A Randomized Clinical Trial of Technology-Enhanced Family-Focused Therapy for Youth in the Early Stages of Mood Disorders

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Abstract

Objective: Family-focused therapy (FFT) is associated with enhanced outcomes in youth with bipolar and depressive disorders, but has not been evaluated in conjunction with mobile health tools. In symptomatic adolescents whose parents had histories of mood disorders, we examined whether the effects of telehealth-based FFT were augmented by mobile health apps that emphasized mood tracking and family coping skills.

Method: Participants (aged 13–19 years) had active mood symptoms and a parent with major depressive or bipolar disorder. Participants received 12 sessions in 18 weeks of telehealth FFT, with random assignment to (1) a mobile app (MyCoachConnect, MCC) that enabled mood tracking, reviews of session content, and text reminders to practice mood management and family communication skills (FFT-MCC); or (2) a mobile app that enabled mood tracking only (FFT-Track). Independent evaluators assessed youth every 9 weeks over 6 months on depressive symptoms (primary outcome), anxiety, and psychosocial functioning.

Results: Participants (N = 65; mean age 15.8 ± 1.6 years) significantly improved in depressive symptoms over 6 months ($F_{1,170} = 45.02$, $p < .0001$; $\acute{\eta}^2 = 0.21$, 95% CI = 0.11–0.31), but there were no effects of treatment condition or treatment by time interactions on depression scores. When secondary outcome measures were considered, the subgroup of youth with bipolar spectrum disorders showed greater improvements in anxiety and global functioning in FFT-MCC compared with FFT-Track.

Conclusion: Youth in the early stages of mood disorder may benefit from FFT enhanced by mobile health apps. Collaborations between researchers and information technologists on mobile app design and user experience may lead to increases in engagement among adolescents.

Clinical trial registration information: Technology Enhanced Family Treatment; https://clinicaltrials.gov/; NCT03913013.

Keywords

mobile health; mobile apps; bipolar disorder; depression; telehealth

There is a significant need for preemptive interventions for youth in the early stages of mood disorders, with the aim of stabilizing symptoms, improving functioning, and preventing trajectories toward full illness onset. Although there are promising individual, group, and family interventions for preventing illness episodes in youth with or at risk for mood disorders,[1–4] these interventions have been tested primarily in clinical practice settings.[5] The COVID-19 pandemic has increased recognition that psychotherapy should be available using telehealth platforms or, at minimum, adjoined with digital mobile health tools. The provision of illness management strategies and the ability to track symptom states through digital tools may help clarify the course of disorder subtypes, identify periods of increased risk, and enhance the outcomes of treatments for early-onset mood disorders.[6–9]

Family-focused therapy (FFT) is an intervention for youth in the early stages of bipolar disorder, depression, or psychosis.[10–15] It consists of weekly and biweekly family sessions of psychoeducation, communication enhancement training, and problem-solving skills training. Each module aims to increase family members' support of the symptomatic individual and to reduce family criticism and conflict. In randomized trials, FFT has been found to be an effective adjunct to pharmacotherapy in adults and adolescents with BD (type I or II) and youth at high risk for BD (ie, those with major depression or other specified BD and a family history of BD), in terms of symptom stabilization and episode prevention.[10–13] Furthermore, a 2-site randomized trial showed that FFT for childhood depression was associated with more rapid symptom response in children (aged 7–14 years) over 1 year, and greater knowledge and skills for managing depression among caregivers compared with individual psychotherapy.[14,15]

Growing research suggests that telehealth delivery of evidence-based therapies for youth yields similar outcomes compared with their clinic-based counterparts.[16–20] However, it is unclear whether FFT would be effective when delivered remotely or enhanced when supplemented with digital tools. To aid in the uptake of FFT, we developed a mobile app (MyCoachConnect [MCC]),[21] which engages youth and parents by providing reviews of prior session content, instructions to practice and record practices of skills to promote mood regulation and healthy family functioning, and track clinical progress through a self-rated mood chart. In an open trial of FFT-MCC in adolescents with parents with depressive and bipolar disorders, we observed significant improvements in adolescents' depression and reductions in the amount of perceived parent/offspring criticism over 6 months.[6]

In this randomized trial, conducted at the outset of the pandemic, we compared a 12-session, remotely administered FFT with the MCC app (FFT-MCC) to the same FFT protocol with a comparison "tracking" app (FFT-Track) that enabled the collection of self-ratings of mood and stress, without the extensive skill review or practice reminders sent by the MCC app. Participants included adolescents who (1) had active symptoms of mania/hypomania or major depression and (2) had at least 1 parent with a history of mood disorder (bipolar I or II disorder or major depressive disorder [MDD]). We hypothesized that FFT-MCC would have

a greater impact on youths' depression (primary outcome), anxiety, and global functioning than FFT-Track.

Youth in the early phases of bipolar disorder (BD) or MDD have heterogeneous clinical presentations, and subgroups (eg, those presenting with mania or hypomania vs depression, or those with vs without attentional disorders) may respond quite differently to mobile health approaches.[22] A secondary aim of this study was to examine whether FFT-MCC was associated with greater symptomatic improvement in youth with bipolar spectrum disorders compared with youth with depressive spectrum disorders. FFT protocols have been found to be effective in youth with major depression,[14,15] suggesting that treatment effects attributable to the 2 different versions of the mobile app might be of comparable size in youth with bipolar and depressive spectrum disorders. However, given the higher levels of mood instability and, possibly, the greater relevance of mood management strategies in youth with bipolar spectrum disorders,[23] we reasoned that this group would show a greater response to FFT with the skill practice—oriented MCC app compared with youth with depressive spectrum disorders.

METHOD

Participants

This study was conducted between January 2020 and December 2021 at the University of California, Los Angeles Semel Institute. Its original purpose was to examine the efficacy of clinic-based FFT as enhanced by either of 2 mobile apps. However, the onset of the COVID-19 pandemic in March 2020 necessitated moving all assessment and treatment procedures to telehealth.

Adolescents were referred through pediatricians, mental health practitioners, advertisements, and study flyers. When parents called about a symptomatic offspring (the proband), a study coordinator conducted a telephone screen to determine eligibility. If at least 1 parent and the proband expressed interest, they were invited to an eligibility assessment meeting in which the study was explained and participants read and signed university institutional review board—approved consent or assent forms. Young participants had to meet the following criteria: (1) age 13 years, 0 months to 19 years, 11 months; (2) current and impairing mood symptoms, as indicated by scores >11 on the Young Mania Rating Scale[24] or >29 on the Children's Depression Rating Scale, Revised[25]; (3) a *DSM-5*[26] depressive spectrum (ie, major depression or other specified depressive) disorder or bipolar spectrum (I, II, or other specified) disorder by the MINI International Neuropsychiatric Interview, Child and Adolescent Version for *DSM-5* (MINI-KID)[27]; (4) evidence of mood instability, as indicated by a score >6 on the Parent General Behavior Inventory for Mania, 10-item scale[28] or >20 on the parent-rated 20-item Children's Affective Lability Scale (CALS)[29]; (5) at least 1 biological parent with a lifetime history of MDD or BD (type I or II) by *DSM-5*, as indicated by direct interview using the MINI International Neuropsychiatric Interview for Adults[30]; (6) the proband rated at least 1 parent as high (>5 on a scale of 1–10) in severity of expressed criticism using the Perceived Criticism Scale[31]; and (7) the adolescent and parent(s) had access to a smartphone, tablet, or desktop computer (of any brand) with an Internet connection.

The Parents' General Behavior Inventory for Mania, a measure of mood and energy dysregulation, consists of 10 items rated on a scale of 0 (never or hardly ever) to 3 (very often, almost constantly) covering the prior year (eg, "Has your child's mood and energy shifted rapidly back and forth from happy to sad or high to low?").[28] The parent-rated CALS, covering the prior 3 months, is composed of 20 mood instability items rated on 1 (never or rarely occurs) to 5 (1 or more times a day) frequency scales, with items concerning elevation/activation, irritability, and anxiety—depression.[29]

Two trained interviewers administered the MINI-KID to the proband and separately, 1 parent regarding the proband's behavior in the last 2 weeks and over the proband's lifetime. The interviewers then made consensus diagnoses. Youth were excluded if they met criteria for a *DSM-5* pervasive developmental disorder or a substance use disorder in the past 4 months.

Treatment Protocols

Probands and all available family members were randomly allocated in a 1:1 ratio to FFT for high-risk youth[10] with the full MCC app (FFT-MCC condition) or the same FFT protocol with a mood tracking app (FFT-Track condition). Both groups received 12 sessions of FFT in 18 weeks (8 weekly and 4 biweekly sessions). Allocation was done using a computerized biased coin toss that balanced the groups on mood diagnosis (bipolar spectrum vs depressive spectrum disorder).

The first 11 study participants were recruited at the beginning of the COVID-19 pandemic but before restrictions began (January to February 2020). For these participants, family sessions began in an outpatient clinic and were switched to telehealth within 1 to 2 months after study entry. Of the 11 study participants, 4 families received the majority (6) of their FFT sessions in the clinic; the rest received their care by telehealth (see "Comparisons of Telehealth vs Clinic Delivery" in Supplement 1, available online).

In the first FFT module, psychoeducation, clinicians explored the proband's most recent mood or anxiety symptoms and assisted the youth and family members in developing a personalized prevention plan, listing warning signs of new episodes (eg, irritability, sleep disturbance), antecedent stressors, coping strategies (eg, exercising, deep breathing, maintaining regular routines), and obstacles to implementing these strategies. In the second module, communication enhancement training, clinicians acquainted families with skills to reduce familial conflict (ie, expressing positive or negative feelings, listening actively, making positive requests for changes in another's behavior, and communicating clearly), with skill practice through in-session and between-session rehearsal assignments (eg, hold a family meeting in which each member practices active listening). In the third module, problem solving, families were encouraged to break down large problems (eg, "you are being disrespectful") into more focused problems, to generate and evaluate solutions to these problems, and to choose specific solutions to implement (eg, alert each other to aggressive voice tones).

Clinicians were trained to administer FFT in group workshops and were provided supervision throughout the trial. Supervisor ratings of session tapes established that clinicians continuously met fidelity criteria on the Therapist Competence and Adherence

Scales[13] throughout the trial, with minimum scores of 4 (good) or higher on 1 (very low) to 7 (excellent) point scales of treatment fidelity. Clinicians who had 1 or more sessions with scores below 4 were given extra supervision until their scores met quality assurance criteria (see clinician's manual at https://www.semel.ucla.edu/champ/downloads-clinicians).

MCC and Track Mobile Apps

The MCC and Track apps were built using Chorus, a platform for creating and hosting mobile, desktop, and text-messaging apps (https://joinchorus.com, accessed March 16, 2023). Both apps contained Web portals for the proband, parent(s) or other caregivers, clinician, and research staff. For FFT-MCC, the proband and parent app portals contained the following: (1) weekly check-ins consisting of questionnaires about mood and family functioning (see below); (2) reminders to make a daily rating of the child's mood (using a scale of −3 to + 3) and family stress; (3) a "progress portal" containing graphs of the youth's daily or weekly moods and ratings of family functioning; (4) reviews of prior session content and themes; and (5) text reminders to practice a "skill of the week" chosen by the clinician (eg, "practice problem-solving"), along with instructions on how to log descriptions of these practices on the app. The FFT-Track mobile app consisted only of the weekly check-in questionnaires on mood and family functioning. Although clinicians administering FFT-Track encouraged participants to practice communication and problem-solving skills between sessions, participants could not review skill instructions on the app, receive text messages reminding them to record practices, or access the progress portal.[6]

Participants in both conditions were asked to complete weekly app check-ins during 18 weeks of treatment and 9 weeks of follow-up. App engagement, defined as the number of weeks during FFT in which youth or parents completed weekly check-ins, was compared across treatment conditions. For the FFT-MCC condition, engagement scores were also calculated for daily mood assessments and logging of FFT skills. When 2 parents used the app, we examined data from the parent who accessed it more frequently.

Clinical Outcome Assessments

Prior to the study, independent evaluators underwent extensive training in each of the study instruments and received consultation from a team of licensed clinical psychologists throughout the trial. Evaluators, who were unaware of participants' treatment assignments, interviewed each proband and 1 parent at baseline (pre-randomization), 9 weeks (mid-treatment), 18 weeks (post-treatment), and 27 weeks (follow-up). The success of the blind was tested at the end of the trial by asking each evaluator to guess the treatment condition of probands that they had interviewed. The primary and secondary evaluators correctly guessed the condition in 49 of 84 follow-up interviews (58.3%), indicating chance prediction.

At each assessment, the evaluator made a 1 to 100 point rating on the Children's Global Assessment Scale (CGAS)[32] covering the prior 2 weeks. Next, they made weekly Psychiatric Status Ratings (PSRs) from the Adolescent Longitudinal Interval Follow-up Evaluation,[33] covering the severity of depression and mania or hypomania symptoms during the baseline period (covering 18 weeks prior to randomization) and then for every 9 prospective weeks, based on a consensus of the youth's and parents' reports. Weekly PSRs

for depression ranged from 1 (no symptoms) to 6 (severe, meets *DSM-5* criteria for major depressive episode), with average PSR scores calculated for each interval. The weekly mania and hypomania PSRs were combined into a single 8-point hypo/mania scale ranging from 1 (no symptoms) to 6 (syndromal hypomania), with scores of 7 and 8 reserved for severe or extremely severe mania. Interrater reliabilities (intraclass *rs*) for the PSR depression and hypo/mania scales were 0.88 and 0.99, respectively, averaged across raters.

Parents completed the CALS mood instability measure about the proband at each assessment visit. In addition, the teen completed the 41-item Screen for Child Anxiety and Related Emotional Disorders (SCARED)[34] covering the prior 2 weeks (eg, "When I feel frightened, it is hard to breathe"). Total mood instability and anxiety scores were tabulated for each visit.

Data Analyses

The study hypotheses centered on the evolution from baseline to 9, 18, and 27 weeks of mean PSR depressive symptoms (primary study outcome) and, secondarily, SCARED anxiety scores and CGAS functioning scores, calculated for each interval and compared across treatment conditions using linear and generalized linear mixed models (PROC MIXED and GLIMMIX, Statistical Analysis System [SAS], V 9.4).[35] Other outcomes described in our study protocol (https://clinicaltrials.gov; NCT03913013), including repeated measures of parental expressed emotion and youths' free speech samples, were not considered in this article because they could be obtained only on a subset of participants in this sample and because they are relevant to longitudinal hypotheses that did not concern treatment outcomes.

Mixed models, calculated using all available data account for correlations induced by repeated measurements within subjects and produce unbiased estimates of missing data, assuming that observations are missing at random. In the models, we used treatment group (FFT-MCC vs FFT-Track) and study visit (0, 9 weeks, 18 weeks, and 27 weeks) as fixed effects and participant as a random effect.[36] Sensitivity analyses redefined mixed models to covary for baseline scores and to examine the effects of outliers (see Figures S1 and S2, Supplement 1, available online).

Secondary models examined 3-way interactions between treatment, study visit (baseline score and 9-, 18-, and 27-week scores), and primary mood diagnoses (depressive vs bipolar spectrum disorder) or comorbid disorders (presence/absence of attention-deficit/hyperactivity disorder [ADHD] or anxiety disorders) on the repeated dependent variables (depression [primary], anxiety, and global functioning [secondary]). Age, sex, parental diagnoses, and baseline parent-rated CALS mood instability scores were included as covariates. For outcomes measured at 4 time points in 60 study completers, we had 80% power to detect an overall group by study visit interaction corresponding to a treatment effect size of $f^2 = 0.03$, just above the Cohen threshold for a small effect ($f^2 = 0.02$). Because of the exploratory nature of the study, we did not correct for multiple comparisons.

In exploratory analyses, we compared treatment groups on app engagement (frequency of adolescents' and parents' weekly app check-ins) using scaled Poisson regression models

(PROC GENMOD in SAS[35]) to account for the skewed distribution of check-in counts. Goodness-of-fit tests indicated no evidence of overdispersion (Pearson χ^2, $p = .5$, deviance $p = .3$). Within the FFT-MCC group, we used Spearman rank-order correlations to examine whether the proportion of weeks in which adolescents reported use of an FFT skill on the app was associated with changes in PSR depression scores over 27 weeks.

RESULTS

Of 65 youth assigned to treatments (32 to FFT-MCC and 33 to FFT-Track) (Figure 1), 58 were followed until at least the post-treatment (18-week) point, and 57 to 27 weeks. The 65 youth did not differ from the 52 youth who were screened but were ineligible or refused the trial on sex (72% vs 62% female participants) or age (means 15.8 ± 1.6 years vs 15.4 ± 1.6 years).

At intake, 53 participants met *DSM-5* criteria for depressive spectrum (major depressive or other specified depressive) disorder and 12 for bipolar spectrum (I, II, or other specified) disorder (Table 1). Of the 53 with depressive spectrum disorder, 43 had parents with lifetime MDD and 10 had parents with lifetime BD. Of the 12 youth with bipolar spectrum disorder, 7 had parents with MDD and 5 had parents with BD. Youth received mean PSR depression ratings of 4.4 ± 0.8 (range, 2.2–5.8) on the scale of 1 to 6 at baseline (moderately severe to severe symptoms across 18 previous weeks), and CGAS ratings of 42.2 ± 9.5 (range, 20–65) over the prior 2 weeks. Participants entered with low mean levels on the 8-point mania/hypomania PSR scale, with little variability (mean 1.4 ± 0.8). This scale was not considered in subsequent analyses. The 2 treatment groups did not differ on any pretreatment demographic or illness severity variable or on baseline medication regimens (Table 1).

Adherence with FFT Sessions and Mobile App Use

Families in FFT-MCC attended an average of 11.3 ± 3.8 sessions (of 12 offered), whereas families in FFT-Track attended an average of 10.9 ± 4.0 sessions ($F_{1,63} = 0.15$, $p = .70$). During the 18 weeks of FFT, adolescents completed an average of 5.2 ± 3.8 weekly symptom check-ins (range, 0–15) on the mobile app, whereas parents completed an average of 9.2 ± 4.5 check-ins [range, 0–21; t(59) = 6.37, $p < .0001$]. App use in teens and parents was modestly correlated (r[60] = 0.30, $p = .02$). Parents (mean 4.9 ± 1.7) and teens (5.1 ± 1.6) did not differ in their ratings of ease of use of either app (using a scale of 1 [difficult] to 7 [very easy]), nor did they differ on ratings of understandability of app features (parents: 5.4 ± 1.3; teens: 5.3 ± 1.4).

In both treatment conditions, app use was most frequent in the first 10 weeks of treatment and tapered off thereafter, with most teens and parents stopping after 18 weeks. A Poisson regression model indicated that adolescents and parents in FFT-MCC and FFT-Track did not differ in frequency of app check-ins over 18 weeks. Across conditions, higher parent-rated CALS mood instability scores of adolescents were associated with lower frequencies of app check-ins among adolescents [Wald $\chi^2(1) = 4.85$, $p = .028$]. No other baseline variable (age, sex, mood or comorbid diagnoses, PSR depression, SCARED, or CGAS scores) was associated with frequency of teen or parent app check-ins.

Within the FFT-MCC condition (n = 32), adolescents conducted daily mood checks during an average of 18.1 ± 19.1 days (range, 0–79) of FFT, whereas parents completed daily mood checks of probands on 28.3 19.6 days (range, 0–94) of FFT. Probands logged skill practices on the app during an average of 6.8 ± 4.3 of the 18 weeks, whereas parents logged skills during half (8.8 ± 5.2) of the 18 weeks.

Effects of Treatment and App Use on Depression and Anxiety Over 6 Months

A linear mixed model indicated that participants significantly improved in depressive symptoms over 6 months, with an average reduction in 6-point depression PSRs of 1.13 ± 1.12 points from baseline to 27 weeks ($F_{1,170} = 45.02$, $p < .0001$; partial $\acute{\eta}^2 = 0.21$, 95% CI = 0.11–0.31). There were no main effects of (or interactions between) treatment condition and baseline mood diagnosis on repeated PSR depression scores, nor was there a 3-way interaction with study visit (Figure 2). There was, however, a 3-way interaction between treatment condition, mood diagnosis, and study visit on SCARED anxiety scores: youth with bipolar spectrum disorders (n = 12) who were assigned to FFT-MCC showed greater decreases in SCARED scores over time than youth with bipolar spectrum disorders assigned to FFT-Track ($F_{1,167} = 4.02$, $p = .047$) (Figure 3; see also Sensitivity Analyses and score distributions in Figure S1, Supplement 1, available online). Among youth with depressive spectrum disorders (n = 53), there were no differences between treatment conditions on SCARED scores.

A Poisson regression model indicated that across treatment conditions, a higher frequency of weekly app use by parents was associated with lower PSR depression scores in probands over 27 weeks [$\chi^2(1) = 4.46$, $p = .035$]. The associations between teen app use and PSR depression or SCARED scores were nonsignificant. Within the FFT-MCC group, neither the number of days with mood checks nor weeks with logged skill practices in teens or parents were associated with PSR depression or SCARED scores at follow-up.

Effects of Treatment Conditions and App Use on Global Functioning

Probands' CGAS scores (covering the prior 2 weeks) improved significantly over successive 9-week intervals ($F_{1,169} = 112.32$, $p < .0001$; partial $\acute{\eta}^2 = 0.40$, 95% CI = 0.29–0.49). Overall, there were greater functional improvements from baseline to 27 weeks in FFT-MCC compared with FFT-Track (treatment group by visit interaction: $F_{1,170} = 5.79$, $p = .017$) (Figure 4). Improvements in CGAS scores in FFT-MCC (vs FFT-Track) were largest in youth with bipolar spectrum disorders compared with those with depressive spectrum disorders ($F_{1,170} = 8.52$, $p = .004$) (Figure 4; see section on Sensitivity Analyses and Figure S2, available online). Regardless of treatment assignment, adolescents who completed more weekly check-ins during FFT had higher CGAS scores at 18 and 27 weeks [$\chi^2(1) = 4.99$, $p = .026$; Poisson model]. When participants' age, sex, mood diagnoses, comorbid disorders, CALS scores, and treatment condition were covaried, the association between teens' weekly app use and follow-up CGAS scores remained significant [$\chi^2(1) = 4.76$, $p = .029$].

DISCUSSION

This study examined whether a remotely administered FFT protocol was associated with improved clinical outcomes in youth with mood disorders who were randomly assigned to a mobile app that encouraged mood tracking and practice of illness management, communication, and problem-solving skills (FFT-MCC) or the same remote FFT protocol with a mood tracking—only app (FFT-Track). Youth in the 2 conditions showed comparable improvements in the primary study outcome, weekly depressive symptoms on the Psychiatric Status Rating Scale. Participants in FFT-MCC did, however, show greater improvements on a secondary outcome variable, global functioning scores, compared with those in FFT-track.

The treatments appeared to operate differently in the smaller subgroup of youth with bipolar spectrum disorders (n = 12) compared with the larger subgroup with depressive spectrum disorders (n = 53). Youth with bipolar spectrum disorders in FFT-MCC showed greater improvements in anxiety symptoms and global functioning (both secondary outcomes) over 6 months compared with youth with bipolar spectrum disorders in FFT-Track. FFT was originally designed for adults and adolescents with bipolar disorders, to assist patients and family members in coping during the aftermath of manic and depressive episodes. Possibly, the greater emphasis of the MCC app on FFT session content and practice may have led to greater generalization of coping skills in youth with bipolar spectrum disorders compared with what was achieved with the Track app. More exposure to and practice with the FFT skills may be particularly useful for youth with bipolar spectrum disorders and their parents, given the wide fluctuations in mood experienced by these youth.[23]

Although parents and teens did not differ in their ratings of ease of use or understandability of the apps, parents were more likely than teens to use the app regularly (mean 9.2 vs 5.20 weekly check-ins) during 18 weeks of treatment. Similar parent/offspring discrepancies in app engagement were observed in our open trial of FFT-MCC.[6] The variability in app use was considerable in teens and parents, from those who never engaged with it to those who used it weekly. Such individual variability has been observed in prior studies,[37] with evidence that symptom severity limits use and adherence to digital health interventions.[38,39] In the current study, adolescents rated by parents as higher in mood instability were less likely to perform app check-ins than those with more stable moods. Possibly, greater mood lability interferes with teens' ability to engage in directed treatment tasks such as tracking moods or practicing communication skills. Mood instability is prospectively associated with more severe symptoms and functional impairment in youth at risk for BD[6,40] and adolescents with BD I or II.[41]

There was a positive relationship in both treatment conditions between teen app use and global functioning over time. Study clinicians systematically integrated use of the apps into FFT sessions, and many participants stated that they valued the ready availability of information on skill strategies between sessions. Engagement with an app may facilitate family psychoeducation beyond the particular skills emphasized in sessions. For example, rating mood on a daily or weekly basis may stimulate teens' curiosity about why their moods or energy levels fluctuate. Making regular ratings of family conflict may orient youth

to proximal triggers for mood swings and help them to engage with exercises relevant to family communication. Clarifying the mechanisms by which mental health apps support evidence-based treatments may facilitate the development of more effective integrated approaches.

This study illustrates some of the limitations of mobile health interventions for youth with mood disorders. During treatment, the weekly app check-ins requested of both groups were lower than expected, with teens completing check-ins during an average of 5 of 18 weeks. Indeed, mental health app uptake and engagement in youth has varied across clinical populations and intervention modalities.[42,43] This variability likely relates to a number of individual, population, and app-specific factors that influence motivation for and adherence to treatment.[22] In future studies, reporting of these factors alongside actual rates of app use may help in designing more engaging digital tools.

App use decreased over time and virtually ceased once telehealth family sessions ended. The lack of app engagement during the 2-month post-treatment interval may reflect the lack of clinician prompting and guidance during this interval. The literature suggests that both adults' and children's adherence to self-guided online resources is higher in clinician-guided interventions compared with programs that expect individuals to access these resources without human support.[44–49] Different levels of clinician involvement, as well as choices of layouts, interactive response options, or response frequency requirements are important considerations in designing apps for youth who vary in clinical status, cognitive functioning, or levels of psychosocial impairment.

We must also be aware of limitations in maintaining users' interest in apps that seek to improve mental health. A meta-analysis concluded that there was little evidence that smartphone interventions reduced the severity of manic or depressive symptoms among adults with BD.[50] Indeed, mental health apps have to compete with gaming apps and social media programs developed by technology companies that vie for the attention of users. Collaborations between clinical researchers and information technologists on mobile app design and user experience may lead to increases in user engagement among teens. Greater attention to study outcomes that may be more meaningful to individuals with mood disorders, such as mood stability and quality of life, may also increase these individuals' commitment to technological innovations.

The present study could not evaluate the value of adding mobile apps to standard FFT on the clinical outcomes of youth with mood disorders. This question would have required a third group of youth who received FFT without an app. In a post hoc comparison of study samples, we observed larger pre- to post-treatment improvements over 18 weeks in depression and global functioning when FFT was supplemented by 1 of the 2 apps (the present sample), compared with a previous sample of youth at high risk for bipolar disorder who received FFT without app supplementation[10] (see Table S1 and Figure S3, Supplement 1, available online). Interpreting these sample differences is limited by comparing youths who met different study eligibility criteria and received treatment by different delivery modes (ie, clinic vs telehealth). Future randomized trials should directly compare high-risk

youth who receive in-person vs remote psychosocial interventions, stratified by use or non-use of mobile health apps.

In this study, youth with parents with depression or bipolar disorder showed significant improvements over time in telehealth-based FFT supplemented by mobile apps, whether the app provided instructions for skill practices or was designed simply to track moods and functioning over time. Future studies need to consider what components of mobile health apps lead to improvements in youths' psychiatric symptoms and functioning, how to design them so that they become sustained and valued health tools, and whether they could be effective with reduced clinician support as well as in combination with evidence-based psychosocial interventions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

REFERENCES

1. Vallarino MA, Henry C, Etain B, et al. An evidence map of psychosocial interventions for the earliest stages of bipolar disorder. Lancet Psychiatry. 2015;2(6):548–563. [PubMed: 26360451]

2. Lynch FL, Dickerson JF, Clarke GN, et al. Cost-effectiveness of preventing depression among at-risk youths: postintervention and 2-year follow-up. Psychiatr Serv. 2019;70(4):279–286. 10.1176/appi.ps.201800144 [PubMed: 30929618]

3. Garber J, Clarke GN, Weersing VR, et al. Prevention of depression in at-risk adolescents: a randomized controlled trial. JAMA. 2009;301(21):2215–2224. 10.1001/jama.2009.788 [PubMed: 19491183]

4. Fristad MA, MacPherson HA. Evidence-based psychosocial treatments for child and adolescent bipolar spectrum disorders. J Child Adolesc Psychol. 2014;43(3):339–355. 10.1080/15374416.2013.822309

5. Weisz JR, Kuppens S, Eckshtain D, Ugueto AM, Hawley KM, Jensen-Doss A. Performance of evidence-based youth psychotherapies compared with usual clinical care: a multilevel meta-analysis. JAMA Psychiatry. 2013;70(7):750–761. [PubMed: 23754332]

6. Miklowitz DJ, Weintraub MJ, Posta F, et al. Development and open trial of a technology-enhanced family intervention for adolescents at risk for mood disorders. J Affect Disord. 2021;281:438–446. 10.1016/j.jad.2020.12.012 [PubMed: 33360365]

7. Post RM, Rowe M, Kaplan D, Findling R. The Child Network for parents to track their child's mood and behavior. J Child Adolesc Psychopharmacol. 2017;27(9):840–843. 10.1089/cap.2017.0002 [PubMed: 28441041]

8. McKnight R, Bilderbeck A, Miklowitz DJ, Hinds C, Goodwin GM, Geddes JR. Longitudinal mood monitoring in bipolar disorder: course of illness as revealed through a short messaging service. J Affect Disord. 2017;223:139–145. 10.1016/j.jad.2017.07.029 [PubMed: 28753472]

9. Faurholt-Jepsen M, Christensen EM, Frost M, Bardram JE, Vinberg M, Kessing LV. Hypomania/mania by DSM-5 definition based on daily smartphone-based patient-reported assessments. J Affect Disord. 2020;264:272–278. 10.1016/j.jad.2020.01.014 [PubMed: 32056761]

10. Miklowitz DJ, Schneck CD, Walshaw PD, et al. Effects of family-focused therapy vs enhanced usual care for symptomatic youths at high risk for bipolar disorder: a randomized clinical trial. JAMA Psychiatry. 2020;77(5):455–463. 10.1001/jamapsychiatry.2019.4520 [PubMed: 31940011]

11. Miklowitz DJ, Schneck CD, Singh MK, et al. Early intervention for symptomatic youth at risk for bipolar disorder: a randomized trial of family-focused therapy. J Am Acad Child Adolesc Psychiatry. 2013;52(2):121–131. 10.1016/j.jaac.2012.10.007 [PubMed: 23357439]

12. Miklowitz DJ, Chung B. Family-focused therapy for bipolar disorder: reflections on 30 years of research. Fam Process. 2016;55(3):483–499. 10.1111/famp.12237 [PubMed: 27471058]

13. Marvin SE, Miklowitz DJ, O'Brien MP, Cannon TD. Family-focused therapy for individuals at clinical high risk for psychosis: treatment fidelity within a multisite randomized trial. Early Interv Psychiatry. 2016;10(2):137–143. 10.1111/eip.12144 [PubMed: 24725329]

14. Asarnow JR, Tompson MC, Klomhaus AM, Babeva K, Langer DA, Sugar CA. Randomized controlled trial of family-focused treatment for child depression compared with individual psychotherapy: one-year outcomes. J Child Psychol Psychiatry. 2020;61(6):662–671. 10.1111/jcpp.13162 [PubMed: 31840263]

15. Tompson MC, Sugar CA, Langer DA, Asarnow JR. A randomized clinical trial comparing family-focused treatment and individual supportive therapy for depression in childhood and early adolescence. J Am Acad Child Adolesc Psychiatry. 2017;56(6):515–523. 10.1016/j.jaac.2017.03.018 [PubMed: 28545757]

16. Stewart RW, Orengo-Aguayo R, Young J, et al. Feasibility and effectiveness of a telehealth service delivery model for treating childhood posttraumatic stress: a community-based, open pilot trial of trauma-focused cognitive–behavioral therapy. J Psychother Integration. 2020;30(2):274–289. 10.1037/int0000225

17. Gorrell S, Reilly EE, Brosof L, Le Grange D. Use of telehealth in the management of adolescent eating disorders: patient perspectives and future directions suggested from the COVID-19 pandemic. Adolesc Health Med Ther. 2022;13:45–53. 10.2147/AHMT.S334977 [PubMed: 35401019]

18. Howes ST, Gorey KM, Charron CM. Relative effectiveness of online cognitive behavioural therapy with anxious or depressed young people: rapid review and meta-analysis. Austral Soc Work. 2021;1–15. 10.1080/0312407x.2021.2001832

19. Anderson KE, Byrne CE, Crosby RD, Le Grange D. Utilizing telehealth to deliver family-based treatment for adolescent anorexia nervosa. Int J Eat Disord. 2017;50(10):1235–1238. 10.1002/eat.22759 [PubMed: 28801943]

20. Comer JS, Furr JM, Kerns CE, et al. Internet-delivered, family-based treatment for early-onset OCD: a pilot randomized trial. J Consult Clin Psychol. 2017;85(2):178–186. 10.1037/ccp0000155 [PubMed: 27869451]

21. Arevian A, O'Hora J, Rosser J, Mango JD, Miklowitz DJ, Wells KB. Patient and provider cocreation of mobile texting apps to support behavioral health: usability study. J Med Internet Res (JMIR) – Mhealth Uhealth. 2020;8(7):e12655.

22. Borghouts J, Eikey E, Mark G, De Leon C, Schueller, et al. Barriers to and facilitators of user engagement with digital mental health interventions: systematic review. J Med Internet Res. 2021;23(3):e24387. 10.2196/24387 [PubMed: 33759801]

23. Miklowitz DJ, Weintraub MJ, Singh MK, et al. Mood instability in youth at high risk for bipolar disorder. J Am Acad Child Adolesc Psychiatry. 2022;61(10):1285–1295. 10.1016/j.jaac.2022.03.009 [PubMed: 35307538]

24. Young RC, Biggs JT, Ziegler VE, Meyer DA. A Rating Scale for Mania: reliability, validity and sensitivity. Br J Psychiatry. 1978;133:429–435. 10.1192/bjp.133.5.429 [PubMed: 728692]

25. Poznanski EO, Mokros HB. Children's Depression Rating Scale, Revised (CDRS-R) Manual. Western Psychological Services; 1995.

26. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders, 5th ed. (DSM-5). American Psychiatric Association; 2013. 10.1176/appi.books.9780890425596

27. Sheehan DV. MINI International Neuropsychiatric Interview: Child and Adolescent Version for DSM-5. Harm Research Institute; 2016; https://harmresearch.org/product/mini-international-neuropsychiatric-interview-mini-kid-tracking-version-7-0-2-5

28. Youngstrom EA, Frazier TW, Demeter C, Calabrese JR, Findling RL. Developing a 10-item mania scale from the Parent General Behavior Inventory for children and adolescents. J Clin Psychiatry. 2008;69(5):831–839. 10.4088/jcp.v69n0517 [PubMed: 18452343]

29. Gerson AC, Gerring JP, Freund L, et al. The Children's Affective Lability Scale: a psychometric evaluation of reliability. Psychiatry Res. 1996;65(3):189–198. 10.1016/s0165-1781(96)02851-x [PubMed: 9029668]

30. Sheehan DV, Lecrubier Y, Harnett-Sheehan K, et al. The Mini International Neuropsychiatric Interview (M.I.N.I.): the development and validation of a structured diagnostic psychiatric interview. J Clin Psychiatry. 1998;59(Suppl 20):22–33; http://www.psychiatrist.com/JCP/article/Pages/1998/v59s20/v59s2005.aspx

31. Masland S, Hooley JM. Perceived criticism: a research update for clinical practitioners. Clin Psychol Sci Pract. 2015;22(3):211–222. 10.1111/cpsp.12110

32. Shaffer D, Gould MS, Brasic J, et al. A Children's Global Assessment Scale (CGAS). Arch Gen Psychiatry. 1983;40(11):1228–1231. 10.1001/archpsyc.1983.01790100074010 [PubMed: 6639293]

33. Keller MB, Lavori PW, Friedman B, et al. The Longitudinal Interval Follow-up Evaluation. A comprehensive method for assessing outcome in prospective longitudinal studies. Arch Gen Psychiatry. 1987;44(6):540–548. 10.1001/archpsyc.1987.01800180050009 [PubMed: 3579500]

34. Birmaher B, Khetarpal S, Brent D, et al. The Screen for Child Anxiety Related Emotional Disorders (SCARED): scale construction and psychometric characteristics. J Am Acad Child Adolesc Psychiatry. 1997;36(4):545–553. 10.1097/00004583-199704000-00018 [PubMed: 9100430]

35. Ger D, Everitt BS. Handbook of Statistical Analyses Using SAS. Second Edition. CRC Press; 2001.

36. Dinh P, Yang P. Handling baselines in repeated measures analyses with missing data at random. J Biopharm Stat. 2011;21(2):326–341. 10.1080/10543406.2011.550113 [PubMed: 21391005]

37. Fleming T, Bavin L, Lucassen M, Stasiak K, Hopkins S, Merry S. Beyond the trial: systematic review of real-world uptake and engagement with digital self-help interventions for depression, low mood, or anxiety. J Med Internet Res. 2018;20(6):e199. 10.2196/jmir.9275 [PubMed: 29875089]

38. Arean PA, Hallgren KA, Jordan JT, et al. The use and effectiveness of mobile apps for depression: results from a fully remote clinical trial. J Med Internet Res. 2016;18(12):e6482. 10.2196/jmir.6482

39. Zhang Y, Pratap A, Folarin AA, et al. Long-term participant retention and engagement patterns in an app and wearable-based multinational remote digital depression study. NPJ Digit Med. 2023;6(1):25. 10.1038/s41746-023-00749-3 [PubMed: 36806317]

40. Hafeman DM, Merranko J, Axelson D, et al. Toward the definition of a bipolar prodrome: dimensional predictors of bipolar spectrum disorders in at-risk youths. Am J Psychiatry. 2016;173(7):695–704. 10.1176/appi.ajp.2015.15040414 [PubMed: 26892940]

41. O'Donnell LA, Ellis AJ, Van de Loo MM, et al. Mood instability as a predictor of clinical and functional outcomes in adolescents with bipolar I and bipolar II disorder. J Affect Disord. 2018;236:199–206. 10.1016/j.jad.2018.04.021 [PubMed: 29747137]

42. Silk JS, Pramana G, Sequeira SL, et al. Using a smartphone app and clinician portal to enhance brief cognitive behavioral therapy for childhood anxiety disorders. Behav Ther 2020;51(1):69–84. 10.1016/j.beth.2019.05.002 [PubMed: 32005341]

43. Weintraub MJ, Ichinose MC, Zinberg J, et al. App-enhanced transdiagnostic CBT for adolescents with mood or psychotic spectrum disorders. J Affect Disord. 2022;311:319–326. 10.1016/j.jad.2022.05.094 [PubMed: 35594972]

44. Kleiboer A, Donker T, Seekles W, van Straten A, Riper H, Cuijpers P. A randomized controlled trial on the role of support in Internet-based problem solving therapy for depression and anxiety. Behav Res Ther. 2015;72:63–71. 10.1016/j.brat.2015.06.013 [PubMed: 26188373]

45. Domhardt M, Gesslein H, von Rezori RE, Baumeister H. Internet- and mobile-based interventions for anxiety disorders: a meta-analytic review of intervention components. Depress Anxiety. 2019;36(3):213–224. 10.1002/da.22860 [PubMed: 30450811]

46. Richards D, Richardson T. Computer-based psychological treatments for depression: a systematic review and meta-analysis. Clin Psychol Rev. 2012;32(4):329–342. 10.1016/j.cpr.2012.02.004 [PubMed: 22466510]

47. Hollis C, Falconer CJ, Martin JL, et al. Annual research review: digital health interventions for children and young people with mental health problems–a systematic and meta-review. J Child Psychol Psychiatry. 2017;58(4):474–503. 10.1111/jcpp.12663 [PubMed: 27943285]

48. Bennett SD, Cuijpers P, Ebert DD, et al. Practitioner review: unguided and guided self-help interventions for common mental health disorders in children and adolescents: a systematic review and meta-analysis. J Child Psychol Psychiatry. 2019;60(8):828–847. 10.1111/jcpp.13010 [PubMed: 30775782]

49. Lehtimaki S, Martic J, Wahl B, Foster KT, Schwalbe N. Evidence on digital mental health interventions for adolescents and young people: systematic overview. JMIR Mental Health. 2021;8(4):e25847. 10.2196/25847 [PubMed: 33913817]

50. Anmella G, Faurholt-Jepsen M, Hidalgo-Mazzei D, et al. Smartphone-based interventions in bipolar disorder: systematic review and meta-analyses of efficacy. A position paper from the International Society for Bipolar Disorders (ISBD) Big Data Task Force. Bipolar Disord. 2022. 10.1111/bdi.13243
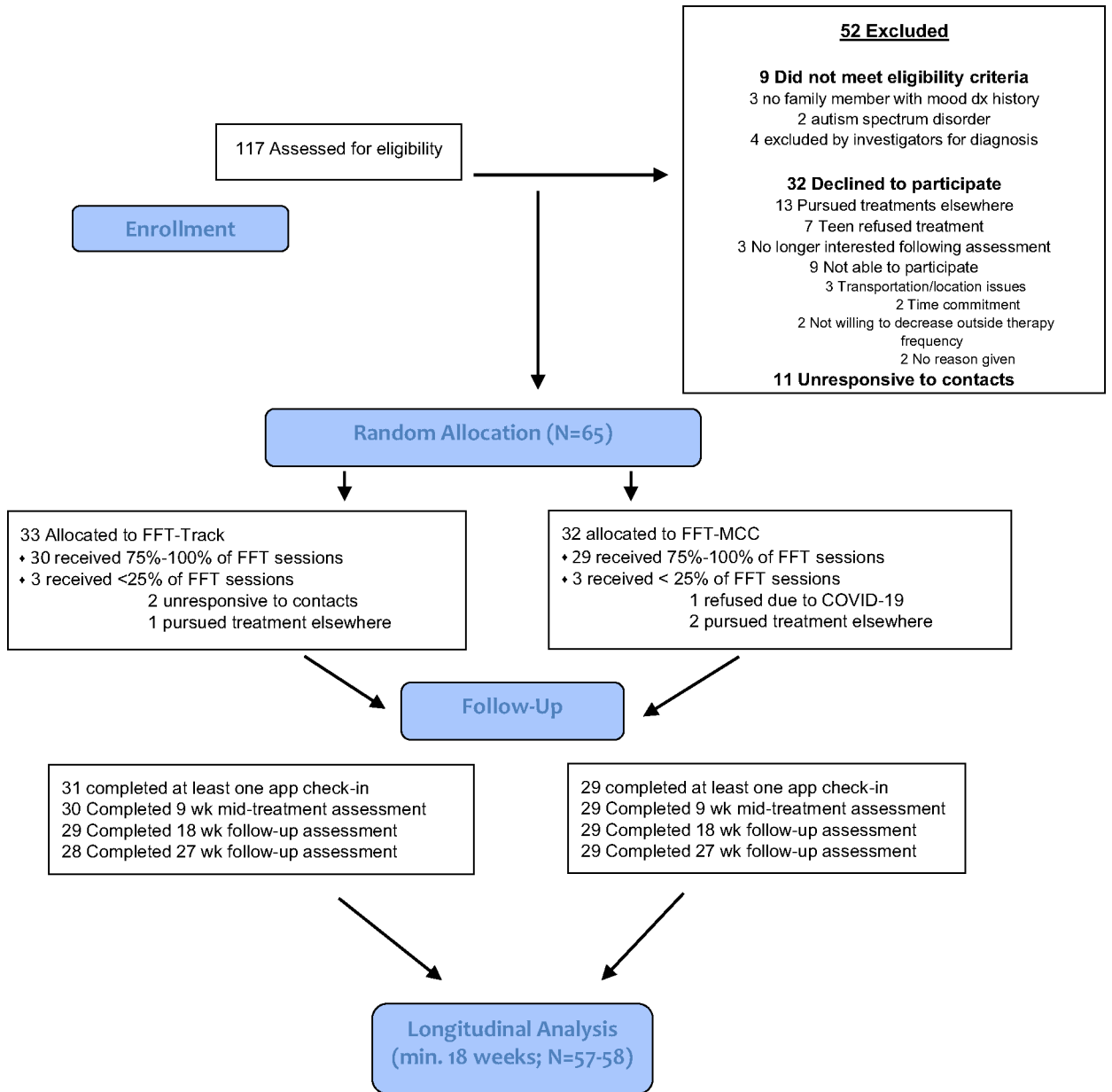
FIGURE 1. CONSORT Flow Diagram

Note: FFT-MCC = family-focused therapy plus full MyCoachConnect app; FFT-Track = family-focused therapy plus mood tracking app.
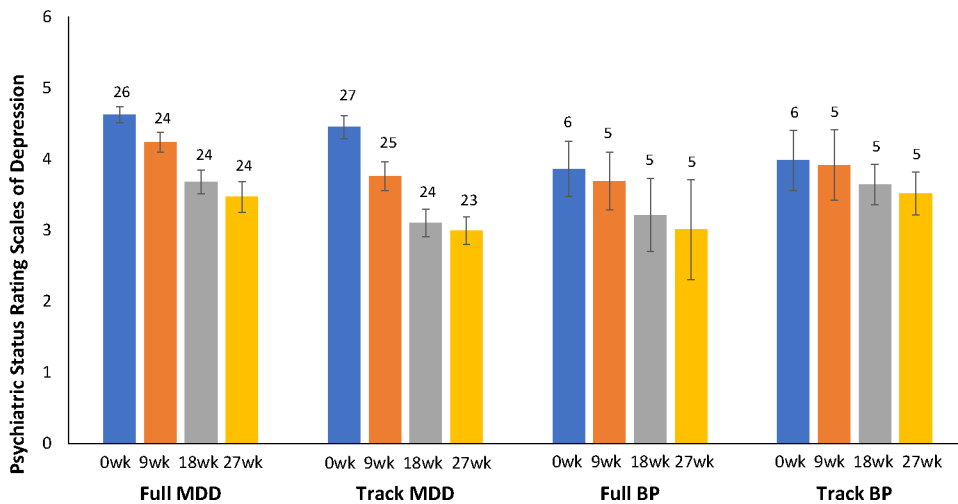
FIGURE 2. Effects of Family-Focused Therapy With MyCoachConnect App or Mood Tracking App on Scale for Mean Weekly Psychiatric Status Ratings of Depression at Four Study Intervals
Note: Numbers above bars refer to sample sizes. MCC MDD = family-focused therapy plus full MyCoachConnect app in participants with major depressive disorder; Track MDD = family-focused therapy plus mood tracking app in participants with major depressive disorder; MCC BD = family-focused therapy plus full MyCoachConnect app in participants with bipolar spectrum disorders; Track BD = family-focused therapy plus mood tracking app in participants with bipolar spectrum disorders.

FIGURE 3. Effects of Family-Focused Therapy With MyCoachConnect App or Mood Tracking App on Scale for Children's Anxiety and Related Emotional Disorders (SCARED) Scores at Four Study Intervals

Note: Numbers above bars refer to sample sizes. MCC MDD = family-focused therapy plus full MyCoachConnect app in participants with major depressive disorder; Track MDD = family-focused therapy plus mood tracking app in participants with major depressive disorder; MCC BD = family-focused therapy plus full MyCoachConnect app in participants with bipolar spectrum disorders; Track BD = family-focused therapy plus mood tracking app in participants with bipolar spectrum disorders.
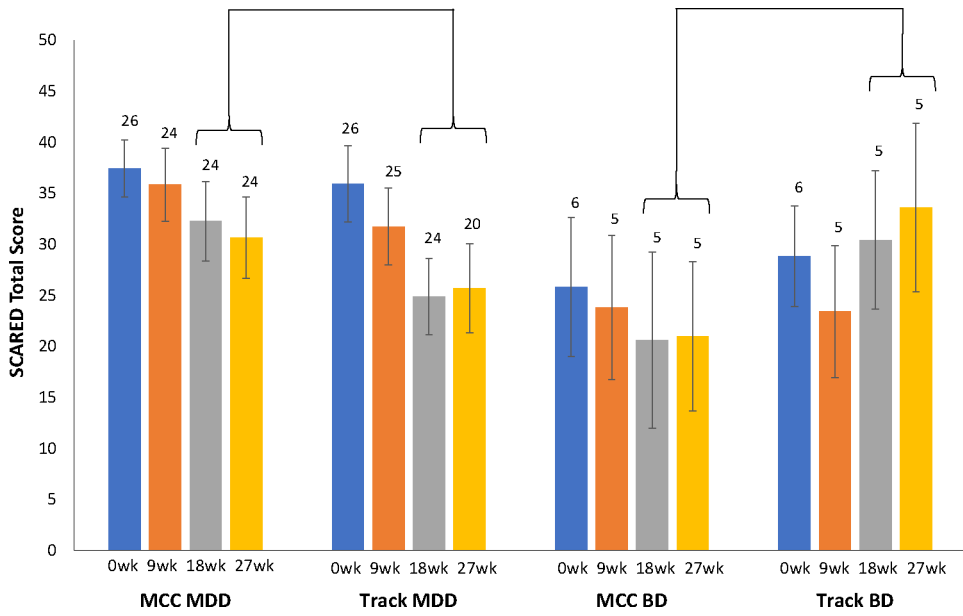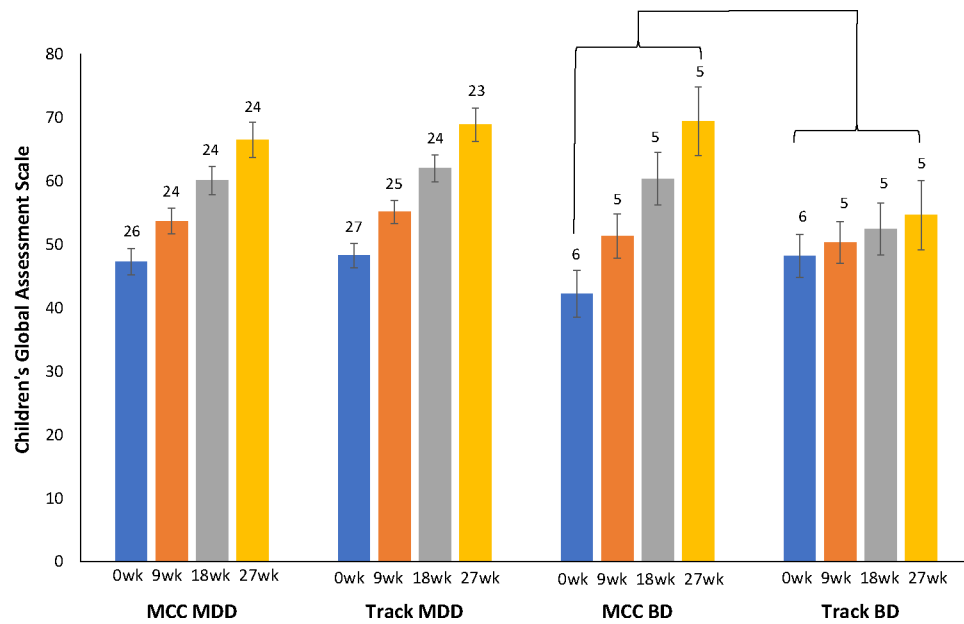
FIGURE 4. Effects of Family-Focused Therapy With MyCoachConnect App or Mood Tracking App on Children's Global Assessment Scale Scores at Four Study Intervals

Note: Numbers above bars refer to sample sizes. MCC MDD = family-focused therapy plus full MyCoachConnect app in participants with major depressive disorder; Track MDD = family-focused therapy plus mood tracking app in participants with major depressive disorder; MCC BD = family-focused therapy plus full MyCoachConnect app in participants with bipolar spectrum disorders; Track BD = family-focused therapy plus mood tracking app in participants with bipolar spectrum disorder.

TABLE 1

Demographics and Illness Characteristics of Participants

Variable	FFT-MCC (n = 32)	FFT-Track (n = 33)	Total (N = 65)	p
Age, mean ± SD	15.6 ± 1.7	15.9 ± 1.5	15.8 ± 1.6	.52
Biological sex, n (%) female participants	24 (75.0)	23 (69.7)	47 (72.3)	.63
Transgender participants, n (%)	3 (9.4)	2 (6.1)	5 (7.7)	.62
Diagnosis				.95
Depressive spectrum disorder, n (%)	26 (81.3)	27 (81.8)	53 (81.5)	
Major depressive disorder, single episode	21 (65.6)	20 (62.5)	41 (63.1)	
Major depressive disorder, recurrent	5 (15.6)	4 (12.1)	9 (13.8)	
Other specified depressive disorder	0 (0)	3 (9.1)	3 (4.6)	
Bipolar spectrum disorder, n (%)	6 (18.8)	6 (18.2)	12 (18.5)	
Bipolar I disorder	0 (0)	3 (9.1)	3 (4.6)	
Bipolar II disorder	3 (9.4)	0 (0)	3 (4.6)	
Other specified bipolar disorder	3 (9.4)	3 (9.1)	6 (9.2)	
ADHD, n (%)	16 (50.0)	12 (36.4)	28 (43.1)	.39
Anxiety disorder, any, n (%)	25 (78.1)	21 (63.6)	46 (70.8)	.16
Race, n (%)				.32
Asian	1 (3.1)	2 (6.1)	3 (4.6)	
Black/African American	0 (0)	3 (9.1)	3 (4.6)	
More than 1 race	7 (21.9)	5 (15.2)	12 (18.5)	
Native American	1 (3.1)	0 (0)	1 (1.5)	
White	23 (71.9)	23 (69.7)	46 (70.8)	
Ethnicity, n (%) Hispanic	6 (18.8)	12 (36.4)	18 (27.7)	.11
Education, highest parental level, n (%)				.56
Pre-baccalaureate	4 (12.5)	4 (12.1)	8 (12.3)	
College degree	9 (28.1)	8 (24.2)	17 (26.2)	
Professional degree	19 (59.4)	19 (57.6)	38 (58.5)	
Missing	0 (0)	2 (6.1)	2 (3.1)	
PSR Depression score (1–6), mean ± SD	4.5 ± 0.7	4.4 ± 0.9	4.4 ± 0.8	.56
PSR (Hypo)mania score (1–8)	1.4 ± 0.7	1.5 ± 0.9	1.4 ± 0.8	.55
Young Mania Rating Scale, prior week	15.6 ± 5.7	14.7 ± 5.9	15.4 ± 5.9	.56

Variable	FFT-MCC (n = 32)	FFT-Track (n = 33)	Total (N = 65)	p
Children's Depression Rating Scale —Revised, prior 2 wk	56.3 ± 10.7	54.8 ± 13.0	55.7 ± 12.4	.61
Children's Global Assessment Scale, 2 wk	41.8 ± 8.5	44.0 ± 9.7	42.2 ± 9.5	.35
Baseline medication regimens, n (%)				
No medications	12 (37.5)	15 (45.5)	27 (41.5)	.52
Antidepressants	16 (50.0)	11 (33.3)	27 (41.5)	.28
Antipsychotics	5 (15.6)	6 (18.2)	11 (16.9)	.74
Mood stabilizers	4 (12.5)	2 (6.1)	6 (9.2)	.39
Anxiolytics	1 (3.1)	0 (0)	1 (1.5)	.31
Psychostimulants	6 (18.8)	6 (18.2)	12 (18.5)	.30
Parental diagnoses, n (%)				
Mother has bipolar I or I disorder	4 (12.5)	4 (12.5)	8 (12.3)	.36
Mother has major depressive disorder	21 (65.6)	19 (57.6)	40 (61.5)	.90
Father has bipolar I or I disorder	2 (6.3)	6 (18.2)	8 (12.3)	.45
Father has major depressive disorder	11 (34.4)	13 (39.4)	24 (36.9)	.22
One or both parents have bipolar disorder	5 (15.6)	10 (30.3)	15 (23.1)	.14
Parent(s) have depressive disorder only	27 (84.4)	23 (69.7)	50 (76.9)	

Note: ADHD = attention-deficit/hyperactivity disorder; FFT-MCC = family-focused therapy with MCC app; FFT-Track = family-focused therapy with mood tracking app; PSR = Psychiatric Status Rating from the Adolescent Longitudinal Interval Follow-up Evaluation.