

Development and Pilot Evaluation of an Internet-Facilitated Cognitive-Behavioral Intervention for Maternal Depression

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Objective: Develop and pilot an Internet-facilitated cognitive-behavioral treatment intervention for depression, tailored to economically disadvantaged mothers of young children. **Method:** Mothers ($N = 70$) of children enrolled in Head Start, who reported elevated levels of depressive symptoms, were randomized to either the 8-session, Internet-facilitated intervention (Mom-Net) or delayed intervention/facilitated treatment-as-usual (DI/TAU). Outcomes were measured using the Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996); the Patient Health Questionnaire 9 (PHQ-9; Spitzer et al., 1999), Behavioral Observations of Parent-Child Interactions using the Living in Family Environments coding system (LIFE; Hops, Davis, & Longoria, 1995); the Dyadic Parent-Child Interaction Coding Systems (DPICS; Eyberg, Nelson, Duke, & Boggs, 2005); the Parent Behavior Inventory (PBI; Lovejoy, Weis, O'Hare, & Rubin, 1999); and the Parenting Sense of Competence scale (PSOC; Gibaud-Wallston & Wandersman, 1978). **Results:** Mom-Net demonstrated high levels of feasibility as indicated by low attrition and high program usage and satisfaction ratings. Participants in the Mom-Net condition demonstrated significantly greater reduction in depression, the primary outcome, at the level of both symptoms and estimates of criteria-based diagnoses over the course of the intervention. They also demonstrated significantly greater improvement on a questionnaire measure of parent satisfaction and efficacy as well as on both questionnaire and observational indices of harsh parenting behavior. **Conclusions:** Initial results suggest that the Mom-Net intervention is feasible and efficacious as a remotely delivered intervention for economically disadvantaged mothers.

Keywords: depression, mothers, Internet intervention, cognitive-behavioral treatment

Economically disadvantaged mothers of young children experience disproportionately high rates of depressive syndromes and constitute an exceptionally important group to target for intervention efforts (McLennan, Kotelchuck, & Cho, 2001; Weissman & Jensen, 2002). Women with depressive disorders or subclinical syndromes evidence harsher and less positive parenting than do nondepressed women, and these parenting styles are associated with children's emotional and behavioral problems (Gotlib & Goodman, 1999; Lovejoy, Graczyk, O'Hare, & Neuman, 2000). Emerging evidence, moreover, suggests that remission of maternal depression is associated with improvements in parenting behavior and child functioning (Foster et al., 2008; Garber, Ciesla, McCauley, Diamond, & Schloredt, 2011; Weissman et al., 2006), sug-

gesting that treatment of maternal depression has the potential to improve outcomes across generations.

Research supports the effectiveness of cognitive-behavioral therapy (CBT) in reducing both self-reported symptomatology and rates of diagnosable disorders (Gloaguen, Cottraux, Cucherat, & Blackburn, 1998; National Institute of Mental Health [NIMH], 2003). Of particular relevance is evidence that CBT has been shown to be an effective intervention for depression both in samples of economically disadvantaged persons (Organista, Muñoz, & Gonzalez, 1994; Satterfield, 1998) and in samples of mothers (Ammerman et al., 2011; Chronis, Gamble, Roberts, & Pelham, 2006; Milgrom et al., 2011; Milgrom, Negri, Gemmill, McNeil, & Martin, 2005; cf. Verduyn, Barrowclough, Roberts, Tarrier, & Harrington, 2003). In samples of mothers, the interventions have been tailored to address issues related to parenting.

Despite the availability of efficacious interventions, however, most depressed persons do not access treatment (NIMH, 2003). Amongst the many potential barriers, several of the most substantial, including lack of mental health coverage, childcare, and transportation, differentially affect women of low socioeconomic status (NIMH, 2003; Weissman & Jensen, 2002). It is thus of critical importance to develop nontraditional service delivery systems to overcome barriers to treatment utilization. One promising example of this is the integration of CBT into in-home visitation programs for at-risk mothers (Ammerman et al., 2011).

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The dramatic increase of Internet technology into the everyday lives of individuals (Pew Internet & American Life Project, 2011) has created the potential of Internet-facilitated treatment delivery as an avenue for increasing access to disadvantaged mothers. Because these interventions allow great flexibility to access services at times and places convenient to the user, and reduce costs associated with travel and therapist time, there is potential for them to overcome many of the barriers facing underserved populations. Moreover, because this approach enables remote delivery, it has particular promise for addressing the challenge posed by the scarcity of providers in rural areas (Gale & Deprez, 2003). It is notable in this regard that among Americans living in rural areas, as well as those living in poverty, approximately two thirds report Internet use (Horrigan, 2009). The increase in Internet penetration has spurred tremendous growth in research on Internet-based mental health interventions to reach underserved populations (Ritterband, Andersson, Christensen, Carlbring, & Cuijpers, 2006).

Internet-based CBT programs for depression have shown significant promise (e.g., Andersson et al., 2005; Christensen, Griffiths, & Jorm, 2004; Clarke et al., 2009; Griffiths & Christensen, 2007; Spek et al., 2007). Meta-analytic data indicate that effects obtained by supported-Internet interventions, that is, those including modest interaction with a coach or therapist, are analogous to those obtained in face-to-face therapy (Cuijpers, Donker, van Straten, Li, & Andersson, 2010). Supported interventions, moreover, evidence both better program adherence (Mohr, Cuijpers, & Lehman, 2011) and stronger effects than nonsupported interventions (Andersson et al., 2005; Andersson & Cuijpers, 2009; Spek et al., 2007).

The Present Study

We developed and piloted the Mom-Net program, an Internet-facilitated, CBT treatment for subthreshold and full syndrome depression, tailored to mothers of young children. The program was designed to facilitate providers' delivery of treatment services to economically disadvantaged or rural women. The content foundation for the program was the Coping with Depression Course (CWDC; Lewinsohn, Clarke, Rohde, Hops, & Seeley, 1996). We chose the CWDC because its extensive history of successful adaptation suggested both that it is amenable to diverse delivery modalities and that core content could be tailored to suit disparate populations (Cuijpers, Muñoz, Clarke, & Lewinsohn, 2009), including depressed and at-risk mothers (Chronis et al., 2006; Milgrom et al., 2005). Mom-Net was designed as an integrated program consisting of both coach support and online materials. Core content was presented via online tutorials. Coaches used weekly phone calls to assist mothers in understanding and applying the CBT strategies as well as to address barriers to engagement. The coach was also available to respond to questions and emergencies. A coach-moderated bulletin board was developed to approximate the social support provided by group administration.

Content adaptations were based on research indicating that material perceived to be of high personal relevance is learned more easily (Knowles, 1984) and translated more effectively into behavioral change (Kreuter & Holt, 2001). To this end, the rationale for the intervention was expanded to cover the relations between depressive symptoms and parenting. Moreover, the teaching of each skill included a discussion of its relevance for improving both mood and parenting behavior. These adaptations were informed by

the work of Milgrom, Martin, and Negri, (1999), who adapted the CWDC for treatment of postpartum depression. As well, participants were taught to implement the strategies in the context of parent-child interactions. For example, in learning the skill of increasing pleasant events, mothers were guided to increase not only the frequency of personally reinforcing activities (e.g., socializing with friends) but also the frequency of positive activities in which they engage with their child. The intervention was shortened to eight sessions because of the difficulty of maintaining engagement over longer periods (Christensen, Griffiths, & Farrer, 2009). The goal of the pilot trial was to provide an initial evaluation of both feasibility and efficacy of the intervention.

Method

Trial Design

Participants were individually randomized (allocation ratio of 1:1) into two parallel intervention groups: Internet-facilitated intervention (Mom-Net) or delayed intervention/facilitated treatment-as-usual (DI/TAU). Randomization was accomplished by shuffling sealed envelopes containing condition assignments. The trial was conducted with approval of an appropriate institutional review board and registered with ClinicalTrials.gov.

Participants and Inclusion Criteria

Participants were 70 mothers of children enrolled in Head Start classrooms. Inclusion criteria were elevated self-reported depression and the ability to comprehend spoken English. Though not a requirement of participation, it is highly likely that nearly all of the mothers were literate in English given that no participants opted to complete the assessment measures orally. Presence of maternal depressive disorder was not a prerequisite for inclusion given evidence that elevated maternal depressive symptoms are associated with parenting difficulties and higher risk for adverse child outcomes regardless of diagnostic status (Lovejoy et al., 2000), and that reduction of depressive symptoms is associated with improved child outcome in young children (Shaw, Connell, Dishion, Wilson, & Gardner, 2009). Elevated depressive symptomatology was operationalized as a score of ≥ 21 on the Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977). This score represented the top quartile in a sample of mothers of young children who participated in a follow-up of the Oregon Adolescent Depression Project (Olinio et al., 2008) and is close to the cutoff of 23 used to define "very elevated" symptoms in a large epidemiological study of maternal depressive symptoms (McLennan et al., 2001). The mean participant CES-D score was 32.90 ($SD = 8.78$). On the basis of responses to the Patient Health Questionnaire 9 (PHQ-9; Spitzer et al., 1999), 41% of the sample met *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition, text revision (*DSM-IV-TR*) criteria for major depressive disorder, and an additional 30% met criteria for minor depressive disorder (American Psychiatric Association, 2000). Demographic data are presented in Table 1.

Recruitment and Assessment Procedures

Screening. Head Start staff gave mothers an invitation letter and the CES-D. The letter provided the informed consent infor-

Table 1
Baseline Demographics, Outcomes, and Treatment Utilization
by Condition

Demographics	Mom-Net (<i>n</i> = 35)	DI/TAU (<i>n</i> = 35)	Test statistic	<i>p</i>
Latino/Hispanic/Spanish <i>n</i> (%)				
Mother	4 (11.1)	4 (11.1)	0.00	1.00
Child	6 (17.1)	8 (22.9)	0.29	.591
Racial category <i>n</i> (%)			3.14 ^a	.08
White	34 (97.2)	31 (88.6)		
Black or African American	0	1 (2.9)		
More than one race	0	2 (5.7)		
Not reported	1 (2.9)	1 (2.9)		
Education <i>n</i> (%)			2.36	.670
Less than high school	3 (8.6)	4 (11.4)		
High school	12 (34.3)	11 (31.4)		
Vocational	4 (11.4)	3 (8.6)		
Some college	16 (45.7)	17 (48.6)		
Marital status <i>n</i> (%)			4.70	.195
Married	7 (20.0)	13 (37.1)		
Living together	7 (20.0)	3 (8.6)		
Divorced/separated	9 (25.7)	12 (34.3)		
Single	11 (31.4) ^b	7 (20.0)		
Annual family income <i>n</i> (%)			0.01	.906
<15k	17 (48.6)	17 (48.6)		
Child's gender <i>n</i> (%)			0.01	.906
Male	17 (48.6)	18 (51.4)		
Mother's age <i>M</i> (<i>SD</i>)	31.1 (5.7)	30.9 (7.0)	-0.13	.900
Child's age <i>M</i> (<i>SD</i>)	4.7 (0.7)	4.5 (0.6)	-1.77	.081

Note. DI/TAU = delayed intervention/facilitated treatment as usual.

^a Due to low frequencies, we tested Caucasian versus non-Caucasian; "not reported" cases were excluded from the analysis (*n* = 68). ^b One participant failed to respond to the marital status item.

mation for the screening. The questionnaire was printed such that the answers (but not the questions) were recorded on a \$20 check.¹ The invitation letter explained that if they completed the questionnaire, provided contact information on the check, and cashed the check, this would indicate consent to the screening and to being contacted by research staff if they were selected for possible further participation.

Screeners were distributed to 793 mothers, with a 70% completion rate. Of mothers completing the questionnaire, 40% (*n* = 222) were eligible for further participation. The first 70 mothers contacted by program staff expressed interest in participating. The high enrollment rate was unanticipated and likely reflected that participants were provided with computers in order to facilitate their use of the intervention (see the Shared Intervention Features section below). Potential participants not contacted before enrollment was closed were provided with referrals by mail.

Preassessment and assignment. Prior to an initial visit, mothers were sent a consent form and the Time 1 (T1) questionnaire. Two staff, a coach and a research assistant (RA), attended each visit. The RA provided an overview of the study, obtained consent, collected the questionnaires, and conducted the mother-child interactions. The coach then conducted a motivational interview (MI; Miller & Rollnick, 2002), as described in the Shared Intervention Features section. Coaches and RAs were blind to condition until the portion of the MI in which treatment options were discussed. At that point, staff opened the envelope containing the condition assignment. Participants were compensated for participating in each assessment.

Post and follow-ups. Assessments were conducted after the intervention/delay period (T2; 14 weeks after T1) and again at T3 (12 weeks after T2). RAs, blind to condition, conducted the T2 assessment. T3 assessments did not include parent-child interactions and were conducted by mail. For participants assigned to Mom-Net, the T3 assessment was a follow-up. For participants initially assigned to DI/TAU, T3 was a postassessment that enabled us to examine response to the intervention. The Appendix presents the Journal Article Reporting Standards (JARS) participant flow diagram.

Measures

Screening: Maternal depressive symptoms. The CES-D was used to screen potential participants for inclusion. The CES-D is widely used and has respectable psychometric properties for use in community samples (Lewinsohn, Solomon, Seeley, & Zeiss, 2000).

Primary treatment outcome: Maternal depression. The PHQ-9, a self-administered version of the Primary Care Evaluation of Mental Disorders, provided estimates of *DSM-IV-TR* diagnoses. The reliability and diagnostic accuracy of the PHQ-9 are well established (Kroenke, Spitzer, & Williams, 2001; Spitzer et al., 1999), and it has been used successfully in studies of maternal depression (Gjerdingen, Crow, McGovern, Miner, & Center, 2011). The Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996) provided a continuous measure of symptoms. Both the BDI and the PHQ-9 are sensitive to change (e.g., Titov et al., 2011).

Secondary outcome: Parenting. Parenting was assessed with both questionnaires and observations of mother-child interactions. Mothers completed the Parent Behavior Inventory (PBI; Lovejoy, Weis, O'Hare, & Rubin, 1999) to assess supportive and hostile parent behavior and the Parenting Sense of Competence scale (Gibaud-Wallston & Wandersman, 1978; Johnston & Mash, 1989) to assess their perceived parenting satisfaction and efficacy.

The parent-child interaction consisted of two 10-min interactions, a child-directed play session, and a parent-directed play session/clean-up task. The interactions were coded using a coding system that included affect codes from the Living in Family Environments coding system (LIFE; Hops, Davis, Longoria, 1995) and verbal content codes from the Dyadic Parent-Child Interaction Coding System (DPICS; Eyberg, Nelson, Duke, & Boggs, 2005). Though the LIFE system can be used to capture verbal content, the DPICS codes are more developmentally appropriate for play interactions with young children. Both the LIFE and DPICS systems have extensive validation histories for examining parent behavior during interactions (e.g., Eyberg et al., 2005; Hops et al., 1995), though using them conjointly represents a modification.

Observers, blind to group and assessment point, coded maternal behavior from video recordings using an event-based approach in which any change in participant affect or verbal behavior prompted a new code. Two constructs indicating aggressive and positive interpersonal behavior were derived from the individual affect and content codes. The Aggressive construct included statements with angry or contemptuous affect as well as oppositional content (e.g., criticism; rudeness) with neutral affect. The Positive construct included statements with happy or pleasant affect and positive statements (e.g., praise, humor) with neutral affect. Kap-

¹ Questions were not printed on the check so that responses were not interpretable by bank staff.

pas were .70 and .81 for aggressive and positive constructs, respectively. These constructs were subsequently combined to create a single variable reflecting the harshness of the mother's behavior toward the child. This variable was created by standardizing the individual constructs, inverting the score for the Positive construct, and taking the mean between the two standard scores.

Mom-Net feasibility. Feasibility was defined as encompassing engagement, satisfaction, and ease of use, as measured by objective indicants as well as by participant- and coach report. Computer-generated indicants included (a) module completion, (b) number of website "visits," and (c) time spent on website. Participant satisfaction was obtained with an adapted version of the Therapy Attitude Inventory (Brestan, Jacobs, Rayfield, & Eyberg, 1999), which provided ratings of the (a) helpfulness of skills and materials, (b) website, including ease of use, (c) coach assistance, and (d) program as a whole. Items were rated on a 5-point Likert scale. Indicants obtained from coach report included number and duration of coach calls as well as ratings of participant comprehension (1 = *minimal*, 4 = *excellent*), therapeutic alliance (1 = *minimal*, 4 = *excellent*), and homework (0 = *no attempt to use skill*, 3 = *multiple successful use of skills*).

Community service utilization. Participants' report of community-based service utilization for behavioral or mental health difficulties was documented at each assessment. With written consent, providers were contacted to obtain a description of the service provided.

Shared Intervention Features

Though there were no similarities in interventions across the two conditions, there was overlap in the resources provided to participants with regard to a preintervention MI and access to computer/Internet technology as described below.

MI. Because motivational deficits may be a barrier to participation, with the treatment literature describing pervasive problems with attendance, homework completion, and ultimately dropout (Weissman & Jensen, 2002), an MI (Miller & Rollnick, 2002) was conducted prior to intervention with participants in both conditions. Brief preintervention MI is effective in promoting participation across a range of interventions and populations (e.g., Nock & Kazdin, 2005; Walitzer, Dermen, & Connors, 1999).

For participants in the Mom-Net condition, the MI ended with a brief *role induction* that outlined what to expect from the intervention and the behaviors on the part of the client that were recommended for a successful experience. Role induction has been found to improve participation in treatment (Walitzer et al., 1999). For participants in the DI/TAU condition, the MI was repeated prior to beginning the Mom-Net intervention.

Computer resources. Mothers in both conditions were given a computer, monitor, and printer, which were theirs to keep, even if they withdrew from the study. They were also provided with Internet access during the study. The computers included browser software, age-appropriate educational software for children, and word-processing software. An RA installed the computer and familiarized parents with its use. Parents in both conditions were provided with a user manual, a project help line for computer support, a set of guidelines for children's computer use, and a list of Internet sites of relevance to families of young children.

Mom-Net Intervention

Course content and structure. Mom-Net consisted of eight sessions focused on CBT skills for the treatment of depression. Session content, outlined in Table 2, included both core CBT skills (left column) and adaptations relevant to mothers of young children (right column). Relative to the original CWDC, Mom-Net had

Table 2
Mom-Net Content

Session	Core CBT	Parenting focus
1	Intervention rationale <ul style="list-style-type: none"> ● Understanding depression ● Intervention description 	<ul style="list-style-type: none"> ● Prevalence of maternal depression ● Influence of depression on parenting and child well-being
2–3	Behavioral activation <ul style="list-style-type: none"> ● Mood monitoring ● Increasing adult-focused pleasant events ● Self-assessment 	<ul style="list-style-type: none"> ● Increasing positive parent–child activities ● Overcoming barriers: time, money, mood, child fussiness
4–5	Interpersonal skills <ul style="list-style-type: none"> ● Importance of social support ● Building a healthy support network 	<ul style="list-style-type: none"> ● Importance of playing with children ● Play skills ● Barriers to enjoying play
6	Cognitive skills: Positive thoughts <ul style="list-style-type: none"> ● Savoring positives events ● Anticipating positive events 	<ul style="list-style-type: none"> ● Savoring parent–child time ● Anticipating positive parent–child time
7	Cognitive skills: Negative thoughts <ul style="list-style-type: none"> ● Identifying negative thoughts ● Responding to negative thoughts 	<ul style="list-style-type: none"> ● Identifying and responding to negative thoughts regarding your child and your parenting
8	Planning for the future <ul style="list-style-type: none"> ● Skill integration ● Anticipating problems ● Developing a response plan 	<ul style="list-style-type: none"> ● Skill integration and planning regarding parenting

Note. CBT = cognitive-behavioral treatment.

a greater emphasis on positive affect and behavioral activation (Hopko, Lejuez, Ruggiero, & Eifert, 2003; McMakin, Siegle, & Shirk, 2011) and lesser focus on cognitive restructuring.

The program was designed in accordance with principles of quality instructional design (Kameenui & Carnine, 2001), with a particular focus on design principles relevant to promoting self-regulated learning. Effective instructional design facilitates learning by reducing the cognitive load so as to not tax the learner's working memory (Kirschner, 2002). This focus is particularly important in an intervention for individuals with depressive symptoms given their difficulties with cognitive processes and vulnerability to depressogenic thoughts under conditions of stress (Wenzlaff & Bates, 1998). Key structural elements, consistent with these principles included (a) *judicious review*, wherein earlier concepts are revisited in subsequent sessions, varied examples are used to promote generalization, and homework is used to provide practice; (b) *conspicuous and integrated strategies*, in which the component steps of each skill are taught to mastery before they are integrated; and (c) *mediated scaffolding*, such that models and feedback are provided to the learner and faded as mastery is achieved (Kameenui & Carnine, 2001). In Mom-Net, the scaffolding was provided via immediate feedback from the computer program as well as by the coach. Another key structural feature was the use of varied multimedia materials and interactive elements to maintain participant interest. A competency-based approach was developed in which knowledge acquisition was examined at the completion of each session. The goal was to achieve mastery (i.e., 80% correct responses) before the user proceeded to the next module. The program identified incorrect responses, reviewed related content, and retested the material, as needed. Most text elements were accompanied by corresponding audio, and the remaining elements had optional narration in order to reduce literacy requirements.

Coach conferences. Prior to initiating the pilot, coaches participated in 2 days of training conducted by one of the intervention developers (ES), who served as the clinical supervisor. Training included didactic presentations and practice in MI and CBT skills as well as in protocols for responding to clinical emergencies. During the pilot, coaches participated in weekly supervision. Three of the four coaches had master's degrees (two in mental health fields) and one was a layperson who did not have an advanced degree.

Coaches scheduled weekly 15- to 20-min phone conferences with participants. Coaches assisted mothers in understanding and applying the CBT strategies. They recognized participants' accomplishments, reviewed content that the participant had not yet "mastered," and answered questions. Reluctance or barriers to engaging in the intervention were addressed within the MI framework, with coaches making reflective statements, emphasizing positive statements, helping mothers to identify whether goals had changed, and problem-solving ways to meet their goals.

Coaching was facilitated by an online infrastructure that provided coaches and supervisors with tools for monitoring client progress and participation. An administrative webpage enabled coaches to (a) monitor participation, understanding, and clinical progress (i.e., program utilization, homework completion, mood/activity ratings, content mastery, and biweekly depression ratings); and (b) tailor content of coach calls based on the information provided. The infrastructure also allowed mothers to connect with

coaches in crisis situations via an online crisis link, which alerted coaches and supervisors via an immediate text message.

Bulletin board. A 24-hr electronic "bulletin board" enabled participants to share experiences. In this way, the Internet was used to approximate the support available in group delivery of parenting and depression interventions. Participants were prompted to visit the bulletin board at the conclusion of each session. Staff posted weekly discussion topics, and participants initiated additional discussion threads. The site hosted an "Ask an Expert" link that provided a public question-and-answer forum in which a coach or the clinical supervisor provided information. Coaches monitored the bulletin board on a daily basis. Their responsibilities were similar to those of a group leader: welcoming new participants, praising participation and good ideas, highlighting key principles, interjecting ideas when the tone or content of the discussion went astray, and being alert to potential risks to participants.

DI/TAU

Mothers randomized to the DI/TAU condition were eligible to participate in the Mom-Net intervention subsequent to the T2 assessment. They were also provided with a description of community agencies that provided counseling services and assistance in making the initial contact. The description included information about services offered, payment options (Medicaid; sliding scale; no-cost), and contact information. Participants were also given a business card-sized list of crisis and emergency contacts.

Sample Size Determination and Statistical Methods

Sample size. Sample size was influenced by the need to balance resources between intervention development and piloting and to accomplish recruitment and service delivery within the shorter time frame of a development study. Estimates of effect sizes were based on a meta-analysis of the CWDC (average $ES = .65$ for controlled trials; Cuijpers, 1998) as well as on a trial of an Internet-based cognitive intervention ($ES = .54$ for participants with elevated CES-D scores; Clarke et al., 2005). A sample size that would provide adequate power (estimate = $.75$) to detect moderate effect sizes (Hedges' $g = .5$) at $p < .10$ was selected. As a sample of 20–25 per condition would meet this criterion, 35 participants per condition were recruited to allow for attrition.

Statistical analysis. Between-subject intervention effects from T1 to T2 were examined within a series of regression models estimated using Mplus statistical software (Version 5.21; Muthén & Muthén, 1998–2007). Covariate-adjusted outcomes were regressed on a dummy-coded variable indicating condition (1 = Mom-Net, 0 = DI/TAU). To control for individual differences at pretest, all models included the initial T1 value of the outcome as a covariate. Parameter estimates were obtained using full information maximum likelihood estimation (FIML) as implemented in Mplus. FIML calculates model parameters and standard errors using all available raw data and are, therefore, less likely to be biased than are estimates based on other methods of handling missing data (Schafer & Graham, 2002). Hedges' g is reported as a metric of effect size; it is defined as the intervention effect divided by the T2 pooled standard deviation of the outcome (What Works Clearinghouse, 2008; $.2$, $.5$, and $.8$ reflect small, medium, and large effects). Within-subject replication from T2 to T3 for the

DI/TAU condition and within-subject maintenance from T1 to T3 for the Mom-Net condition were examined using contingency table analyses and paired *t* tests for categorical and continuous outcomes, respectively.

Results

Preliminary Analyses

The Mom-Net and DI/TAU groups did not significantly differ with respect to demographic characteristics (see Table 1). Descriptive statistics for nondiagnostic outcome measures at each time are in Table 3. No between-group differences were evident on outcome measures at the baseline assessment, $t(68) = -0.07-1.30$, *ns*. Fifty participants evidenced either minor ($n = 11$ Mom-Net; $n = 10$ DI/TAU) or major depression ($n = 16$ Mom-Net; $n = 13$ DI/TAU) at T1, with no differences between groups, $\chi^2(1, N = 70) = 0.82$, *ns*. Additionally, there were no between-group differences in the frequency with which mothers accessed community services for themselves (14 Mom-Net; 12 DI/TAU) or their children (three Mom-Net; five DI/TAU) during the trial, $\chi^2(1, N = 69) = 0.06-0.35$.

Attrition rates for Mom-Net and DI/TAU groups were, respectively, 2.9% ($n = 1$) and 0.0% ($n = 0$) between pre- and posttest, and 5.7% ($n = 2$) and 5.7% ($n = 2$) between pretest and follow-up. Attrition rates did not differ as a function of condition, demographic characteristics, or baseline values on outcome measures; interactions between attrition and condition were also nonsignificant predictors of the outcome measures. Given the minimal rates of missing data and that the data appear to be missing completely at random (Little's missing completely at random test statistic = 208.30, $p = .578$), FIML estimation is appropriate for modeling the between-group intervention effects.

Program Utilization, Satisfaction, and Usability

Table 4 presents the descriptive statistics for the measures of program utilization, satisfaction, and usability. Measures for the DI/TAU participants reflect their use of the Mom-Net program subsequent to the T2 assessment. As can be seen, Mom-Net participants completed on average 6.4 of the eight modules (63% completed all modules); the mean number of modules completed by DI/TAU participants was 6.0 (49% complete all modules). The website was used extensively by both groups as indicated by the

Table 4
Program Utilization, Satisfaction, and Usability by Condition

Measure	Mom-Net <i>M (SD)</i>	DI/TAU <i>M (SD)</i>
Computer-generated indices		
Number of modules completed	6.4 (2.6)	6.0 (2.7)
Number of program visits	31.0 (23.7)	23.5 (23.7)
Number of bulletin board visits	13.4 (9.1)	11.7 (10.3)
Hours on program	15.1 (6.2)	13.0 (5.9)
Participant-rated satisfaction		
Skills and materials	4.5 (0.4)	4.1 (0.7)
Website	4.4 (0.4)	4.1 (0.6)
Coach assistance	4.6 (0.5)	4.2 (0.7)
General	4.7 (0.4)	4.4 (0.6)
Coach reports		
Number of coach calls	6.5 (2.4)	6.9 (1.9)
Duration of calls in minutes	19.12 (6.21)	18.34 (6.02)
Participant comprehension	3.1 (0.6)	3.0 (0.4)
Therapeutic alliance	3.4 (0.5)	3.2 (0.6)
Homework experience	2.09 (0.4)	2.07 (0.3)

Note. DI/TAU = delayed intervention/treatment as usual.

mean number of program visits, mean number of bulletin board visits, and the average total hours of use. With respect to program satisfaction, the mean ratings were above 4 on a 5-point Likert-type scale for skills, coach support, and general satisfaction across both conditions, indicating that the participants were highly satisfied with the Mom-Net intervention. Participants also rated the website as quite usable, with mean ratings above 4 on a 5-point Likert-type scale. Coaches reported that, on average, mothers participated in over 80% of scheduled calls, had good comprehension of the material, established a good working relationship with the coach, and successfully used skills between sessions.

Between-Group Intervention Effects

Table 3 presents the descriptive statistics for the five nondiagnostic outcome measures at the three assessment points by condition. The test statistics along with the effect sizes for the intervention effects are summarized in Table 5. As can be seen in the first set of columns in Table 5, moderate-to-large effects were obtained on four of the five outcome measures. A significant and large effect of Mom-Net condition was obtained on the BDI ($g = .89$),

Table 3
Descriptive Statistics for Nondiagnostic Outcome Measures by Assessment

Outcome	Mom-Net			DI/TAU		
	T1 <i>M (SD)</i>	T2 <i>M (SD)</i>	T3 <i>M (SD)</i>	T1 <i>M (SD)</i>	T2 <i>M (SD)</i>	T3 <i>M (SD)</i>
BDI	26.2 (9.8)	13.4 (10.4)	11.9 (10.6)	25.4 (9.0)	22.5 (11.0)	13.3 (9.4)
OBS	-0.1 (0.7)	-0.2 (0.7)		0.1 (0.6)	0.2 (0.7)	
PBI HC	17.6 (3.9)	15.2 (4.1)	14.7 (4.6)	19.3 (6.8)	18.1 (7.1)	15.5 (6.5)
PBI SE	38.0 (4.8)	40.5 (4.6)	40.8 (3.6)	37.9 (6.2)	39.3 (5.2)	40.5 (6.2)
PSOC	54.2 (9.3)	45.4 (10.2)	44.8 (10.6)	55.1 (13.9)	50.5 (11.5)	45.6 (13.2)

Note. DI/TAU = delayed intervention/treatment as usual; T1-T3 = Time 1-Time 3; BDI = Beck Depression Inventory; OBS = observation-based mother aggression/low support; PBI HC = Parent Behavior Inventory hostile/coercive; PBI SE = Parent Behavior Inventory supportive/engaged; PSOC = Parenting Sense of Competence Scale.

Table 5
 Test Statistics From Main Effects, Maintenance of Gains, and Replication Analyses for Nondiagnostic Data

Outcome	T1–T2 intervention effect			T1–T3 maintenance effect			T2–T3 replication effect		
	<i>t</i>	<i>p</i>	Hedges' <i>g</i>	<i>t</i>	<i>p</i>	<i>r_{ppb}</i>	<i>t</i>	<i>p</i>	<i>r_{ppb}</i>
BDI	–4.03	<.001	0.89	7.58	<.001	.80	4.79	<.001	.65
OBS	–1.84	.065	0.39	—	—	—	—	—	—
PBI HC	–1.91	.056	0.31	3.61	.001	.53	2.56	.015	.41
PBI SE	1.19	.236	0.25	–3.29	.002	.50	–1.32	.197	.23
PSOC	–2.57	.010	0.44	5.29	<.001	.68	3.21	.003	.49

Note. For Hedges' *g*, an effect size of .2, .5, and .8 is considered small, medium, and large, respectively. T1–T3 = Time 1–Time 3; *r_{ppb}* = partial point-biserial *r* (.14 a small effect, .36 a medium effect, .51 a large effect); BDI = Beck Depression Inventory; OBS = observation-based mother aggression/low support; PBI HC = Parent Behavior Inventory hostile/coercive; PBI SE = Parent Behavior Inventory supportive/engaged; PSOC = Parenting Sense of Competence scale. Dashes indicate that data were not collected on this measure at these assessment periods.

followed by a significant and medium-size effect on parenting sense of competence ($g = .44$). Moderate-size effects emerged for observed mother aggressive/low-supportive behavior ($g = .39$) and self-reported hostile/coercive parenting ($g = .31$). The condition effect for self-report of supportive/engaged parenting was not significant and had a small effect size ($g = .25$).

Participants in the two conditions were also compared on the rates of remission from the index depressive episode. We selected participants who met criteria for minor or major depression on the basis of the PHQ-9 at pretest ($n = 50$). Mom-Net participants were significantly more likely than DI/TAU participants to have remitted from their index depressive episode based on the T2 PHQ-9 (69% vs. 30%; OR = 5.1, 95% CI [1.5, 17.4]).²

Pretest to Follow-Up Maintenance Effect for Mom-Net Condition

Because the DI/TAU condition was provided access to the Mom-Net program after the completion of the posttest assessment, a between-subjects examination of effects was not possible at follow-up. We conducted a within-subjects analysis comparing follow-up scores (T3) with pretest scores (T1) for participants in the Mom-Net condition. Descriptive and test statistics are reported in Table 3 and the middle set of columns in Table 5, respectively. The four outcomes collected at T3 had significant and large gains at follow-up compared with the pretest levels, indicating that intervention effects were maintained. As shown in Table 3, mean follow-up scores were the same or improved as compared with the posttest means. A graphical depiction of the BDI trend over time is presented in Figure 1 for the Mom-Net condition.

Among Mom-Net participants who met PHQ-9 criteria for minor or major depression at T1, the remission rate at the T3 follow-up was 72%. Of the 18 Mom-Net participants who remitted from their index episode by T2, three (17%) had relapsed by T3. Thus, the remission rate remained high at T3 accompanied by a low relapse rate, providing preliminary evidence for the durability of program effects.

Post- to Follow-Up Replication Effect for the DI/TAU Condition

With respect to the replication of program effects among the DI/TAU participants, we conducted a within-subjects analysis

comparing follow-up scores with posttest scores on the four outcome measures assessed at follow-up. With the exception of the PBI supportive/engagement scale, we obtained significant and moderate-to-large effects in the hypothesized direction for each outcome (see Tables 3 and 5). The BDI trend over time is presented in Figure 1 for the DI/TAU condition. Of the 17 DI/TAU participants who met PHQ-9 criteria for minor or major depression at T2, 13 (77%) had remitted by T3. Thus, the effects of the intervention were replicated after the DI/TAU participants were provided access to the Mom-Net program.

Discussion

Mom-Net was designed as a remotely delivered CBT intervention composed of both online tutorials and weekly coach phone calls. The results of this pilot study provide preliminary support for the feasibility and efficacy of Mom-Net for the treatment of subthreshold and full syndrome depression in mothers of young children. With regard to feasibility, it is notable that attrition was exceptionally low, and participants evidenced very high levels of engagement with the program, completing, on average, more than 75% of both computer sessions and coach calls. Moreover, nearly two thirds of participants completed all sessions. Additionally, both participant- and coach report data were positive. Participants reported high levels of satisfaction with the program, indicating that they found the intervention helpful, the website easy to use, and the coaches to be supportive. Coaches, moreover, reported that they had a good working alliance with the mothers and that the mothers demonstrated a good understanding of the material, and made several successful efforts at using program skills between sessions. These indices of engagement and satisfaction compare favorably with those of other Internet interventions (Andrews, Cuijpers, Craske, McEvoy, & Titov, 2010; Christensen et al., 2009; Kaltenthaler, Parry, Beverley, & Ferriter, 2008; Waller & Gilbody, 2009).

With regard to efficacy, the results were very promising. Participants in the Mom-Net condition demonstrated significantly greater reduction in depression, the primary outcome, at the level of both symptoms and estimates of criteria-based diagnoses over the course of the intervention. The large effect size is greater than

² Due to the high correlation between the BDI-II and the PHQ-9 ($r = .84, p < .001$), we did not examine the PHQ-9 as a continuous variable.

that reported in meta-analyses of Internet interventions for depression, including other supported interventions (Andersson & Cuijpers, 2009; Andrews et al., 2010) as well as for both face-to face and guided self-administration approaches to delivery of the CWDC (Cuijpers et al., 2009).

Of particular significance, given the adverse effects of depression on parenting behavior, mothers in the Mom-Net condition also demonstrated significantly greater improvement on a questionnaire measure of parent satisfaction and efficacy as well as on both questionnaire and observational indices of harsh parenting behavior. This finding is consistent with recent evidence that CBT interventions for maternal depression may improve cognitions around parenting and child behavior (Ammerman et al., 2011; Chronis et al., 2006) and that remission of maternal depression is associated with improved parenting behavior (Foster et al., 2008; Garber et al., 2011; Weissman et al., 2006). However, to our knowledge, this is the first study to demonstrate that an Internet-facilitated intervention for depression may improve parenting behavior in depressed mothers. Finally, it is worth noting that within-group follow-up assessments indicated that effects on both depression and self-reported parenting were maintained at follow-up for participants initially assigned to the Mom-Net condition and replicated when participants in the DI/TAU condition received the intervention.

A question could be raised regarding the extent to which treatment effects are due to the online tutorials versus the coach support. Given that the two components of the intervention were highly integrated (e.g., “Try this strategy and then discuss how it went with your coach”; “Make a plan and send it to your coach for review”), with both aspects designed to facilitate engagement and skill acquisition, the unique effects of each component cannot be determined. The extent of the integration reflects our conceptualization of the intervention as facilitating remote delivery of services rather than as a self-help intervention. This is in contrast to programs in which coach support is conceptualized primarily as an aid to engagement or adherence (Mohr et al., 2011). That said, revising the tutorials so as to enable self-administration without coach support may be a useful direction for future research. Though effect sizes would likely be significantly lower (Andersson & Cuijpers, 2009), the public health benefit could be large given the potentially greater reach (Glasgow, 2007) if attention to instructional design is successful in overcoming barriers to engagement and retention evident in unsupported programs (Christensen et al., 2009).

There are several methodological limitations, reflecting the pilot nature of the investigation, that highlight directions for future research. First, the sample was relatively small, providing power to detect only medium and large effects, and precluding an examination of factors, such as the severity or complexity of clinical issues that have been suggested as potential moderators of engagement and outcome (Cuijpers et al., 2009; Verduyn et al., 2003). As well, because the sample was homogeneous with regard to demographic characteristics, we do not know how the intervention would have fared in a more diverse sample, though meta-analyses on the CWDC indicate that its effectiveness is robust across populations (Cuijpers et al., 2009). Second, the provision of the computer equipment likely contributed to the ease of enrolling participants into the project and possibly to retention. However, as computers were provided to participants in both conditions, we do

not think that they explain the strong intervention effects. Third, as participants in the DI/TAU condition were provided with the Mom-Net intervention subsequent to the T2 assessment, the study design allowed us to show that the result replicated in the DI condition but precluded a controlled examination of maintenance effects. Moreover, the within-group examination of maintenance was relatively brief. Fourth, we did not include a clinician rating of depressive symptoms or disorder. As evidence suggests that self-report and clinician ratings of outcome are not equivalent, with clinician ratings yielding greater effect sizes (Cuijpers, Li, Hofmann, & Andersson, 2010), inclusion of clinician ratings in future work will provide a more thorough estimate of efficacy. Finally, we did not evaluate the cost-effectiveness of the intervention, which is an important component of feasibility. As cost-effectiveness is a frequently cited rationale for Internet-based interventions (Tate, Finkelstein, Khavjou, & Gustafson, 2009), and of particular relevance to overcoming barriers associated with economic disadvantage, it is an important direction for future research. We are presently initiating a larger randomized controlled trial, which will address these limitations and provide an opportunity to extend the findings.

In summary, the Mom-Net intervention appears to be feasible and efficacious as a remotely delivered treatment for economically disadvantaged mothers. Relative to facilitated usual care, it demonstrated large effects on the primary outcome of depressive symptoms and moderate effects on parenting behavior and experiences. Though it will be important to replicate and extend the findings, the Mom-Net intervention holds significant promise as a means for providers to overcome barriers to treatment delivery to economically disadvantaged or rural mothers.

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Appendix

Mom-Net: JARS Participant Flow Diagram

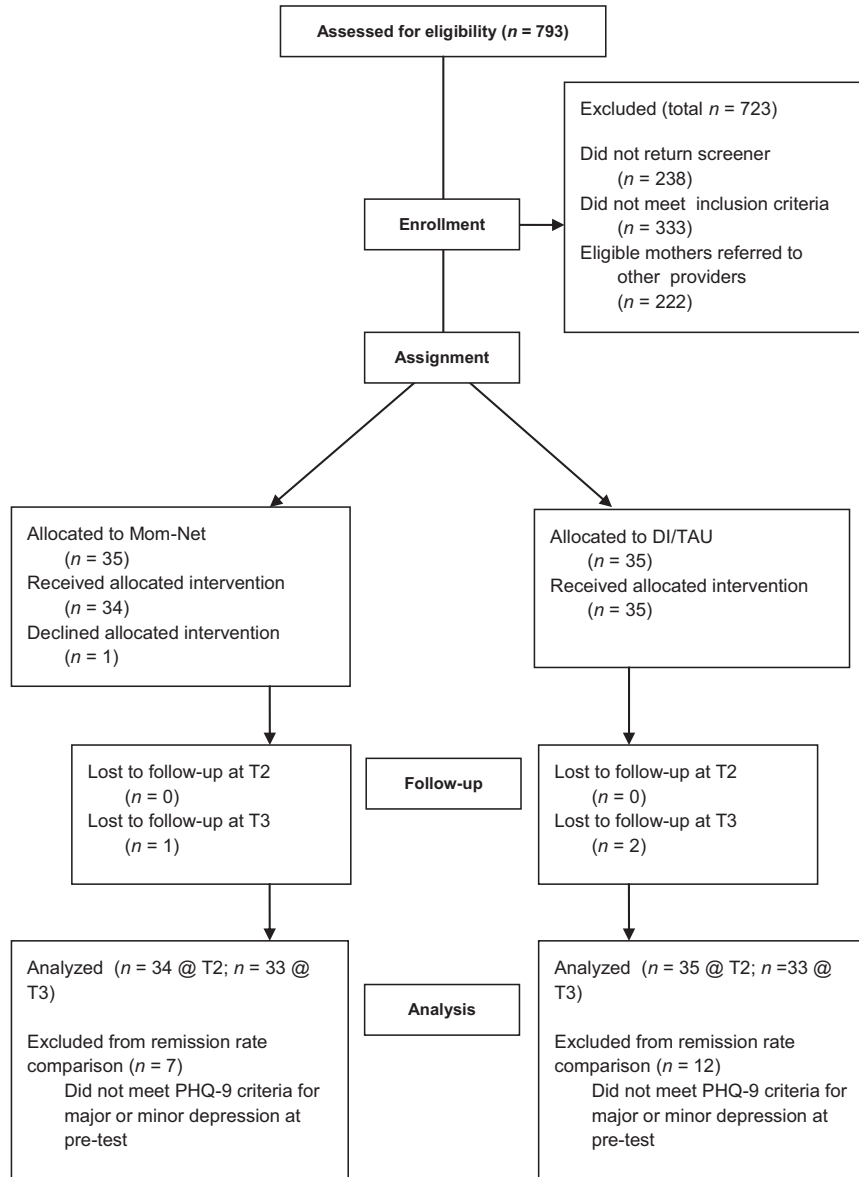


Figure A1. BDI scores across time. JARS = Journal Article Reporting Standards; DI/TAU group received the intervention beginning at Time 2. BDI = Beck Depression Inventory; TX = Treatment; DI/TAU = delayed intervention/facilitated treatment as usual; T1–T3 = Time 1–Time 3; PHQ-9 = Patient Health Questionnaire 9.

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