



HHS Public Access

Author manuscript

J Clin Child Adolesc Psychol. Author manuscript; available in PMC 2018 October 10.

Published in final edited form as:

J Clin Child Adolesc Psychol. 2014 ; 43(1): 102–114. doi:10.1080/15374416.2013.850697.

Understanding Adolescent Response to a Technology-Based Depression Prevention Program

Tracy Gladstone,

Wellesley Centers for Women, Wellesley College

Monika Marko-Holguin,

Department of Pediatrics, University of Illinois at Chicago

Jordan Henry,

Department of Pediatrics, University of Illinois at Chicago

Joshua Fogel,

Department of Finance and Business Management, Brooklyn College

Anne Diehl, and

Judge Baker Children's Center, Harvard University

Benjamin W. Van Voorhees

Department of Pediatrics, University of Illinois at Chicago

Abstract

Guided by the Behavioral Vaccine Theory of prevention, this study uses a no-control group design to examine intervention variables that predict favorable changes in depressive symptoms at 6- to 8-week follow-up in at-risk adolescents who participated in a primary care, Internet-based prevention program. Participants included 83 adolescents from primary care settings ages 14 to 21 ($M = 17.5$, $SD = 2.04$), 56.2% female, with 41% non-White. Participants completed self-report measures, met with a physician, and then completed a 14-module Internet intervention targeting the prevention of depression. Linear regression models indicated that several intervention factors (duration on website in days, the strength of the relationship with the physician, perceptions of ease of use, and the perceived relevance of the material presented) were significantly associated with greater reductions in depressive symptoms from baseline to follow-up. Automatic negative thoughts significantly mediated the relation between change in depressive symptoms scores and both duration of use and physician relationship. Several intervention variables predicted favorable changes in depressive symptom scores among adolescents who participated in an Internet-based prevention program, and the strength of two of these variables was mediated by automatic negative thoughts. These findings support the importance of cognitive factors in preventing adolescent depression and suggest that modifiable aspects of technology-based intervention experience and relationships should be considered in optimizing intervention design.

Twenty percent of all adolescents will experience a depressive episode by age 18, with potential long-term adverse impacts on educational attainment, relationship functioning, risk of substance abuse, and future depressive episodes, even among those who receive treatment (Curry et al., 2006; Saluja et al., 2004). Most adolescents with major depression do not seek treatment, and of those who do, very few complete treatment (Jaycox et al., 2003). Also, even under controlled research conditions, only about half of adolescents who receive treatment for depression fully recover (Asarnow, Jaycox, & Anderson, 2002; Asarnow et al., 2005). Among those who do recover, relapse is quite common (Lewinsohn, Clarke, Seeley, & Rohde, 1994).

Due to the increased risk of depression during adolescence (Costello, Mustillo, Erkanli, Keeler, & Angold, 2003), and the proportion of adolescents who struggle with depression but do not receive treatment, adolescence is an optimal time to implement depression prevention interventions (National Research Council and Institute of Medicine, 2009). Prevention approaches have the potential to reach a large number of adolescents and may be more acceptable than seeking treatment, in part because prevention services can be rendered in settings not explicitly designated for mental health (e.g., schools, primary care settings), and because receiving prevention services does not require adolescents to identify themselves as ill.

TECHNOLOGY-BASED INTERVENTIONS

An Institute of Medicine report suggests the importance of developing and evaluating new technologies that aim to prevent the onset of psychiatric disorders (Mrazek & Haggerty, 1994; National Research Council and Institute of Medicine, 2009). Technology-based interventions offer several distinct advantages over more traditional face-to-face interventions, including easy access, privacy, personalization, and decreased cost (Muñoz, Cuijpers, Smit, Barrera, & Leykin, 2010; Van Voorhees et al., 2010). Such depression interventions are now widely available on the Internet (Kaltenthaler et al., 2006), for adolescents as well as adults (Van Voorhees et al., 2011), and many have demonstrated effectiveness (Christensen, Griffiths, & Jorm, 2004; Clarke et al., 2005; Proudfoot et al., 2004), but we know little about the components that contribute to their apparent efficacy. Analysis of these interventions within a theory-based framework could elucidate core intervention design principles.

THE BEHAVIORAL VACCINE THEORY OF PREVENTION

We propose the behavioral vaccine model (Siemer, Fogel, & Van Voorhees, 2011; Van Voorhees et al., 2011) as one way to better understand and evaluate technology-based interventions designed to reduce the likelihood of developing mental and behavioral disorders. We choose this model because we recognize similarities between the traditional biological vaccine that is designed to prevent infectious disease and technology-based interventions that are designed to prevent the onset of disorders such as depression.

The behavioral vaccine model indicates that there are three key ingredients to a successful vaccine. Successful biological vaccines have an antigenic core designed to induce immunity,

an adjuvant that enhances the body's immune system response, and a delivery system to introduce the vaccine into the body. Likewise, a successful "behavioral vaccine" requires *effective components* (the core material of the vaccine), a *motivational framework* (to enhance response), and a *structured implementation strategy* (to deliver the vaccine effectively). To explore why a "behavioral vaccine" is efficacious, using the behavioral vaccine model as a theoretical framework, one must evaluate these three key ingredients (effective components, motivational framework, and structured implementation strategy) of the "behavioral vaccine" and analyze their impact on intervention outcome.

CATCH-IT INTERNET TECHNOLOGY INTERVENTION

We developed Competent Adulthood Transition with Cognitive-behavioral, Humanistic and Interpersonal Training (CATCH-IT) as a primary care/Internet-based "behavioral vaccine" intended to prevent depressive disorder in an indicated sample of adolescents who report an elevated level of depressive symptoms (Landback et al., 2009; Van Voorhees et al., 2007). CATCH-IT teaches resiliency skills through web-based modules, with motivational support provided through the primary care setting. Primary care is an optimal location, due to its function of providing other preventive care, and is an environment without the stigma often associated with mental health services. Previous clinical trials indicate an association between CATCH-IT use and significant reductions in adolescent depressive symptoms (Van Voorhees, Fogel, Reinecke, et al., 2009), but there are no studies on the intervention components associated with these changes. Using the behavioral vaccine model as a theoretical framework, we assess the three elements of a successful "behavioral vaccine" (the effective components, motivational framework, and structured implementation strategy) in CATCH-IT and analyze their relation to adolescent depression outcomes.

BEHAVIORAL VACCINE ELEMENTS IN RELATION TO INTERVENTION RESPONSE

Effective Components

The effective components of a "behavioral vaccine" include its core material and are designed to strengthen protective factors and reduce vulnerability factors. Technology-based preventive interventions adapt materials already shown to be efficacious in face-to-face and/or traditional biblio-therapy models of delivery. Substantial evidence exists that when an adequate dose of a "behavioral vaccine" is delivered through an appropriately designed Internet intervention, the intervention is efficacious at levels comparable to face-to-face interventions (Christensen, Griffiths, Groves, & Korten, 2006; Gellatly et al., 2007). The effective components of CATCH-IT consist of 14 Internet modules that teach strategies from behavioral activation, cognitive behavioral therapy (CBT), interpersonal psychotherapy, and a community resiliency concept model, all of which have demonstrated effectiveness in face-to-face therapy (Bell, 2001; Clarke, 1994; Cuijpers, van Straten, & Warmerdam, 2007; Jacobson, Martell, & Dimidjian, 2001; Mufson, Pollack-Dorta, Moreau, & Weissmann, 2004; Stuart & Robertson, 2003).

Motivational Framework

The motivational framework incorporated into this technology-based intervention is designed to enhance response to the “behavioral vaccine.” Although adolescents report extensive use of the Internet (Rideout, Foehr, & Roberts, 2010), with mixed reports on the utilization of health-related Internet websites (Rideout et al., 2010; Santor, Poulin, LeBlanc, & Kusumakar, 2007), the literature suggests adolescents need to be reminded and encouraged (e.g., via contact with a clinician) to visit the website in order to sustain their use of an Internet-based intervention (Evers, Cummins, Prochaska, & Prochaska, 2005; Verheijden, Jans, Hildebrandt, & Hopman-Rock, 2007). The most effective Internet-based programs use some form of reminder or professional guidance to facilitate technology use and to encourage technology-based learning and behavior change (Clarke et al., 2005; Cuijpers, Donker, van Straten, Li, & Andersson, 2010; Van’t Hof, Cuijpers, & Stein, 2009). The CATCH-IT intervention pairs a web-based learning program with two different levels of physician engagement and support (i.e., brief advice or motivational interview). In a previous study, we found that adolescents who participated in CATCH-IT paired with a physician motivational interview reported fewer clinician-diagnosed depressive episodes postintervention than adolescents who used the website without significant physician support (brief advice only; Van Voorhees, Fogel, Reinecke, et al., 2009).

Structured Implementation Strategy

The purpose of a structured implementation strategy is to successfully deliver the effective components of the “behavioral vaccine.” This means optimizing web-site design and varying teaching methods (Nation et al., 2003; Ritterband, Thorndike, Cox, Kovatchev, & Gonder-Frederick, 2009). Internet sites must balance education, behavior change, and entertainment functions in order to retain their audience (Gagne, Briggs, & Wager, 1992). In addition, as many technology-based interventions provide their core content primarily in text format (Andersson et al., 2005; Christensen et al., 2004), “behavioral vaccines” must be presented at the appropriate reading level, be easy to use and understand, and provide an opportunity for identification and behavior change/adoption (Ritterband et al., 2009). A structured implementation strategy was employed in the development of the CATCH-IT intervention, such that text length was minimized; written material could be easily understood; and pictures, video, and other varied design elements were included.

FACTORS THAT MAY INFLUENCE THE RELATION BETWEEN BEHAVIORAL VACCINE ELEMENTS AND RESPONSE

The literature on the behavioral vaccine model highlights the importance of exploring potential mediators and moderators of response to a “behavioral vaccine,” but few studies explore these factors (Van Voorhees et al., 2011). However, previous studies of adolescent depression identify factors that may mediate the relation between the aforementioned key intervention variables and outcome. For example, automatic negative thoughts may mediate the response to a “behavioral vaccine.” Negative cognitions predict depressive symptoms in children (Van Voorhees, Paunesku, Gollan, et al., 2008), and changes in negative cognitions

and automatic thoughts mediate the relation between cognitive therapy/cognitive-behavioral therapy and depression outcomes (Hollon, Evans, & DeRubeis, 1990; Kwon & Oei, 1992).

Social support also may be a mediator of response to a “behavioral vaccine.” Inadequate perceived social support is a salient risk factor for depression in adolescents, with perceived deficits in social support associated with increased adolescent depressive symptoms (Rubin et al., 1992; Windle, 1992). As deficient social support increases depressive symptoms risk, improvements in social support might provide a pathway for decreasing depression risk. Also, some studies suggest that deficient family support predicts increases in depressive symptoms and onset of major depressive disorder in adolescents, but deficient peer support does not (Stice, Ragan, & Randall, 2004; Windle, 1992).

Several additional demographic factors can influence adolescents’ responses to preventive interventions for mental and behavioral disorders. Numerous reviews and meta-analyses of adolescent depression prevention programs indicate gender, age, and race/ethnicity may influence intervention outcome (Horowitz & Garber, 2006; Stice, Shaw, Bohon, Marti, & Rohde, 2009; Weisz, Sandler, Durlak, & Anton, 2005). Our sample size and concerns with statistical power precluded separate analyses stratifying for these factors, and therefore these variables were controlled for in our analytical models. We also controlled for physician support format (motivational interview vs. brief advice), as our sample size did not allow us to examine the components of the behavioral vaccine model by each intervention group separately.

HYPOTHESES

We believe the behavioral vaccine model offers a framework with which we can evaluate factors that influence intervention response to the CATCH-IT intervention. Specifically, we hypothesize that measures of effective components (i.e., time participating, modules completed, sessions initiated, website exercises, perceived benefit of content), motivational framework (i.e., relationship with physician), and structured implementation strategy (i.e., usability, internal rationale, identification/relevance) will be associated with higher change scores on the CESD-20 from baseline to 6- to 8-week follow-up. Furthermore, we hypothesize that the relation between these intervention variables and change in CESD score will be mediated by theoretically and empirically validated vulnerability factors for depressive episodes (i.e., automatic negative thoughts, social support from family, and social support from friends). Our mediation model is not the typical one used in intervention research. Rather, we examine the mechanisms of change within our intervention group.

METHOD

Study Design

This study aims to examine intervention variables that predict favorable changes in depressive symptoms at 6-to 8-week follow-up in at-risk adolescents who participated in an experimental primary care, Internet-based prevention program. Participants were randomly assigned to CATCH-IT with physician brief advice or to CATCH-IT with physician motivational interview, but physician communication format was controlled for in this study.

Practices were called directly or contacted through physician leaders in health care systems. Practices could elect either to have their own physicians conduct the interview ($n = 10$ practices), whereby physicians would receive reimbursement of \$100 per adolescent, or have the study Principal Investigator, a primary care physician, conduct the interview ($n = 3$ practices).

Adolescents who were eligible and enrolled completed a series of self-administered questionnaires at baseline and 6 to 8 weeks after study completion. The dose was obtained by using simple algorithms in the website. The full methods for this study have been reported previously in detail (Van Voorhees, Fogel, Reinecke, et al., 2009; Van Voorhees, Vanderplough-Booth, et al., 2008). Participants received an incentive of \$100. All protocols were approved by the University of Chicago Institutional Review Board and local site Institutional Review Boards.

Recruitment

Participants were recruited from 13 U.S. primary care sites within four states throughout the Midwest and South (from rural, suburban, and urban areas). Recruitment of adolescents occurred between February 1 and November 31, 2007, whereby all adolescents with primary care visits at participating clinics were screened for risk of disorder (subthreshold depressive symptoms). Advertisements in and around the clinics (including Internet postings for a campus clinic) also were used. The screening instrument was a two-item questionnaire based on the Patient Health Questionnaire Adolescent (PHQ-A) core depression symptom items (Johnson, Harris, Spitzer, & Williams, 2002). Those reporting core depressive symptoms (depressed mood, loss of pleasure, or irritability) for a few days or more were considered positive screens and were contacted by study staff for an eligibility assessment, which included the full Patient Health Questionnaire Adolescent. Participants younger than age 18 were not contacted until parental permission was obtained. As appropriate, all participants provided informed consent and/or assent.

Eligibility Criteria

Eligible participants were between the ages of 14 and 21 years and experienced persistent subthreshold depression (>1 core symptom of depression: depressed mood, irritability or loss of pleasure) at both the screening and eligibility assessments (1–2 weeks after initial screening). Adolescents were excluded based on the following: current active treatment for major depression or minor depression, current bipolar disorder, expressing frequent suicidal ideation or intent, or meeting criteria for conduct, substance abuse, generalized anxiety, panic, or eating disorders. Because mental health services in rural areas were not readily available, physicians in rural practices were allowed to enroll a limited number of adolescents who met borderline criteria for major depression and/or generalized anxiety disorder.

Internet Intervention

The intervention comprised 14 online modules based on behavioral activation, cognitive behavioral therapy, interpersonal psychotherapy, and a community resiliency concept model. The intervention intends to reduce cognitions (dysfunctional thoughts, impaired problems

solving, and pessimistic expectations), behaviors (procrastination, passivity, and avoidance), and interpersonal interactions (indirect communications) that are associated with increased risk of depression, and to strengthen behaviors (behavioral scheduling of pleasurable activities), thoughts (optimistic appraisals, counter thoughts, and effective problem solving), and interpersonal relations (effective social problem solving, building and engaging social support) thought to be protective against depression. Acknowledging that risk factors occur within ecological contexts and across multiple domains, a parent workbook, which focuses on supporting resiliency in one's adolescent, was provided to the parents of adolescents younger than 18 to enhance the intervention effects. This Internet intervention has been described previously (Van Voorhees, Fogel, Reinecke, et al., 2009). Current and previous studies indicate this intervention is effective in decreasing depressive symptoms in adolescents and that it is more cost-effective than a course of 15 in-person CBT sessions (Ruby, Marko-Holguin, Fogel, & Van Voorhees, 2013).

Data Collection

We collected outcome data on key vulnerability and protective factors from adolescents. Baseline questionnaires were completed before any study intervention was received, except where time restraints required the adolescent to take measures home for completion. Follow-up was completed between 6 and 8 weeks after enrollment. In a few cases ($n = 15$), follow-up occurred several weeks later. Because of the wide dispersion of clinics and voluntary cooperation of primary care clinic staff, some poststudy data collection was incomplete. A clerical error omitted some items for the first 20 participants.

Measures

Dependent Variable—The dependent variable is the change score of baseline minus 6- to 8-week follow-up of the Center for Epidemiological Studies—Depression Scale (CES-D; Radloff, 1977), which is a self-report measure of the frequency of 20 depressive symptoms over the past week using a 5-point Likert scale. Sample items include “I was bothered by things that usually don't bother me” and “I could not get going.” We chose this outcome because adolescents with elevated symptoms of depression are at significantly greater risk of later developing affective disorders (Lewinsohn, Gotlib, & Seeley, 1995; Van Voorhees, Paunesku, Kuwabara, et al., 2008; Van Voorhees, Vanderplough-Booth, et al., 2008). The use of self-report scales like the CES-D as depression case-finding or screening instruments has been successfully validated with both adults (Dohrenwend & Shrout, 1984; Roberts & Vernon, 1983) and adolescents (Fendrich, Warner, & Weissman, 1990; Lewinsohn, Rohde, Seeley, & Hops, 1991). The CES-D is short and easy to read, has been successfully administered in several large adolescent school samples (Lewinsohn et al., 1991; Schoenbaum, Kaplan, Grimson, & Wagner, 1982), and has strong psychometrics with youth (Roberts, Andrews, Lewinsohn, & Hops, 1990). In our sample, both baseline and follow-up Cronbach's alphas were .91.

Intervention Variables

Effective components:

Time.: Our time measures were total time on website in minutes, total time spent on story components in minutes, and duration of website use in days. To calculate the total time on the website in minutes, we collected the time stamps of first and last page loaded for each session (i.e., each time a participant loaded a module) and subtracted the starting from the final time stamp. To avoid measuring time spent on other open pages, the length of time for each session was capped at 7 min, the estimated amount of time required to review the material with a fifth-grade reading level. The lengths of all sessions were combined to create a variable for total time spent on the website measured in minutes. To calculate the time spent on story component of intervention in minutes, we used a similar algorithm that subtracted the time stamp from when the story component was opened from the time stamp of when the following page was loaded. To calculate the duration of website use (the total number of days a participant spent on the intervention), we counted the number of days from the first login until the last day of the participant's activity on the website.

Modules.: For every participant, we recorded the total number of modules completed. A module was considered complete if at least one exercise in that module was completed and/or the short online survey offered at the end of the module was completed.

Sessions.: We defined a session as the discrete occasion when a participant logged onto the website. Total number of sessions for each participant was manually calculated by adding the total number of sessions per participant (if there was no activity after logging in, a participant was logged out after 7 min, but it was still counted as a session).

Exercises.: Exercise measures (percentage of exercises completed and number of characters typed) were used to measure the active behavior of the participants. They were selected because they are similar to "homework" assignments in cognitive behavioral psychotherapy and were easy to measure. For each participant, we calculated the percentage of exercises completed by adding the number of exercises completed across all modules and dividing this by the total number of available exercises. To measure the degree to which each exercise was completed, we counted the total number of characters typed by each participant across all modules.

Perceived benefits of intervention content.: We measured the perceived benefits of cognitive behavioral and interpersonal principles taught through the modules. Perceived benefits of the cognitive behavioral principles in the intervention were measured by five questions, which were rated on a 10-point Likert scale, from 1 (*very unhelpful*) to 10 (*very helpful*), with higher scores indicating a stronger perceived benefit for learning cognitive behavioral therapeutic techniques (Zabinski et al., 2001). A sample item is, "Change my behaviors in ways that have improved my mood." In our sample, Cronbach's alpha was .92. Perceived benefits of the interpersonal principles in the intervention were measured by four questions (e.g., "Express my feelings and reactions to important people in my life") on a 10-point Likert scale, from 1 (*very unhelpful*) to 10 (*very helpful*), with higher scores indicating

a stronger perceived benefit for learning interpersonal therapeutic techniques (Zabinski et al., 2001). In our sample, Cronbach's alpha was .85.

Motivational framework

The motivational framework was operationalized through the Physician Scale (Van Voorhees, Fogel, Pomper, et al., 2009). We recorded responses to nine items rating the participant's relationship with his or her physician in understanding, engagement, helpfulness, comfort, and trust. Adolescents indicated their response using a Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*). A sample item is, "I trust my physician." Higher scores reflect a more positive relationship with the physician. In our sample, Cronbach's alpha was .85.

Structured implementation strategy:

Usability: Participants responded to questions about ease of use (i.e., "This module was easy to use"), ease of understanding (i.e., "This module was easy to understand"), and ease of reading (i.e., "This module was easy to read") of the online intervention. Items were scored using a 5-point Likert scale, from 1 (*strongly disagree*) to 5 (*strongly agree*) (Van Voorhees, Fogel, Pomper, et al., 2009). In our sample, Cronbach's alphas for these scales were .94, .96, and .97, respectively.

Internal rational: Participants responded to statements about internal rationale. A sample item is, "The lessons in this module made sense to me." Items were scored using a 5-point Likert scale, from 1 (*strongly disagree*) to 5 (*strongly agree*). Cronbach's alpha for this scale was .96.

Identification/relevance: Participants responded to statements about identification and relevance of the lesson. A sample item is, "The module struck a chord with my own life." Items were scored using a 5-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*). Cronbach's alpha was .96.

Factors Considered for Mediation—The Automatic Thoughts Questionnaire Revised (Kaufman, Rohde, Seeley, Clarke, & Stice, 2005; Kendall, Howard, & Hays, 1989) is a 30-item scale that includes 10 positive thought items. Items were rated on a 5-point scale, from 1 (*not at all*) to 5 (*all the time*). A sample question is, "No one understands me." Higher scores indicate greater level of automatic negative thoughts that are believed to relate to depressed mood. In the original study, Cronbach's alpha was .90 (Kendall et al., 1989). In our study, Cronbach's alpha was .97 at baseline and .96 at follow-up. We used a change score of baseline minus follow-up.

The Perceived Social Support from Friends (PSS-fr) was originally developed to evaluate vulnerability and protection in relation to depression risk (Procidano & Heller, 1983). This 20-item scale has possible responses of *no* = 0 and *yes* = 1. A sample question is, "My friends enjoy hearing about what I think." Cronbach's alpha has been reported as 0.85 (Van Voorhees, Fogel, Reinecke, et al., 2009). In our study, Cronbach's alpha was .91 at both baseline and follow-up. We used a change score of baseline minus follow-up.

The Perceived Social Support from Family (PSS-fa) was developed at the same time as the PSS-fr and uses the same 0-to-20 scale with yes/no responses. A sample item is, "I rely on my family for emotional support." Cronbach's alpha values in previous studies have ranged from 0.87 to 0.90 (Van Voorhees, Fogel, Reinecke, et al., 2009). Initial validity studies demonstrated that both the PSS-fr and the PSS-fa scales measure distinct constructs and were internally valid with regard to demonstrating an inverse correlation with psychopathology (Procidano & Heller, 1983). In our study, Cronbach's alpha was .94 at baseline and .89 at follow-up.

Analytic Design

All analyses were adjusted for treatment group, age, gender, and race/ethnicity (White vs. non-White), due to the small sample size and concerns with statistical power. To examine the relation between the intervention variables (which were classified as "effective components," "motivational framework," or "structural implementation strategy") and outcome (Hypothesis 1), linear regression analyses were conducted separately with each of the intervention variables and the dependent variable of change in depressive symptoms (baseline score minus follow-up). To test the strength of association between the intervention variables and changes in variables considered potential mediators, another series of linear regression analyses were conducted with these aforementioned intervention independent variables and with the dependent variable of the potential mediators change score (baseline minus follow-up). Finally, to determine significant mediation (Hypothesis 2), another series of linear regression analyses were conducted only for the intervention independent variables that were statistically significant in both of the aforementioned two analyses of the outcome of depressive symptoms change score and the outcome of potential mediator change score. This analysis included both the intervention independent variable and the potential mediator variable and had a dependent variable of depressive symptoms change score. Sobel-Goodman tests were calculated as part of these latter regression analyses to determine statistically significant mediation. The Sobel-Goodman tests are analyses that consider the impact of the mediator variable on the dependent variable while evaluating a reduction in the impact of the original independent variable (i.e., a reduced beta coefficient; Sobel, 1982). This was used to test the mediation indirect effect. Stata SE Version 12 (StataCorp, 2011) was used for the analyses.

RESULTS

Sample Description

Participants included 83 individuals ages 14 to 21 ($M = 17.5$, $SD = 2.04$). More than half were female ($n = 47$, 56.2%). Most self-identified as White ($n = 49$, 59.0%), followed by Black ($n = 19$, 22.9%), Asian ($n = 5$, 6.0%), Hispanic ($n = 4$, 5.0%), Other ($n = 3$, 3.6%), and three (3.6%) chose not to disclose their race/ethnicity. Most lived at home with both parents ($n = 44/79$, 55.7%), with some reporting their parents were divorced ($n = 16/79$, 20.3%) or never married ($n = 17/79$, 21.5%). Most came from families where both parents had completed college ($n = 35/74$, 47.3% of fathers and $n = 30/76$, 39.5% of mothers). Most adolescents completed at least 2 years of high school ($n = 43/74$, 58.1%), and 20 of the young adults ($n = 20/74$, 27.0%) completed at least 2 years of college.

The sample had a mean baseline CES-D-20 score of 24.4 ($SD = 12.6$). Most participants reported no current depressive disorders ($n = 64, 77.1\%$). However, 18 ($n = 18, 24.0\%$) reported having received prior counseling, 13 ($n = 13, 18.0\%$) reported having been treated with medication, and 23 ($n = 23, 30.0\%$) reported a family history of depression. Nearly half ($n = 37, 44.9\%$) reported at least one core symptom of Generalized Anxiety Disorder, and only a small portion ($n = 15, 18.1\%$) disclosed at least one core symptom of substance abuse.

With regard to attrition from baseline to follow-up, in the brief advice group, seven of 40 (17.5%) dropped out, whereas among the motivational interview group, seven of 43 (16.3%) dropped out. This did not significantly differ between the groups ($p = .88$).

Linear Regression Analyses

Table 1 shows linear regression analyses for the outcome of depressive symptoms change score. Of the nine effective components variables, one variable (increased duration on website) was significantly associated with increased changes in depressive symptoms ($B = .06, p = .03$). The motivational framework variable, physician relationship scale, was significantly associated with increased changes in depressive symptoms ($B = 1.06, p = .002$). Of the five structured implementation strategy variables, two—ease of use ($B = 5.06, p = .04$) and identification/relevance ($B = 3.99, p = .046$)—were significantly associated with increased change in depressive symptoms score.

Table 2 shows linear regression analyses for the outcome of the potential mediators (i.e., variables being considered as mediators). Regarding automatic negative thoughts, eight of the nine effective components variables—time on website ($B = .07, p = .01$), duration on website ($B = .19, p < .001$), modules completed ($B = 1.23, p = .04$), number of sessions ($B = 1.29, p = .01$), percentage of exercises completed ($B = 17.27, p = .04$), number of characters typed ($B = .003, p = .02$), perceived benefit of cognitive behavioral content ($B = 5.14, p < .001$), and perceived benefit of interpersonal content ($B = 3.69, p = .04$) were significantly associated with changes in automatic negative thoughts, whereas the ninth variable, time spent on stories, approached significance ($p = .054$). The motivational framework variable of physician scale was significantly associated with changes in automatic negative thoughts ($B = 2.14, p = .002$). None of the five structured implementation variables (ease of use, ease of understanding, ease of reading, internal rational scale, and identification/relevance scale) were significantly associated with this potential mediator.

Regarding social support, one of the nine effective component variables (perceived benefit of cognitive behavioral content) was significantly associated with changes in perceived family support ($B = -.05, p < .001$). Motivational framework and structured implementation strategy variables were not significantly associated with changes in perceived family support. Six of the nine effective components variables—time on website ($B = .001, p < .001$), time spent on stories ($B = .01, p = .01$), modules completed ($B = .02, p < .001$), number of sessions ($B = .01, p < .004$), percentage of exercises completed ($B = .27, p < .001$), and number of characters typed ($B = 3.70, p = .01$)—were significantly associated with change in perceived friend support. None of the motivational framework and structured

implementation variables were significantly associated with changes in perceived friend support.

Only two analyses (those with duration on website and physician scale) showed a significant relation between automatic negative thoughts change score and a reduced beta coefficient for the intervention independent variable with the outcome of depressive symptoms change score. The analyses showed statistically significant Sobel-Goodman mediation tests for automatic negative thoughts with duration on website for changes in depressive symptoms (Sobel: $Z = 3.35$, $p = .001$; Goodman-1: $Z = 3.31$, $p = .001$; Goodman-2: $Z = 3.38$, $p = .001$) and with physician scale on changes in depressive symptoms (Sobel: $Z = 2.71$, $p = .01$; Goodman-1: $Z = 2.66$, $p = .01$; Goodman-2: $Z = 2.75$, $p = .01$). Statistically significant mediation was not found for either the perceived family or friend social support change scores.

DISCUSSION

In our diverse sample, we found that measures derived from elements of the behavioral vaccine model predict CES-D change scores in adolescents enrolled in a primary care, Internet-based depression prevention trial. Data from our multivariate regression model, adjusted for group assignment and demographic variables, demonstrated that intervention variables (i.e., factors from effective components, motivational framework, and structured implementation strategy) predicted favorable changes in CES-D change scores, supporting Hypothesis 1. Similarly, an examination of factors that mediated the relation between intervention variables and intervention response (i.e., CES-D change scores) demonstrated an important mediating role of automatic negative thoughts, but not other proposed mediators, supporting Hypothesis 2 with regard to mediation through cognitive vulnerability.

It is noteworthy that at least one intervention variable from each element of the behavioral vaccine model predicted CES-D change scores, even after controlling for group assignment and demographic variables. Regarding effective components, duration on website significantly predicted CES-D change scores, suggesting that the number of days adolescents use the Internet intervention is an important marker of intervention response and that longer durations may yield greater outcomes. This is consistent with research on learning and distributed practice, which suggests that spacing out learning tasks, including tasks designed to teach skills, improves retention over massed practice or “cramming” (Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006; Donovan & Radosevich, 1999). Regarding motivational factors, we found that the physician scale, which measures participants’ perceptions of their relationship with their physician, was predictive of CES-D change scores. It is possible that adding some therapist input to Internet-based approaches may potentially enhance participants’ satisfaction with the experience (Almlov, Carlbring, Berger, Cuijpers, & Andersson, 2009). For example, we found that combining a motivational interview with the CATCH-IT intervention yielded an advantage in preventing depressive episodes in adolescents (Van Voorhees, Vanderplough-Booth, et al., 2008). Similarly, adding a discussion group to a traditional CBT intervention yielded a greater effect size than did the CBT intervention alone (Andersson et al., 2005). Also, therapeutic alliance and client motivation are reported as important factors contributing to outcomes (Meyer et al., 2002).

Regarding structured implementation factors, we found that both the ease of use and the identification/relevance scales predicted CES-D change scores. Measures of implementation framework, including perceptions of quality of the presentation of the technology-based learning, have not been previously shown to predict favorable outcomes in mental health studies. However, there is strong theoretical and empirical support for the importance of these factors from the educational literature (e.g., instructional design theory), suggesting the important role of the proper development of materials in producing favorable outcomes (Gagne et al., 1992). One study identified ease of use, clear structure, and easily understood information as key factors in effective interventions (Schneider, van Osch, & de Vries, 2012). Another study concluded that experiential factors, including general appeal and visual interest, were important in strengthening use and outcomes for Internet health interventions for adolescents (Crutzen et al., 2008).

This is the first attempt of a mediation analysis to account for the relation between intervention variables and response to an Internet-based intervention for depressive disorders in adolescents. The primary benefits of this Internet intervention in the first 6 to 8 weeks appear to be mediated through changes in automatic negative thoughts. This is consistent with theories of cognitive vulnerabilities to depression, and with findings from prior work with group therapy models (Kaufman et al., 2005). In fact, a primary focus of the CATCH-IT intervention is on changing adolescents' thought patterns and problem-solving strategies. Interventions that have such a strong cognitive focus have been associated with sustained preventive benefits for adolescents at risk for depression (Beardslee et al., 2013; Garber et al., 2009). It is possible that the self-directed nature of this intervention did not engender improved social skills, accounting for the absence of significant findings when examining mediating effects for friend and family support in this study. A group-based CBT program did show mediation through changes in friend but not family social support (Stice, Rohde, Gau, & Ochner, 2011).

Limitations

This study was conducted in primary care settings, and we enrolled adolescents from a range of racial/ethnic backgrounds, thus enhancing its external validity. However, because we have a relatively small sample size, our ability to analyze and interpret results was somewhat limited. For example, we were not able to separately examine intervention response for adolescents by age, gender, and race/ethnicity, and thus needed to control for these variables in our analyses. Similarly, moderation analyses could not be performed. Also, although our study randomly assigned adolescents to the motivational interview or brief advice condition, due to lack of statistical power, we had to analyze all data together and controlled for group assignment. In addition, all adolescents had access to the CATCH-IT intervention. Without a no-intervention group, we cannot determine whether the changes we report in depressive symptoms result from participating in this study or whether they are due to other factors (e.g., the passage of time, significant life events). Another limitation is that because multiple physicians within each practice conducted the intervention, it is possible that there was a cluster effect of physicians from particular practices, which was not accounted for in our analyses due to our small sample size. Last, the current study is limited in its test of mediation in two ways. First, it did not examine an intervention versus a comparison group,

but rather whether the effects of intervention variables were explained by autonomic negative thoughts and social support. Second, the mediator and outcome variables were assessed at the same point in time, rather than sequentially, which conflicts with literature that suggests three time points are required for testing mediation (Kraemer, Kiernan, Essex, & Kupfer, 2008; MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002).

Future Directions

Future studies should address the limitations of the present study by exploring the role of age, gender, and race/ethnicity as potential mediators/moderators. We currently have two depression prevention trials in the field that will enable us to address a number of the limitations of the present study. The first trial, Promoting Adolescent Health, is a two-site investigation that will examine the efficacy of the CATCH-IT intervention relative to 14 modules of a health education control intervention in 400 adolescents. This study will address the lack of a nonintervention comparison group and will have a larger sample size, which will enable analysis by important demographic factors (age, gender, and race/ethnicity). In our second trial, Chicago Urban Resiliency Building, 125 adolescents will be randomized to either 14 modules of an ethnically adapted version of CATCH-IT or to a wait-list control. This study will enable us to analyze the impact of racial/ethnic group on outcome with an intervention that is specifically adapted to be culturally responsive and reflective of the lived experience of urban minority adolescents. In both studies, we will evaluate potential mediators; aspects of effective preventive interventions (adherence/dose, positive relationships, training, and perceived benefit of content); and changes in motivation, vulnerability, and protective factors (social support, automatic negative thoughts, depressed mood).

Conclusions

This study makes clinically meaningful contributions to both the field of technology-based mental health interventions, and to the field of adolescent depression prevention. This is the first study of a primary care, Internet-based depression prevention program for adolescents. Through this work we demonstrate that mental health researchers can collaborate with primary care practices to identify at-risk youth and to provide the motivational components necessary to engage youth in a technology-based intervention. We also demonstrate that carefully constructed technology-based interventions that include effective components, employ a motivational framework, and attend to key implementation factors are associated with positive response by adolescents. These findings can inform the development of future successful Internet-based interventions. Finally, our outcome data suggest that adolescents who participate in a technology-based depression prevention program may in fact show significant reductions in depressive symptoms over 6- to 8-week follow-up and that intervention response may be mediated through a reduction in automatic negative thoughts.

REFERENCES

- Almlov J, Carlbring P, Berger T, Cuijpers P, & Andersson G (2009). Therapist factors in Internet-delivered cognitive behavioural therapy for major depressive disorder. *Cognitive Behavior Therapy*, 38, 247–254.

- Andersson G, Bergstrom J, Hollandare F, Carlbring P, Kaldo V, & Ekselius L (2005). Internet-based self-help for depression: Randomised controlled trial. *British Journal of Psychiatry*, 187, 456–461. [PubMed: 16260822]
- Asarnow JR, Jaycox LH, & Anderson M (2002). Depression among youth in primary care models for delivering mental health services. *Child and Adolescent Psychiatric Clinics of North America*, 11, 477–497, viii. [PubMed: 12222079]
- Asarnow JR, Jaycox LH, Duan N, LaBorde AP, Rea MM, Murray P, ... Wells KB (2005). Effectiveness of a quality improvement intervention for adolescent depression in primary care clinics: A randomized controlled trial. *Journal of the American Medical Association*, 293, 311–319. [PubMed: 15657324]
- Beardslee WR, Brent DA, Weersing VR, Clarke G, Porta G, Hollon SD, ... Garber J (2013). Prevention of depression in at-risk adolescents: Longer-term effects. *JAM A Psychiatry*. Advance online publication. doi: 10.1001/jamapsychiatry.2013.295
- Bell CC (2001). Cultivating resiliency in youth. *Journal of Adolescent Health*, 29, 375–381. [PubMed: 11691598]
- Cepeda NJ, Pashler H, Vul E, Wixted JT, & Rohrer D (2006). Distributed practice in verbal recall tasks: A review and quantitative synthesis. *Psychological Bulletin*, 132, 354. [PubMed: 16719566]
- Christensen H, Griffiths K, Groves C, & Korten A (2006). Free range users and one hit wonders: Community users of an Internet-based cognitive behaviour therapy program. *Australian and New Zealand Journal of Psychiatry*, 40, 59–62.
- Christensen H, Griffiths KM, & Jorm AF (2004). Delivering interventions for depression by using the internet: Randomised controlled trial. *British Medical Journal*, 328, 265. [PubMed: 14742346]
- Clarke GN (1994). *The coping with stress course: Adolescent workbook*. Portland, OR: Kaiser Permanente Center for Health Research.
- Clarke G, Eubanks D, Reid E, Kelleher C, O'Connor E, DeBar LL, ... Gullion C (2005). Overcoming Depression on the Internet (ODIN) (2): A randomized trial of a self-help depression skills program with reminders. *Journal of Medical Internet Research*, 7, e16. [PubMed: 15998607]
- Costello EJ, Mustillo S, Erkanli A, Keeler G, & Angold A (2003). Prevalence and development of psychiatric disorders in childhood and adolescence. *Archives of General Psychiatry*, 60, 837–844. [PubMed: 12912767]
- Crutzen R, de Nooijer J, Brouwer W, Oenema A, Brug J, & de Vries NK (2008). Internet-delivered interventions aimed at adolescents: A Delphi study on dissemination and exposure. *Health Education Research*, 23, 427–439. [PubMed: 18209115]
- Cuijpers P, Donker T, van Straten A, Li J, & Andersson G (2010). Is guided self-help as effective as face-to-face psychotherapy for depression and anxiety disorders? A systematic review and meta-analysis of comparative outcome studies. *Psychological Medicine*, 1–15.
- Cuijpers P, van Straten A, & Warmerdam L (2007). Behavioral activation treatments of depression: A meta-analysis. *Clinical Psychology Review*, 27, 318–326. [PubMed: 17184887]
- Curry J, Rohde P, Simons A, Silva S, Vitiello B, Kratochvil C, ... March J (2006). Predictors and moderators of acute outcome in the Treatment for Adolescents with Depression Study (TADS). *Journal of the American Academy of Child & Adolescent Psychiatry*, 45, 1427–1439. [PubMed: 17135988]
- Dohrenwend BP, & Shrout PE (1984). Toward the development of a two-stage procedure for case identification and classification in psychiatric epidemiology In Simmons R (Ed.), *Research in community and mental health* (Vol. 2, pp. 295–323). Greenwich, CT: JAI Press.
- Donovan JJ, & Radosevich DJ (1999). A meta-analytic review of the distribution of practice effect: Now you see it, now you don't. *Journal of Applied Psychology*, 84, 795–805.
- Evers KE, Cummins CO, Prochaska JO, & Prochaska JM (2005). Online health behavior and disease management programs: Are we ready for them? Are they ready for us? *Journal of Medical Internet Research*, 7, e27. [PubMed: 15998618]
- Fendrich M, Warner V, & Weissman MM (1990). Family risk factors, parental depression, and psychopathology in offspring. *Developmental Psychology*, 26, 40–50.
- Gagne RM, Briggs LJ, & Wager WW (1992). *Principles of instructional design*. Fort Worth, TX: Harcourt Brace Jovanovich.

- Garber J, Clarke GN, Weersing VR, Beardslee WR, Brent DA, Gladstone TR, ... Hollon SD (2009). Prevention of depression in at-risk adolescents. *JAMA: The Journal of the American Medical Association*, 301, 2215–2224. [PubMed: 19491183]
- Gellatly J, Bower P, Hennessy S, Richards D, Gilbody S, & Lovell K (2007). What makes self-help interventions effective in the management of depressive symptoms? Meta-analysis and meta-regression. *Psychological Medicine*, 37, 1217–1228. [PubMed: 17306044]
- Hollon SD, Evans MD, & DeRubeis RJ (1990). Cognitive mediation of relapse prevention following treatment for depression: Implications of differential risk In *Contemporary psychological approaches to depression* (pp. 117–136). New York, NY: Springer.
- Horowitz JL, & Garber J (2006). The prevention of depressive symptoms in children and adolescents: A meta-analytic review. *Journal of Consulting and Clinical Psychology*, 74, 401–415. [PubMed: 16822098]
- Jacobson NS, Martell CR, & Dimidjian S (2001). Behavioral activation treatment for depression: Returning to contextual roots. *Clinical Psychology: Science and Practice*, 8, 255–270.
- Jaycox LH, Miranda J, Meredith LS, Duan N, Benjamin B, & Wells K (2003). Impact of a primary care quality improvement intervention on use of psychotherapy for depression. *Mental Health Service Research*, 5, 109–120.
- Johnson JG, Harris ES, Spitzer RL, & Williams JB (2002). The patient health questionnaire for adolescents: Validation of an instrument for the assessment of mental disorders among adolescent primary care patients. *Journal of Adolescent Health*, 30, 196–204. [PubMed: 11869927]
- Kaltenthaler E, Brazier J, De Nigris E, Tumur I, Ferriter M, Beverley C, ... Sutcliffe P (2006). Computerised cognitive behaviour therapy for depression and anxiety update: A systematic review and economic evaluation. *International Journal of Technology Assessment in Health Care*, 10, iii, xi–xiv, 1–168.
- Kaufman NK, Rohde P, Seeley JR, Clarke GN, & Stice E (2005). Potential mediators of cognitive-behavioral therapy for adolescents with comorbid major depression and conduct disorder. *Journal of Consulting and Clinical Psychology*, 73, 38–46. [PubMed: 15709830]
- Kendall PC, Howard BL, & Hays RC (1989). Self-referent speech and psychopathology: The balance of positive and negative thinking. *Cognitive Therapy and Research*, 13, 583–598.
- Kraemer HC, Kiernan M, Essex M, & Kupfer DJ (2008). How and why criteria defining moderators and mediators differ between the Baron & Kenny and MacArthur approaches. *Health Psychology*, 27, 101–108.
- Kwon S-M, & Oei TP (1992). Differential causal roles of dysfunctional attitudes and automatic thoughts in depression. *Cognitive Therapy and Research*, 16, 309–328.
- Landback J, Prochaska M, Ellis J, Dmochowska K, Kuwabara SA, Gladstone T, ... Van Voorhees BW (2009). From prototype to product: Development of a primary care/internet based depression prevention intervention for adolescents (CATCH-IT). *Community Mental Health Journal*, 45, 349–354. [PubMed: 19641992]
- Lewinsohn PM, Clarke GN, Seeley JR, & Rohde P (1994). Major depression in community adolescents: age at onset, episode duration, and time to recurrence. *Journal of the American Academy of Child and Adolescent Psychiatry*, 33, 809–818. [PubMed: 7598758]
- Lewinsohn PM, Gotlib IH, & Seeley JR (1995). Adolescent psychopathology: IV. Specificity of psychosocial risk factors for depression and substance abuse in older adolescents. *Journal of the American Academy of Child and Adolescent Psychiatry*, 34, 1221–1229. [PubMed: 7559318]
- Lewinsohn PM, Rohde P, Seeley JR, & Hops H (1991). Comorbidity of unipolar depression: I. Major depression with dysthymia. *Journal of Abnormal Psychology*, 100, 205–213. [PubMed: 2040772]
- MacKinnon DP, Lockwood CM, Hoffman JM, West SG, & Sheets V (2002). A comparison of methods to test mediation and other intervening variable effects. *Psychological Methods*, 7, 83–104. [PubMed: 11928892]
- Meyer B, Pilkonis PA, Krupnick JL, Egan MK, Simmens SJ, & Sotsky SM (2002). Treatment expectancies, patient alliance, and outcome: Further analyses from the National Institute of Mental Health Treatment of Depression Collaborative Research Program. *Journal of Consulting and Clinical Psychology*, 70, 1051–1055. [PubMed: 12182269]

- Mrazek PB, & Haggerty RJ (1994). Reducing risks for mental disorders: Frontiers for preventive intervention research. Washington, DC: National Academies Press.
- Mufson L, Pollack-Dorta K, Moreau D, & Weissmann MM (2004). Interpersonal psychotherapy for depressed adolescents. New York, NY: Guilford.
- Muñoz RF, Cuijpers P, Smit F, Barrera AZ, & Leykin Y (2010). Prevention of major depression. *Annual Review of Clinical Psychology*, 6, 181–212.
- Nation M, Crusto C, Wandersman A, Kumpfer KL, Seybolt D, Morrissey-Kane E, & Davino K (2003). What works in prevention. Principles of effective prevention programs. *American Psychologist*, 58, 449–456. [PubMed: 12971191]
- National Research Council & Institute of Medicine. (2009). Preventing mental, emotional, and behavioral disorders among young people: Progress and possibilities. Washington, DC: The National Academies Press.
- Procidano ME, & Heller K (1983). Measures of perceived social support from friends and from family: Three validation studies. *American Journal of Community Psychology*, 11, 1–24. [PubMed: 6837532]
- Proudfoot J, Ryden C, Everitt B, Shapiro DA, Goldberg D, Mann A, ... Gray JA (2004). Clinical efficacy of computerised cognitive-behavioural therapy for anxiety and depression in primary care: Randomised controlled trial. *British Journal of Psychiatry*, 185, 46–54. [PubMed: 15231555]
- Radloff LS (1977). A CESD scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*, 1, 385–401.
- Rideout VJ, Foehr UG, & Roberts DF (2010). Generation M: Media in the lives of 8-to 18-year-olds. Henry J. Kaiser Family Foundation.
- Ritterband LM, Thorndike FP, Cox DJ, Kovatchev BP, & Gonder-Frederick LA (2009). A behavior change model for internet interventions. *Annals of Behavioral Medicine*, 38, 18–27. [PubMed: 19802647]
- Roberts RE, Andrews J, Lewinsohn PM, & Hops H (1990). Assessment of depression in adolescents using the Center for Epidemiological Studies-Depression Scale. *Psychological Assessment: Journal of Consulting and Clinical Psychology*, 2, 122–128.
- Roberts RE, & Vernon SW . (1983). The Center for Epidemiologic Studies Depression Scale: Its use in a community sample. *American Journal of Psychiatry*, 140, 41–46. [PubMed: 6847983]
- Rubin C, Rubenstein J, Stechler G, Heeren T, Halton A, Housman D, & Kasten L (1992). Depressive affect in “normal” adolescents: Relationships to life stress, family and friends. *American Journal of Orthopsychiatry*, 63, 430–441.
- Ruby A, Marko-Holguin M, Fogel J, & Van Voorhees BW (2013). Economic analysis of an Internet-based depression prevention intervention. *Journal of Mental Health Policy and Economics*, 16, 121–130. [PubMed: 24327482]
- Saluja G, Iachan R, Scheidt PC, Overpeck MD, Sun W, & Giedd JN . (2004). Prevalence of and risk factors for depressive symptoms among young adolescents. *Archives of Pediatrics & Adolescent Medicine*, 158, 760–765. [PubMed: 15289248]
- Santor DA, Poulin C, LeBlanc JC, & Kusumakar V (2007). Online health promotion, early identification of difficulties, and help seeking in young people. *Journal of the American Academy of Child and Adolescent Psychiatry*, 46, 50–59. [PubMed: 17195729]
- Schneider F, van Osch L, & de Vries H (2012). Identifying factors for optimal development of health-related websites: A delphi study among experts and potential future users. *Journal of Medical Internet Research*, 14, e18. [PubMed: 22357411]
- Schoenbaum M, Kaplan BH, Grimson R . C., & Wagner, E. H. (1982). Use of a symptom scale to study the prevalence of a depressive syndrome in young adolescents. *American Journal of Epidemiology*, 116, 791–800. [PubMed: 7148805]
- Siemer CP, Fogel J, & Van Voorhees BW (2011). Telemental health and web-based applications in children and adolescents. *Child and Adolescent Psychiatric Clinics of North America*, 20, 135–153. [PubMed: 21092918]
- Sobel ME . (1982). Asymptotic confidence intervals for indirect effects in structural equation models. *Sociological Methodology*, 13, 290–312.

- StataCorp. (2011). Stata statistical software: Release 12 (Version SE version 12). College Station, TX: Author.
- Stice E, Ragan J, & Randall P (2004). Prospective relations between social support and depression: Differential direction of effects for parent and peer support? *Journal of Abnormal Psychology*, 113, 155–159. [PubMed: 14992668]
- Stice E, Rohde P, Gau J, & Ochner C (2011). Relation of depression to perceived social support: Results from a randomized adolescent depression prevention trial. *Behavior Research and Therapy*, 49, 361–366.
- Stice E, Shaw H, Bohon C, Marti CN, & Rohde P (2009). A meta-analytic review of depression prevention programs for children and adolescents: Factors that predict magnitude of intervention effects. *Journal of Consulting and Clinical Psychology*, 77, 486–503. doi: 10.1037/a0015168 [PubMed: 19485590]
- Stuart S, & Robertson M (2003). *Interpersonal psychotherapy: A clinician's guide*. New York, NY: Oxford University Press.
- Van't Hof E, Cuijpers P, & Stein DJ . (2009). Self-help and Internet-guided interventions in depression and anxiety disorders: A systematic review of meta-analyses. *CNS Spectrums*, 14(2 Suppl 3), 34–40. [PubMed: 19238128]
- Van Voorhees BW, Ellis J, Gollan J, Bell C, Stuart S, Fogel J,...Ford DE (2007). Development and process evaluation of a primary care internet-based intervention to prevent depression in emerging adults. *Primary Care Companion to the Journal of Clinical Psychiatry*, 9, 346–355.
- Van Voorhees BW, Fogel J, Pomper BE, Mariko M, Reid N, Watson N,...Domanico R (2009). Adolescent dose and ratings of an Internet-based depression prevention program: A randomized trial of primary care physician brief advice versus a motivational interview. *Journal of Cognitive and Behavioral Psychotherapies*, 9, 1–19. [PubMed: 20694059]
- Van Voorhees BW, Fogel J, Reinecke MA, Gladstone T, Stuart S, Gollan J,...Bell C (2009). Randomized clinical trial of an Internet-based depression prevention program for adolescents (Project CATCH-IT) in Primary Care: 12-week outcomes. *Journal of Developmental and Behavioral Pediatrics*, 30, 23–37. [PubMed: 19194326]
- Van Voorhees BW, Mahoney N, Mazo R, Barrera AZ, Siemer CP, Gladstone T, & Munoz RF (2011). Internet-based depression prevention over the life course: A call for behavioral vaccines. *Psychiatric Clinics of North America*, 34, 167–183. [PubMed: 21333846]
- Van Voorhees BW, Paunesku D, Gollan J, Kuwabara S, Reinecke M, & Basu A (2008). Predicting future risk of depressive episode in adolescents: The Chicago Adolescent Depression Risk Assessment (CADRA). *Annals of Family Medicine*, 6, 503–511. [PubMed: 19001302]
- Van Voorhees BW, Paunesku D, Kuwabara S, Basu A, Gollan J, Hankin BL... Reinecke M (2008). Protective and vulnerability factors predicting new-onset depressive episode in a representative of U.S. adolescents. *Journal of Adolescent Health*, 42, 605–616. [PubMed: 18486870]
- Van Voorhees BW, Vanderplough-Booth K, Fogel J, Gladstone T, Bell C, Stuart S,...Reinecke M (2008). Integrative Internet-based depression prevention for adolescents: A randomized clinical trial in primary care for vulnerability and protective factors. *Journal of the Canadian Academy of Child and Adolescent Psychiatry*, 17, 184–196. [PubMed: 19018321]
- Van Voorhees BW, Watson N, Bridges JF, Fogel J, Galas J, Kramer C, ... Bell C (2010). Development and pilot study of a marketing strategy for primary care/Internet-based depression prevention intervention for adolescents (The CATCH-IT Intervention). *Primary Care Companion to the Journal of Clinical Psychiatry*, 12.
- Verheijden MW, Jans MP, Hildebrandt VH, & Hopman-Rock M (2007). Rates and determinants of repeated participation in a web-based behavior change program for healthy body weight and healthy lifestyle. *Journal of Medical Internet Research*, 9, e1. [PubMed: 17478410]
- Weisz JR, Sandler IN, Durlak JA, & Anton BS (2005). Promoting and protecting youth mental health through evidence-based prevention and treatment. *American Psychologist*, 60, 628–648. [PubMed: 16173895]
- Windle M (1992). A longitudinal study of stress buffering for adolescent problem behaviors. *Developmental Psychology*, 28, 522.

Zabinski MF, Wilfley DE, Pung MA, Winzelberg AJ, Eldredge K, & Taylor CB (2001). An interactive Internet-based intervention for women at risk of eating disorders: A pilot study. *International Journal of Eating Disorders*, 30, 129–137.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

TABLE 1

Linear Regression Analyses for CES-D 20 Change Score

Variables	CES-D 20 Change Score		
	Beta (SE)	p Value	95% CI
Effective Components			
Time			
Time on Website (minutes)	.02 (.01)	.15	-.01, .05
Time Spent on Stories (minutes)	.09 (.1)	.36	-.1, .28
Duration on Website (days)	.06 (.03)	.03	.01, .11
Modules			
Total No. of Modules Completed	.29 (.31)	.34	-.32, .91
Sessions			
Total No. of Sessions	.36 (.25)	.15	-.13, .86
Exercises			
% of Exercises Completed	4.13 (4.27)	.34	-4.45, 12.71
No. of Characters Typed	.001 (.001)	.09	<-.001, .003
Perceived Benefit			
Cognitive Behavioral Scale	1.60 (.90)	.08	-.22, 3.41
Interpersonal Scale	1.65 (.92)	.08	-.21, 3.51
Motivational Framework			
Positive Relationships			
Physician Scale	1.06 (.32)	.002	.41, 1.72
Structured Implementation Strategy			
Training Ratings			
Ease of Use Scale	5.06 (2.27)	.04	.24, 9.88
Ease of Understanding Scale	3.69 (2.53)	.16	-1.67, 9.05
Ease of Reading Scale	3.78 (2.58)	.16	-1.69, 9.26
Internal Rationale Scale	3.49 (2.28)	.15	-1.35, 8.32
Identification/Relevance Scale	3.99 (1.85)	.046	.07, 7.91

Note: Each variable analyses adjusted for treatment group, age, sex, and race/ethnicity. CI = confidence interval.

TABLE 2

Linear Regression Analyses for Potential Mediators

Variables	Automatic Negative Thoughts Scale Change Score			Perceived Family Support Scale Change Score			Perceived Friend Support Scale Change Score		
	Beta (SE)	p	95% CI	Beta (SE)	p	95% CI	Beta (SE)	p	95% CI
Effective Components									
Time									
Time on Website (Minutes)	.07 (.03)	.01	.02, .13	-2.00 E-4 (2.01E-4)	.34	-6.10 E-4, 2.10 E-4	.001 (2.40 E-4)	<.001	3.60 E-4, 1.30 E-3
Time Spent on Stories (Minutes)	.36 (.18)	.054	-.01, .72	-.001 (.001)	.56	-.004, .002	.01 (.002)	.01	.001, .01
Duration on Website (Days)	.19 (.05)	<.001	.10, .28	-1.30 E-4 (3.70 E-4)	.73	-8.80 E-4, 6.20 E-4	8.80 E-4 (4.80 E-4)	.08	-9.90 E-5, 1.90 E-3
Modules									
Total No. of Modules Completed	1.23 (.59)	.04	.06, 2.39	-.004 (.004)	.41	.01, .01	.02 (.01)	<.001	.01, .03
Sessions									
Total No. of Sessions	1.29 (.46)	.01	.37, 2.20	-.003 (.003)	.38	-.01, .003	.01 (.004)	<.004	.01, .02
Exercises									
% of Exercises Completed	17.27 (8.04)	.04	1.10, 33.45	-.05 (.06)	.43	-.17, .08	.27 (.07)	<.001	.27 (.07)
No. of Characters Typed	.003 (.001)	.02	.001, .006	-1.30 E-5 (9.80 E-6)	.18	-3.30 E-5, 6.62 E-6	3.70 E-5 (1.20 E-5)	.01	1.20 E-5, 6.20 E-5
Perceived Benefit									
Cognitive Behavioral Scale	5.14 (1.66)	<.001	1.80, 8.48	-.05 (.01)	<.001	-.07, -.02	.03 (.02)	.15	-.01, .06
Interpersonal Scale	3.69 (1.79)	.04	.10, 7.29	-.02 (.01)	.08	-.05, .003	.01 (.02)	.67	-.03, .04
Motivational Framework									
Positive Relationships									
Physician Scale	2.14 (.63)	.002	.87, 3.41	-.007 (.005)	.17	-.02, .003	.002 (.007)	.78	-.01, .02
Structured Implementation Strategy									
Training Ratings									
Ease of Use Scale	8.45 (5.39)	.14	-2.99, 19.88	-.07 (.05)	.17	-.17, .03	-.04 (.05)	.38	-.15, .06
Ease of Understanding Scale	8.57 (5.60)	.15	-3.30, 20.44	-.06 (.05)	.28	-.17, .05	-.04 (.05)	.39	-.15, .07
Ease of Reading Scale	8.13 (5.78)	.18	-4.12, 20.38	-.08 (.05)	.11	-.18, .02	-.05 (.05)	.28	-.16, .05
Internal Rationale Scale	7.96 (5.06)	.14	-2.78, 18.69	-.05 (.04)	.29	-.15, .05	-.01 (.05)	.82	-.11, .09
Identification/relevance Scale	6.85 (4.35)	.14	-2.37, 16.07	-.03 (.04)	.36	-.11, .05	.01 (.04)	.73	-.07, .09

Note: Each variable analyses adjusted for treatment group, age, sex, and race/ethnicity. CI = confidence interval.