and direct them to the correct week of content (i.e., Week 1 through Week 4). All participants agreed to receive these automatic weekly text messages. Thirty days after the orientation onboarding phone call, participants were emailed the post-study survey link and asked to complete it within 2 days. No protocol deviations or adverse events occurred during the course of the study.

Provider Participants

Healthcare providers were recruited from LKZ's clinical network of colleagues, community practitioners, and from an international listserv reaching healthcare providers within various domains of pediatric pain (e.g., nursing, psychology, medicine, physical therapy, etc.). Providers were emailed an IRB-approved recruitment script and replied to indicate their willingness to participate. A research coordinator then emailed the providers the study information sheet (serving as waiver of signed consent), a brief background and rationale for the project, the instructions for reviewing the app, and the link to the acceptance test.

Participant Instructions

Instructions to parents about participation expectations included: (1) listening to one relaxation audio per day, 5 days per week, and (2) exploring the peer videos and written pain educational content as they wished throughout the study period. Providers were instructed to complete four steps during their review of the app: (1) view introductory webinar used during parent onboarding; (2) download and try out the app, including sampling a self-selected variety of mindfulness sessions and introductory/takeaway videos; (3) view a self-selected sampling of the parent peer videos and supporting articles; and (4) complete the online acceptance test. Provider participants were informed that their participation was expected to take around one hour.

Measures

Demographics

Participants completed a brief demographics questionnaire assessing sex, race, ethnicity, and date of birth (not asked of providers). Parents were also asked about their child's sex, age, and pain problems.

App Usage

Parental app usage was measured by sample averages of the following three measures: (1) *number of engagement days* (the number of days during the 30-day study period during which the participant engaged with the mindfulness content on the app; (2) *total engagement time* (the amount of time, in minutes, that the participant engaged with the mindfulness content within the app); and (3) the *number of unique sessions* completed (assessed separately for intro/takeaway sessions, max = 8, and mindfulness sessions, max = 20). Individual session completion was defined as watching or listening to $\geq$70% of each video/audio session.

Parent Acceptance Test

A 27-item acceptance test for parents was developed for the purposes of this study in order to gather participants' feedback that could be used to refine the next version of the intervention. The parent acceptance test contained both open-ended (11 items) and 7-point Likert scale (16 items) questions to ascertain parents' impressions of the app. Likert scales were anchored by 1 = "*Not at all* (easy/helpful)"/"*Definitely no*" to 7 = "*Very* (easy/helpful)"/"*Definitely yes.*" Domains included in the parent acceptance test included: (1) how much parents enjoyed using the app overall and how much they enjoyed each week of audio content (e.g., "How much did you enjoy using the prototype mindfulness mobile app?"); (2) how helpful parents found the introduction videos, peer videos, and informational articles; (3) whether the app helped parents to relax, learn about communicating with others, and learn about practicing self-kindness; (4) whether parents would continue using the app and recommend the app to other parents of children with a chronic health condition; and (5) what parents liked and did not like about participating in the study (e.g., "What did you like most about participating in the study?").

Provider Acceptance Test

A 13-item acceptance test for providers was developed for the purposes of this study. The provider acceptance test also contained both open-ended (5 items) and 7-point Likert scale (8 items) questions, anchored as described above, to ascertain providers' impressions of the app. Domains included in the provider acceptance test included: (1) how helpful providers believed the app and its components would be for parents of a child with chronic pain (e.g., "Recalling the peer video clips featuring parents of children with chronic pain, how helpful do you think these videos would be?"); (2) whether providers would recommend the program to parents and other healthcare providers; and (3) the usefulness of MBIs in this population and what resources would be helpful for providers (e.g., "In general, how useful do you think resiliency and mindfulness-based stress reduction strategies are for parents of children managing chronic pain?").

Feasibility

Feasibility was assessed by sample averages of server-side documented usage on ≥50% of the days in the intervention period and completion of ≥70% of the mindfulness content.

Acceptance

Parental and provider acceptance would be demonstrated by ≥70% of parent and provider participants' rating of each evaluation question as ≥5 on the 7-point Likert scale.

Psychosocial Questionnaires

Questionnaires were selected in order to assess potential change in areas targeted by the intervention and to obtain pilot data for estimating the sample size of the upcoming randomized controlled trial.

Solicitousness

Parents' levels of solicitousness were assessed using the 15-item Protect subscale from the Adults' Responses to Children's Symptoms (ARCS) parent report version (Walker, Levy, & Whitehead, 2006). Response choices range from 0 (*never*) to 4 (*always*); individual item scores are averaged to create the subscale score, with higher scores indicating higher levels of parental solicitousness. The ARCS has demonstrated acceptable reliability and validity in samples of parents of children with chronic pain conditions (Claar, Guite, Kaczynski, & Logan, 2010). Internal reliability in the current sample was good (Cronbach's $\alpha = 0.852$).

Stress

Parental stress was assessed using the Perceived Stress Scale (PSS), a 10-item measure asking parents how often they felt certain ways during the preceding month (Cohen, Kamarck, & Mermelstein, 1983). Response choices range from 0 (*never*) to 4 (*very often*); summary scores are computed by reverse-scoring the positively worded questions and summing the values for all responses. Scores range from 0 to 40 with higher scores indicating higher levels of perceived stress. The PSS is a valid and reliable measure that has been used in numerous adult populations (Cohen & Janicki-Deverts, 2012), including in studies assessing effects of mindfulness interventions (Jayewardene, Lohrmann, Erbe, & Torabi, 2017). Internal reliability in the current sample was good (Cronbach's $\alpha = 0.858$).

Mindfulness in Parenting

The 28-item Mindfulness in Parenting Questionnaire (MIPQ) was used to assess the extent to which parents felt they interacted with their child according to themes of mindfulness (e.g., careful listening, noticing, accepting, etc.) during the prior 2 weeks (McCaffrey, Reitman, & Black, 2017). The MIPQ is comprised of two factors: (1) mindful discipline and, (2) being in the moment with the child. Answer choices range from 1 (*Infrequently*) to 4 (*Almost Always*). Total raw scores for each factor are transformed into standardized scores using published conversion tables. Average scores range from 90 to 110 and higher scores indicate higher levels of mindful parenting (McCaffrey et al., 2017). Internal reliability in the current sample was good (Cronbach's α Factor $1 = 0.897$, Factor $2 = 0.851$).

Resilience

The 6-item Brief Resilience Scale (BRS) assessed parents' "ability to bounce back or recover from stress" (Smith et al., 2008) (e.g., "It is hard for me to snap back when something bad happens"). Items are scored on a 1 (*strongly disagree*) to 5 (*strongly agree*) scale. Summary scores range from 6 to 30 with higher scores indicating higher resilience (Smith et al., 2008). Internal reliability in the current sample was good (Cronbach's $\alpha = 0.873$).

Statistical Analyses

Descriptive analyses were utilized as the primary statistical analyses to examine feasibility and acceptability of this pilot intervention. For the ARCS, PSS, and BRS, values for missing items were imputed from the means of answered questions if no more than 20% of data was missing. Instructions for the MIPQ specify that no items may be missing so scores were only calculated for participants with complete data. Shapiro-Wilk tests of normality were conducted on psychosocial measures. Paired-samples t-tests were used to assess change in psychosocial outcomes determined to be normally distributed (solicitousness, perceived stress, and resilience), and Wilcoxon signed ranks tests were used for those with non-normal distributions (mindfulness in parenting). Cohen's *d* effect sizes and confidence intervals were also calculated to assess meaningfulness of observed differences. All analyses were performed using SPSS version 24.0 (IBM Corp). An alpha level less than 0.05 was considered statistically significant. All analyses were conducted using an intent-to-treat framework such that all participants who completed the onboarding process (those who had access to the intervention; $n = 30$) were included regardless of whether or not they completed any intervention components. Given the study's status as a pilot study assessing feasibility and acceptability, no power analyses were conducted.

Table II. *App Usage Data*

	Mean (*SD*)	Median	Min	Max
Engagement Days	11.2 (7.0)	11.0	0	28
Total Minutes of Engagement	95.2 (54.5)	108.1	0	213.7
Unique Intro/Takeaway Sessions Completed	5.6 (2.9)	6.5	0	8
Unique Mindfulness Sessions Completed	14.7 (7.2)	19.0	0	20
Unique Total Sessions Completed	20.2 (10.0)	25.5	0	28

Results

Demographics and Descriptive Statistics

A full demographic breakdown of study participants is found in Table I. In brief, the majority of parent participants were Non-Hispanic White mothers (83.3%). Average parental age was 49.5 years. Two-thirds of the parent participants (66.7%) were parenting a daughter with chronic pain; average child age was 14.8 years. Parent-reported child pain diagnoses are presented in Table I. Providers were 91.7% female, with an average of 18.5 years' experience treating children and adolescents with chronic pain. Participant recruitment began in December 2017; all study procedures were completed by April 2018.

App Usage

Server-side monitoring of parents' app usage revealed that the average number of engagement days was 11.2 (range 0–28), and average total engagement time was 95.2 min (range 0–213.7). The average number of unique introductory and takeaway videos completed was 5.6 (median = 6.5; range 0–8), and the average number of unique mindfulness audio sessions completed was 14.7 (median = 19.0; range 0–20), yielding a combined average curriculum completion rate of 72.1% (20.2 out of 28). Twelve parents (40%) completed the full audio and video curriculum. Two parents did not use the mindfulness components of the app during the 30-day intervention, but their data is included in the analyses per the intent-to-treat model of data analysis. One of these parents did complete three sessions after her 30-day period had ended but prior to completing the acceptance test. App usage data is presented in Table II.

Parent Acceptance Tests

Twenty-nine of the 30 parent participants completed the post-study acceptance test. Of the 16 Likert-scale questions, 11 met the criterion for acceptance as defined by ≥70% of parent participants rating the question as ≥5 on the 7-point Likert scale. The questions eliciting the highest percentage of parents answering ≥5 were: the helpfulness of the peer videos (94.7%), the helpfulness of peer videos for parents at the beginning of the medical experience (90.0%), and whether parents would recommend the mobile app to another parent of a child with a chronic health condition (82.8%). The questions eliciting the lowest percentage of parents answering ≥5 were: whether the mobile app helped the parent to learn about communicating with others (55.2%), and how much the parents liked the audio relaxations offered during Week 4 (58.3%) and Week 3 (64.0%). Results of all quantitative acceptance test items are presented in Table III.

Responses to open-ended questions revealed perceived strengths of the program and potential areas for improvement. One parent who appreciated the app's focus on her specific situation expressed: "I really appreciated that it was geared for parents of children with chronic pain. I felt confident that the people leading the sessions were knowledgeable about what we deal with." Responses to open-ended text questions are presented in the Supplementary online materials.

Provider Acceptance Tests

Overall, provider support for the program was high. All eight of the Likert scale questions met the acceptance criterion (range 83.3–100% of providers responding with ≥5). As one provider expressed on an open-ended question:

> So many parents are anxious when they come into the clinic. Most parents do not understand pain physiology, are often anxious (which) further contributes to the overall pain dynamics. Allowing parents to have tools to lower their anxiety and to further understand what their child is dealing with, along with tools to address it, is priceless. Parents who are able to support their child in a calm manner are better able to empower their child to heal.

Additional quantitative provider acceptance test results are presented in Table III, and sample responses to open-ended questions are presented in the Supplementary online materials.

Psychosocial Measures

As shown in Table IV, paired-sample t-tests revealed a significant reduction in solicitousness ($t = 2.46$, $p = .02$, $d = -0.30$), and perceived stress ($t = 3.47$, $p = .002$, $d = -0.43$). No significant change was observed in resilience ($t = 0.27$, $p > .05$, $d = -0.05$). Wilcoxon signed ranks tests revealed a significant increase in the mindful discipline factor of mindfulness in parenting ($Z = -2.02$, $p = .044$, $d = 0.28$) and a trend toward a significant increase in the being in the

Table III. *Parent- and Provider-Completed Likert-Scale Acceptance Test Items*

Question	*N*	Mean (*SD*)	% ≥5
Parents			
Enjoyed using	28	5.36 (1.7)	71.4
Easy/difficult to navigate	29	5.14 (1.4)	75.9
Like/not like audio relaxations offered			
Week 1	28	5.46 (1.7)	71.4
Week 2	26	5.23 (1.5)	73.1
Week 3	25	5.20 (1.7)	64.0
Week 4	24	5.13 (1.6)	58.3
Helpfulness of the...			
Program host videos in presenting the content	28	5.14 (1.5)	71.4
Program host videos for parents at beginning of medical experience	28	6.04 (1.2)	82.1
Peer videos	19	6.05 (1.0)	94.7
Peer videos for parents at beginning of medical experience	20	6.30 (1.0)	90.0
Supplemental informational articles	20	5.40 (1.8)	75.0
Did the mobile app help you to...			
Relax?	29	5.48 (1.6)	72.4
Learn about communicating with others?	29	4.55 (1.9)	55.2
Learn about practicing self-kindness?	29	4.97 (1.7)	69.0
If it was available, would you continue to use the mobile app?	29	5.10 (2.3)	69.0
Would you recommend the mobile app to another parent of a child with a chronic health condition?	29	5.90 (1.7)	82.8
Providers			
Helpfulness...			
for parents of a child managing chronic pain	12	6.67 (0.7)	100%
of program host videos in presenting the content	12	5.92 (1.1)	83.3%
of peer videos	12	6.50 (0.7)	100%
of weekly supplementary articles and educational materials	12	6.50 (0.8)	100%
Likeliness to recommend app/program to...			
A parent with a child managing chronic pain	12	6.75 (0.6)	100%
Another health provider	12	6.83 (0.6)	100%
General usefulness of resiliency and mindfulness-based stress reduction strategies for parents of children managing chronic pain	12	6.83 (0.6)	100%
Overall helpfulness of the app for providers/teams to offer parents of a child with a chronic pain?	12	6.67 (0.9)	91.7%

Table IV. *Psychosocial Questionnaire Measures [Mean (SD)]*

	Pre	Post	*N*	Test Statistic	*p* value	Cohen's *d*	95% CI
Solicitousness	1.65 (0.57)	1.49 (0.53)	29	2.46[a]	.020	−0.30	(−0.49 to −0.09)
Perceived stress	17.03 (6.21)	14.38 (6.31)	29	3.47[a]	.002	−0.43	(−2.73 to 1.83)
Resilience	3.75 (0.77)	3.71 (0.78)	29	0.27[a]	ns	−0.05	(−0.34 to 0.23)
Mindful discipline	112.08 (15.82)	117.08 (19.97)	24	−2.02[b]	.044	0.28	(−7.71 to 6.61)
Being in the moment with the child	100.35 (14.28)	103.50 (17.73)	26	−1.93[b]	.053	0.20	(−6.62 to 5.69)

Note. CI = Confidence Interval.
[a]*t* statistic.
[b]*Z* statistic.

moment with the child factor ($Z = -1.93$; $p = .053$, $d = 0.20$). Effect sizes were small to moderate for all measures except resilience, which demonstrated a negligible effect size.

Discussion

The aim of the current study was to pilot test the MRI: Parents program, a mobile-based mindfulness and psychoeducational intervention for parents of children with chronic pain. Overall, parents used the intervention, gave positive feedback, and the majority of the acceptance and feasibility criteria were met. Parents completed the mindfulness curriculum above the hypothesized level. The frequency of daily usage was slightly lower than the pre-established feasibility criterion. The majority of parent acceptance test questions and all of the provider acceptance test questions

met acceptance criterion. Dropout after enrollment (12%) was low compared to similar mobile-based wellness studies (Donker et al., 2013; Turner & Hingle, 2017). One barrier to onboarding experienced by two enrolled parents was the inability to download the app due to forgotten app store password. Despite support and troubleshooting from the research team, these two individuals were not able to download the app. Future studies evaluating MRI: Parents will include troubleshooting and support to overcome this barrier. The current study extends the emerging body of research on MBIs for parents of children with chronic illness and suggests that it may be acceptable to deliver this content through a mobile device.

Open-ended acceptance question responses provided useful insights into the strengths of the intervention and potential targets for improvement. Specifically, strengths included providing a variety of mindfulness exercises and tailoring content to this unique population. The peer videos stood out as an important component of the program as well as a potential area for expansion. Parents' recommendations highlighted a need for more opportunities to interact with other parents and the ability to customize content based on treatment goals and preferences. Parents and providers also recommended improving navigation, increasing the variety of mindfulness content, and simplifying the language used. Future work will incorporate this feedback within the context of the app usage data to inform adaptation of the intervention content and structure.

The effect size results were small to moderate and align with results of parental behavior change and mental health variables in other psychological interventions for parents of children with chronic conditions (Eccleston, Fisher, Law, Bartlett, & Palermo, 2015). The change score demonstrating the largest effect size was for levels of perceived stress. Parents began the study with higher baseline levels of stress compared to comparable subgroups within the general population (Cohen & Janicki-Deverts, 2012), which is an indicator of the high burden of caring for a child with chronic pain. Our results are consistent with research that indicates that MBIs have a beneficial effect on stress in adults (Khoury et al., 2015) and parents of children with chronic illness (Minor et al., 2006). Parent protective behavior is often addressed in family based, pediatric chronic pain interventions (Fisher et al., 2018) and the current results align with the reported effects of family based cognitive behavioral therapy and parent-focused problem solving therapy on parental solicitousness and problematic behaviors (Law et al., 2017). In the MRI: Parents intervention, parent solicitousness was directly addressed in the psychoeducational material and the parent videos. Of note, changes in measures of mindful parenting and resilience were either marginally- or nonsignificant despite these areas being intervention targets. It is possible that the app content did not adequately address these issues or that these constructs may not respond to shorter interventions. Future work is needed to explore treatment mechanisms, how the MRI: Parents intervention compares to other parent-focused pediatric pain interventions, and whether treatment outcomes are dose-dependent.

There are several limitations to the current study. First, parents of males and younger children were under-represented in the current sample. Moreover, although this does represent the trend in tertiary outpatient pediatric pain clinics (Vetter, 2008), it does necessitate future work to tailor the intervention based on the child's sex and age. In addition, the sample was comprised primarily of nonminority mothers, which limits the intervention's generalizability to fathers and parents from minority racial and ethnic backgrounds. We also did not collect data on income or socioeconomic status, which limits our ability to draw conclusions about the acceptability of the intervention across populations with varied access to resources. Future work in more diverse samples may provide important feasibility and acceptability data in populations that may especially benefit from a mobile-based intervention (Anderson-Lewis, Darville, Mercado, Howell, & Di Maggio, 2018). Psychosocial interventions are well-established in the treatment of pain and stress, but it is possible that our sample of healthcare providers self-selected into the study based on their interest in or acceptance of these practices and might thus not represent pediatric pain providers at large. Last, the lack of a control or comparison group limits the impact of the findings.

Future research using the MRI: Parents mobile program is needed in order to assess the intervention's efficacy. Next steps include incorporating parent and provider feedback into an adapted and expanded app and assessing the potential benefits of the mobile program above standard of care in a randomized controlled trial. A large-scale study of this type will help identify which parents would benefit the most from the intervention, determine the mechanisms through which the intervention acts, and determine the effect of the parent intervention on the child with chronic pain and the overall family dynamics.

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Supplementary Data

Supplementary data can be found at: https://academic.oup.com/jpepsy.

Conflicts of interest: ED is Chief Science Officer at BodiMojo, Inc. TMC is Chief Executive Officer at BodiMojo, Inc. MWT is an employee at BodiMojo, Inc.

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References

Anderson-Lewis, C., Darville, G., Mercado, R. E., Howell, S., & Di Maggio, S. (2018). mHealth technology use and implications in historically underserved and minority populations in the United States: Systematic literature review. *JMIR Mhealth Uhealth*, *6*, e128.

Bogels, S. M., Lehtonen, A., & Restifo, K. (2010). Mindful parenting in mental health care. *Mindfulness (NY)*, *1*, 107–120. doi: 10.1007/s12671–010–0014–5

Cachia, R. L., Anderson, A., & Moore, D. W. (2016). Mindfulness, stress and well-being in parents of children with autism spectrum disorder: A systematic review. *Journal of Child and Family Studies*, *25*, 1–14. doi: 10.1007/s10826–015–0193–8

Chow, E. T., Otis, J. D., & Simons, L. E. (2016). The longitudinal impact of parent distress and behavior on functional outcomes among youth with chronic pain. *Journal of Pain*, *17*, 729–738. doi: 10.1016/j.jpain.2016.02.014

Claar, R. L., Guite, J. W., Kaczynski, K. J., & Logan, D. E. (2010). Factor structure of the Adult Responses to Children's Symptoms: Validation in children and adolescents with diverse chronic pain conditions. *The Clinical Journal of Pain*, *26*, 410–417. doi: 10.1097/AJP.0b013e3181cf5706

Cohen, S., & Janicki-Deverts, D. (2012). Who's stressed? Distributions of psychological stress in the United States in probability samples from 1983, 2006, and 2009. *Journal of Applied Social Psychology*, *42*, 1320–1334.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*, 385–396.

Donker, T., Petrie, K., Proudfoot, J., Clarke, J., Birch, M. R., & Christensen, H. (2013). Smartphones for smarter delivery of mental health programs: A systematic review. *Journal of Medical Internet Research*, *15*, e247. doi: 10.2196/jmir.2791

Eccleston, C., Fisher, E., Law, E., Bartlett, J., & Palermo, T. M. (2015). Psychological interventions for parents of children and adolescents with chronic illness. *Cochrane Database of Systematic Reviews, 4,* CD009660. doi: 10.1002/14651858.CD009660.pub3

Fisher, E., Law, E., Dudeney, J., Palermo, T. M., Stewart, G., & Eccleston, C. (2018). Psychological therapies for the management of chronic and recurrent pain in children and adolescents. *Cochrane Database of Systematic Reviews*, *9*, CD003968.

Hofmann, S. G., & Gómez, A. F. (2017). Mindfulness-based interventions for anxiety and depression. *Psychiatric Clinics of North America*, *40*, 739–749. doi: 10.1016/j.psc.2017.08.008

Jayewardene, W. P., Lohrmann, D. K., Erbe, R. G., & Torabi, M. R. (2017). Effects of preventive online mindfulness interventions on stress and mindfulness: A meta-analysis of randomized controlled trials. *Preventive Medicine Reports*, *5*, 150–159. doi: 10.1016/j.pmedr.2016.11.013

Julious, S. A. (2005). Sample size of 12 per group rule of thumb for a pilot study. *Pharmaceutical Statistics*, *4*, 287–291.

Khoury, B., Sharma, M., Rush, S. E., & Fournier, C. (2015). Mindfulness-based stress reduction for healthy individuals: A meta-analysis. *Journal of Psychosomatic Research*, *78*, 519–528.

King, S., Chambers, C. T., Huguet, A., MacNevin, R. C., McGrath, P. J., Parker, L., & MacDonald, A. J. (2011). The epidemiology of chronic pain in children and adolescents revisited: A systematic review. *Pain*, *152*, 2729–2738. doi: 10.1016/j.pain.2011.07.016

Law, E. F., Fisher, E., Howard, W. J., Levy, R., Ritterband, L., & Palermo, T. M. (2017). Longitudinal change in parent and child functioning after internet-delivered cognitive-behavioral therapy for chronic pain. *Pain*, *158*, 1992–2000.

McCaffrey, S., Reitman, D., & Black, R. (2017). Mindfulness in Parenting Questionnaire (MIPQ): Development and validation of a measure of mindful parenting. *Mindfulness*, *8*, 232–246. doi: 10.1007/s12671–016–0596–7

Minor, H. G., Carlson, L. E., Mackenzie, M. J., Zernicke, K., & Jones, L. (2006). Evaluation of a Mindfulness-Based Stress Reduction (MBSR) program for caregivers of children with chronic conditions. *Social Work in Health Care*, *43*, 91–109. doi: 10.1300/J010v43n01_06

Noel, M., Beals-Erickson, S. E., Law, E. F., Alberts, N. M., & Palermo, T. M. (2016). Characterizing the pain narratives of parents of youth with chronic pain. *The Clinical Journal of Pain*, *32*, 849–858. doi: 10.1097/AJP.0000000000000346

Palermo, T. M., & Eccleston, C. (2009). Parents of children and adolescents with chronic pain. *Pain*, *146*, 15–17. doi: 10.1016/j.pain.2009.05.009

Palermo, T. M., Eccleston, C., Lewandowski, A. S., Williams, A. C., & Morley, S. (2010). Randomized controlled trials of psychological therapies for management of chronic pain in children and adolescents: An updated meta-analytic review. *Pain*, *148*, 387–397.

Palermo, T. M., Valrie, C. R., & Karlson, C. W. (2014). Family and parent influences on pediatric chronic pain: A developmental perspective. *American Psychologist*, *69*, 142–152. doi: 10.1037/a0035216

Palermo, T. M., Wilson, A. C., Peters, M., Lewandowski, A., & Somhegyi, H. (2009). Randomized controlled trial of an Internet-delivered family cognitive-behavioral therapy intervention for children and adolescents with chronic pain. *Pain*, *146*, 205–213. doi: 10.1016/j.pain.2009.07.034

Peng, P., Stinson, J. N., Choiniere, M., Dion, D., Intrater, H., LeFort, S.,…Veillette, Y. (2007). Dedicated multidisciplinary pain management centres for children in Canada: The

current status. *Canadian Journal of Anaesthesia*, *54*, 985–991. doi: 10.1007/BF03016632

Rosenzweig, S., Greeson, J. M., Reibel, D. K., Green, J. S., Jasser, S. A., & Beasley, D. (2010). Mindfulness-based stress reduction for chronic pain conditions: Variation in treatment outcomes and role of home meditation practice. *Journal of Psychosomatic Research*, *68*, 29–36. doi: 10.1016/j.jpsychores.2009.03.010

Smith, B. W., Dalen, J., Wiggins, K., Tooley, E., Christopher, P., & Bernard, J. (2008). The brief resilience scale: Assessing the ability to bounce back. *International Journal of Behavioral Medicine*, *15*, 194–200.

Stanford, E. A., Chambers, C. T., Biesanz, J. C., & Chen, E. (2008). The frequency, trajectories and predictors of adolescent recurrent pain: A population-based approach. *Pain*, *138*, 11–21. doi: 10.1016/j.pain.2007.10.032

Treede, R. D., Rief, W., Barke, A., Aziz, Q., Bennett, M. I., Benoliel, R.,...Wang, S. J. (2015). A classification of chronic pain for ICD-11. *Pain*, *156*, 1003–1007.

Turner, T., & Hingle, M. (2017). Evaluation of a mindfulness-based mobile app aimed at promoting awareness of weight-related behaviors in adolescents: A pilot study. *JMIR Research Protocols*, *6*, e67. doi: 10.2196/resprot.6695

Vetter, T. R. (2008). A clinical profile of a cohort of patients referred to an anesthesiology-based pediatric chronic pain medicine program. *Anesthesia & Analgesia*, *106*, 786–794. doi: 10.1213/ane.0b013e3181609483

Walker, L. S., Levy, R. L., & Whitehead, W. E. (2006). Validation of a measure of protective parent responses to children's pain. *The Clinical Journl of Pain*, *22*, 712–716.

Wen, L., Sweeney, T. E., Welton, L., Trockel, M., & Katznelson, L. (2017). Encouraging mindfulness in medical house staff via smartphone app: A pilot study. *Academic Psychiatry*, *41*, 646–650. doi: 10.1007/s40596–017–0768–3