RELATIONSHIP BETWEEN MATERNAL AND ADOLESCENT DEPRESSIVE

SYMPTOMS ACROSS TWO ADOLESCENT DEPRESSION PREVENTION

PROGRAMS

By

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ABSTRACT OF THE DISSERTATION

Relationship Between Maternal and Adolescent Depressive Symptoms Across Two

Adolescent Depression Prevention Programs

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Given the prevalence of adolescent depression, its prevention has become an important area of clinical research. While prevention programs such as Interpersonal Psychotherapy − Adolescent Skills Training (IPT-AST) have demonstrated effectiveness, little research to date has studied the impact of maternal depression on adolescent outcomes in these programs. The current study investigated the relationship between maternal and adolescent depressive symptoms across two adolescent depression prevention programs (IPT-AST and group counseling (GC)) in three ways. The study first examined the relationship between initial levels of adolescent and maternal depressive symptoms in this sample. The study then examined whether initial levels of maternal depressive symptoms moderated or predicted adolescent outcomes through the active interventions and across a two-year follow-up period. Lastly, the study investigated whether maternal depressive symptoms improved, and whether maternal and adolescent depressive symptoms changed concurrently across the two-year period. Participants were 167 mother-adolescent dyads who enrolled in a depression prevention study, the Depression Prevention Initiative (DPI). Results indicated that initial levels of maternal and adolescent depressive symptoms were positively associated. Maternal depressive symptoms did not

moderate or predict outcomes through the active intervention, though we found a marginal prediction effect through the follow-up period. Lastly, results indicated that maternal depressive symptoms improved across the two-year period, and maternal and adolescent depressive symptom outcomes were related across time: as adolescents improved in our study, their mothers also experienced improvements in depressive symptoms. These findings extend the current understanding of the impact of maternal depressive symptoms on adolescent depressive symptom outcomes, and have important implications for understanding the effects of adolescent depression prevention programs.

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Introduction

Prevention of Adolescent Depression. Depression in adolescence is a common and debilitating disorder. By the end of adolescence, nearly one in five individuals experience a depressive episode (Thapar, et al., 2012). Major Depressive Disorder (MDD) increases an adolescent's risk for interpersonal, legal, and academic difficulties, as well as risk for suicidal ideation and behavior (Klein, Torpey, Bufferd, & Dyson, 2008). Given the high rates of depression in adolescence and its significant public health implications, the prevention of depression has increasingly become a focus of clinical research. Depression prevention programs have demonstrated small to moderate effects on depressive symptoms, yet there are less clear effects on depression diagnoses (Cuijpers, van Straten, Smit, Mihalopoulous, & Beekman, 2008; Horowitz & Garber, 2006; Merry et al., 2012; Stice et al., 2009).

The magnitude of preventive intervention effects depends on the risk status of the targeted population. The Institute of Medicine (IOM) classifies three categories of preventive interventions: *universal* prevention programs include all individuals of a given population, *selective* prevention programs are administered to individuals who are classified as "above average risk" due to a known risk factor, and *indicated* prevention programs include individuals with subclinical symptoms of the targeted disorder (Horowitz et al., 2007). While Merry and colleagues (2012) found evidence that all levels of prevention are likely to be effective in reducing depressive symptoms when compared to no intervention, effects are greatest in selective and indicated programs (Horowitz & Garber, 2006; Stice et al., 2009).

One promising indicated prevention program is Interpersonal Psychotherapy - Adolescent Skills Training (IPT-AST) (Young & Mufson, 2003). IPT-AST focuses on the interpersonal context in which depression occurs. IPT-AST aims to prevent depressive symptoms by improving adolescents' communication skills and promoting positive relationships (Young & Mufson, 2003; Young, Mufson, & Schueler, 2016). IPT-AST has demonstrated promising results in four efficacy studies (Horowitz, Garber, Ciesla, Young, & Mufson, 2007; Young, Mufson, & Davies, 2006; Young, Mufson, & Gallop, 2010; Young et al., 2016). Three of these studies were administered to indicated populations; across these studies, adolescents with elevated depressive symptoms showed improvement in depressive symptoms and global functioning in IPT-AST, and these improvements were significantly greater than those experienced by adolescents in the control conditions (either usual school counseling (SC) or group counseling (GC), meant to reflect the type of services typically provided in schools). Horowitz and colleagues (2007) conducted a universal efficacy study comparing the effects of IPT-AST and a cognitive behavioral depression prevention program, Coping with Stress (CWS), for 9th grade adolescents. Though there were no differences on the main outcomes between the two interventions, students in both interventions had lower levels of depressive symptoms at post-intervention than those in a no-intervention control group.

The largest study of IPT-AST to date was the Depression Prevention Initiative (DPI) (Young et al., 2016), which compared the effects of IPT-AST to GC in schools through the active intervention and two-years of follow-up. The two interventions will be discussed in greater detail below, as the current study utilizes data from this large RCT. During the first 6-months of follow-up, we found that while adolescents in both

interventions experienced improvement in depressive symptoms across time, youth in IPT-AST experienced significantly greater improvements in depressive symptoms than youth in GC (Young et al., 2016). Our findings in the long-term follow-up showed that between 6-month to 24-month follow-up, this difference dissipated; youth in GC continued to show a decrease in depressive symptoms, while youth in IPT-AST showed a non-significant increase in depressive symptoms. Looking across the entire study period, youth in both interventions experienced significant reductions in depressive symptoms, with no significant differences in overall rates of change between the two conditions (Young et al., 2018, Under Review).

Maternal Depression as a Moderator/Predictor of Adolescent Outcomes

While the results of prevention programs such as IPT-AST have been encouraging, the next step in maximizing effects is to find subgroups of youth who may benefit the most (Garber, 2008; Gillham et al., 2001). Predictor variables are considered indicators of general prognosis of outcome and have a main effect on outcome regardless of intervention condition. Moderator variables, on the other hand, identify which adolescents are more likely to benefit from one of the study interventions as compared with the others (Kraemer, Wilson, Fairburn, & Agras, 2002). Identifying moderators may help maximize the benefits of future prevention efforts, allowing matching of individuals to the interventions that will be most beneficial, and can help the field move toward personalized prevention. Knowledge about predictors and moderators can also inform researchers and clinicians about the limits of interventions. By identifying individuals for whom interventions are least effective, modifications can be made to address limitations (Garber, 2008).

Risk status variables are critically important to investigate as predictors and moderators of depression prevention programs. Maternal depression is a well-documented and well-replicated risk factor for youth depression. Children of depressed versus non-depressed mothers are three times more likely to develop depression, and adolescence is the period of greatest risk for children of depressed mothers (Weissman et al., 2016). According to a report by the IOM, at least 15 million children are living with a depressed parent at any time (Downey & Coyne, 1990). Given its high prevalence, maternal depression is an important risk factor to study in relation to adolescent depression interventions.

To date, there have been mixed findings about whether maternal depression predicts or moderates outcomes in the youth depression prevention and treatment literature. Generally, maternal depression has been linked to worse outcomes in cognitive behavioral interventions for youth depression (i.e., Brent et al., 1998; Weersing et al., 2016), while some studies have failed to find prediction or moderation effects (i.e., Curry et al., 2006; Kennard et al., 2008). For example, maternal depression moderated outcomes in a study of three psychosocial treatments for adolescents with depression (Brent et al., 1998). The three treatments included CBT, family therapy, and supportive therapy. While maternal depression did not universally predict worse outcomes across treatment condition, the presence of self-reported maternal depressive symptoms moderated acute outcomes. CBT was found to be more effective at treating adolescent depression than the other two interventions, but only in the absence of maternal depression. The efficacy of CBT significantly weakened in the presence of maternal depressive symptoms.

Similarly, maternal depression also moderated outcomes in the Prevention of Depression (POD) study (Beardslee et al., 2013; Brent et al., 2015; Garber et al., 2009; Weersing et al., 2016). The POD study was a multisite randomized controlled trial (RCT) that compared the efficacy of a group cognitive behavioral prevention (CBP) program with usual care (UC) in preventing the onset of depression in a targeted population. The adolescents recruited were the offspring of parents with current or prior depressive disorders, who themselves had current subsyndromal depressive symptoms, a prior depressive episode, or both. Through the nearly three-year follow-up, the CBP program had a significant prevention effect; adolescents in the CBP program had lower rates of depressive episodes and greater improvement in self-reported depressive symptoms than those in usual care. However, current parental depression at baseline moderated these effects. Among adolescents whose parents were not actively depressed, the CBP program was more effective in preventing onset of a depression diagnosis than UC. However, this difference dissipated among youth with a currently depressed parent. These moderating effects persisted at 33-month and 75-month follow-ups (Beardslee et al., 2013; Brent et al., 2015; Garber et al., 2009; Weersing et al., 2016). Of note, maternal depression did not moderate outcomes on adolescents' self-report of depressive symptoms as measured by the CES-D; amongst adolescents who had a currently depressed parent, adolescents in the CB prevention program showed significantly greater reductions in self-reported depressive symptoms than did those in usual care (Garber et al., 2009). The lack of moderation findings on self-reported depressive symptoms persisted through 75-month follow-up (Brent et al., 2015).

Contrary to the study by Brent and colleagues (1998) and the POD study, maternal depression did not predict or moderate outcomes in the Treatment for Adolescents with Depression (TADS) study. The TADS study was a multi-site RCT that compared four treatments for adolescents with MDD: CBT, fluoxetine, combination fluoxetine plus CBT, or placebo pill. During the first 12 weeks of treatment, combination treatment and fluoxetine were more effective than placebo, and combination treatment was found to be the most effective intervention (Curry et al., 2006). Moderator analyses found that age, symptom severity, and comorbidity moderated treatment outcome; younger and less severe adolescents responded better to treatment than older, more impaired, or multiply comorbid adolescents. However, self-reported maternal depression did not predict or moderate rate of improvement in adolescent depressive symptoms.

Covariation of Maternal and Youth Depression Outcomes

Given the documented impact of maternal depression on youth outcomes, studies have begun to examine whether maternal depressive symptoms improve during the course of youth treatment for depression. Specifically, studies have begun to investigate the concurrent trajectories of maternal and adolescent depression intervention outcomes. Across studies of evidence-based treatments including cognitive behavioral therapy (CBT), interpersonal psychotherapy (IPT), and pharmacotherapy, results generally show significant associations across mothers' and their children's treatment trajectories with few exceptions (i.e., see small pilot study by Verdeli and colleagues (2004)).

For example, in the Treatment of Resistant Depression in Adolescents (TORDIA) study, changes in maternal and adolescent depressive symptoms were significantly associated. TORDIA was a multisite RCT that compared treatments for youth with

moderately severe and chronic depression who had previously failed to respond to a pharmacologic trial with a selective serotonin reuptake inhibitor (SSRI). Participants were randomly assigned to receive medication alone or in combination with CBT. The study found that combination treatment was more effective at treating adolescent depression than medication alone (Perloe, Esposito-Smythers, Curby, & Renshaw, 2014). In the TORDIA study, about one third of mothers self-reported at least mild levels of depression. Contrary to the study hypothesis and some prior research, initial levels of maternal and adolescent depression were not correlated significantly. However, changes in maternal and adolescent depressive symptoms were correlated across time. This relationship was stronger amongst mother-adolescent pairs in which the mother reported at least a single depressive symptom. The findings suggested that as an adolescent's depression improved during treatment, his or her mother's depressive symptoms also improved. A limitation to the TORDIA study was that mothers had only mild symptomatology; therefore, it was unclear whether these effects would generalize to mothers with more severe depression.

One study with similar results to the TORDIA trial did include mothers with more severe symptoms. In this study, a sample of children with moderate to severe depression participated in a pediatric treatment study of fluoxetine (Kennard et al. 2008). While the mothers were not directly targeted for treatment, nearly thirty percent had moderate to severe levels of depression at baseline. Unlike the TORDIA study, initial levels of depression between mothers and children were associated; mothers with higher levels of depressive symptoms at baseline had children with higher levels of depressive symptom severity both at baseline and throughout treatment. The trial of fluoxetine was found to be

effective, and the children's depression severity significantly improved by the end of the acute treatment. By the end of their children's treatment, mothers reported significant improvement in their own depressive symptoms, and only 17% had moderate to severe levels of depression. Further, children whose mothers' depression improved had similar or higher remission rates as those with mothers who were never depressed. While associations were found across time, maternal depressive symptoms at baseline did not predict rates of improvement in their children. Rather, maternal depressive symptoms had a positioning effect on the child's level of depression; while the children of the more depressed mothers improved at the same rate as children with less depressed mothers, they ended treatment with higher levels of depressive symptoms than those children of less depressed mothers. These findings provide additional evidence that maternal and youth depression are related and outcome trajectories covary over time.

In another RCT targeting adolescent depression, the Adolescent Depression Antidepressant and Psychotherapy Trial (ADAPT), adolescents with MDD who had not responded to a brief intervention were randomized to treatment with an SSRI alone or in combination with CBT. The main outcomes of this longitudinal effectiveness study found that combination treatment was no more effective than medication alone. The degree of improvement in adolescent mental health outcomes was positively associated with parental mental health outcomes across time (Wilkinson, Harris, Kelvin, Dubicka, & Goodyer, 2013). However, the ADAPT trial was not able to establish the direction of this association due to the correlational nature of the study.

While the study by Kennard and colleagues (2008) as well as TORDIA and ADAPT investigated associations of maternal and youth depression in the context of

treatment for adolescents, other studies investigated this association in the context of treatment for mothers. Studies such as the Sequenced Treatment Alternatives to Relieve Depression (STAR*D), for example, provide additional support that maternal and youth depression outcomes covary across time. STAR*D was a multisite study that compared the effectiveness of various treatment options for adult outpatients with MDD (Weissman et al., 2006). The STAR*D study assessed the children of depressed women at baseline and through one-year follow-up to assess whether changes in children's depressive symptoms were related to changes in severity of maternal depression, and whether youth outcomes differed among women who remitted versus those who did not (Pilowsky et al., 2008). In the year following the beginning of treatment for maternal depression in STAR*D, remission among mothers was associated with a significant decrease in youth depressive diagnoses as well as reduction in internalizing and externalizing symptoms and an improvement in functioning. Fifty-seven percent of the 123 mothers in the sample experienced remission. Improvement in the offspring was only found amongst mothers who experienced a reduction of at least 50% of their depressive symptoms. In contrast, among children of non-remitting mothers, the number of youth-reported symptoms actually increased and did not significantly change through the follow-up.

While further research is needed, these studies suggest that adolescent and maternal depressive symptoms may change concurrently while adolescents or mothers participate in depression interventions, at least in the treatment literature. The findings from the TORDIA and ADAPT trials complement the findings from the STAR*D trial, and together suggest that treatment of either the adolescent or the parent may lead to a positive cycle; as either member of the mother-adolescent pair improves, the other does

as well, leading to further improvements in each member across time. To date, no depression prevention studies have examined whether maternal depressive symptoms improve as a function of their adolescents participating in a prevention program.

The Current Study

The research outlined above highlights the importance of studying the effects of maternal depression on youth intervention outcomes. With few exceptions (i.e., TADS study), maternal depression moderated depression intervention outcomes such that the benefits of evidence-based interventions over usual care dissipated amongst youth whose mothers were actively depressed. While level of maternal depression and adolescent depression were associated at baseline in some studies (i.e., Kennard et al., 2008), others failed to find such a correlation (i.e., TORDIA study). Finally, adolescent depression intervention outcomes typically showed associations with mothers' depression trajectories (i.e., Kennard et al., 2008; Weissman et al., 2006; Wilkinson et al., 2013). Understanding the breadth and specificity of these associations could lead to important advances in the prevention and treatment of adolescent depression. While maternal depression has been studied as a predictor and moderator of youth outcomes in prevention programs (i.e., POD study), no study has looked at the effects of maternal depression on adolescent outcomes in IPT-AST. Further, no study to date examined the associations between maternal and adolescent depression outcomes in the depression prevention literature. In order to fill these gaps in the literature, the current study examined the following questions:

Aim 1: Were initial levels of maternal depressive symptoms correlated with initial levels of adolescent depressive symptoms as measured by a self-report depression scale (CES-D)?

We hypothesized that there would be a significant correlation between level of maternal depressive symptoms and adolescent depressive symptoms at baseline.

Aim 2: Did maternal depressive symptoms at baseline, as measured by the CES-D, predict or moderate rates of change in adolescent depressive symptoms (CES-D) in two depression prevention programs (IPT-AST and GC) through 24-month follow up?

We hypothesized that maternal depression would emerge as a significant moderator, such that the efficacy of IPT-AST relative to GC would be weakened in the presence of maternal depression at baseline, both during active intervention and throughout follow-up.

Aim 3: Did maternal depressive symptoms (CES-D) change over the course of intervention, and did changes in maternal depressive symptoms covary with changes in adolescent depressive symptoms across time in IPT-AST and GC?

Based on the treatment literature, we hypothesized that maternal depressive symptoms would improve over the course of the intervention, particularly in mothers whose adolescents experienced substantial improvements in depressive symptoms. Additionally, we hypothesized that there would be an association between the outcome trajectories of adolescents and their mothers. We hypothesized that as adolescents improved over time, their mothers would also improve.

Method

Participants

The current study utilized data collected from the Depression Prevention Initiative (DPI), the largest study of IPT-AST to date (Young et al., 2016). One hundred eighty-six adolescents who were enrolled in the 7th to 10th grades and had elevated depressive symptoms were randomized to either IPT-AST (N = 95) or usual group counseling (GC) (N = 91). Mothers and fathers completed self-report measures. The current study examined data from 167 mother-adolescent pairs (GC=76, IPT-AST=91); in the remaining 19 families a father or other parent completed the parent-report measures and therefore were not included in the present analyses. Among these 167 adolescents, 67.7% were female, and the average age was 13.49 years (*SD=1.21).* Racial minorities represented one third of the adolescent sample, with 21.6% of participants identifying themselves as African-American, 4.8% as Asian-American, 0.6% American Indian, and 6.6% as other or mixed race. The rest of the sample comprised Hispanic individuals (37.7%), and White non-minority, non-Hispanic individuals (37.1%). When examining the sample of mothers included in the study, racial minorities also represented one third of the group; 19.8% of mothers identified themselves as African American, 4.8% as Asian-American, and 2.4% as other or mixed-race. The rest of the sample comprised Hispanic mothers (38.3%) and White non-minority, non-Hispanic individuals (41.9%).

Procedures

Youth who gave signed assent and whose parents gave signed consent participated in the study. Adolescents with elevated symptoms of depression were identified through a two-stage screening procedure. At the initial screening evaluation,

adolescents completed the Center for Epidemiologic Studies-Depression Scale (CES-D;

Radloff, 1977), a scale which measured depressive symptoms over the past week that is

described in greater detail below. Adolescents with a CES-D score of 16 or higher were

eligible to be approached for the prevention project. As the second stage of the eligibility

process, trained evaluators administered the Schedule for Affective Disorders and

Schizophrenia for School-Age Children (K-SADS-PL; Kaufman, Birmaher, Brent, &

Rao, 1997). Youth were eligible if they had at least two current threshold or subthreshold

depression symptoms on the K-SADS-PL, at least one of which was a criterion A

symptom (depressed mood, irritability, or anhedonia). Twenty-four youth did not endorse

at least two subthreshold or threshold symptoms and therefore were not eligible to

participate. Adolescents were also excluded from the study if they had a current diagnosis

of major depression or dysthymia ($N = 36$), bipolar disorder ($N = 0$), psychosis ($N=1$),

substance abuse ($N = 0$), or conduct disorder ($N = 3$). Youth were also excluded if they

endorsed significant suicidal ideation or non-suicidal self-injury (NSSI) *($N = 11$)*, or had

significant cognitive or language impairments ($N = 1$). Those excluded from the study for

a current mental health diagnosis were provided with community referrals (Young et al.,

2016).

At a baseline evaluation which occurred on average 7.37 (*SD* = 1.66) weeks after

the initial screening evaluation, adolescents completed the CES-D. Parents completed the

baseline CES-D at the time of consent. Adolescents and parents also completed

assessments at post-intervention, and at 6, 12, 18, and 24-months post-intervention. At

each assessment, adolescents met with a trained clinical evaluator to complete a

diagnostic interview and self-report forms. At these time points, parents completed the

CES-D and other measures over the phone. Evaluators were blind to random assignment. Adolescents were compensated $20 and parents were compensated $10 per assessment. This study analyzed data collected through the 24-month follow-up assessment.

Interventions

IPT-AST. IPT-AST is a manual based intervention (Young, Mufson, & Schueler, 2016) consisting of two individual pre-group sessions, eight group sessions, and an individual or dyadic (adolescent and parent) mid-group session. Four individual booster sessions were also conducted after conclusion of the group during the six-month follow-up period. In the pre-group sessions, the adolescent and group co-leader collaboratively identified the adolescent's interpersonal goals for the group. These goals either focused on particular relationships, such as communicating more effectively with a parent, or more general interpersonal goals, such as sharing one's feelings with others or making new friends. The group focused on psychoeducation and interpersonal skill-building. The psychoeducation portion of group defined the concept of prevention, educated about depression and its symptoms, and discussed the relationship between mood and interpersonal interactions. Next, adolescents learned communication strategies such as using "I statements," and practiced these strategies through group activities and role-plays in session. Group members were then asked to apply the skills learned to their relationships outside of group. There were 18 IPT-AST groups, ranging in size from 3-7 youth. All groups were conducted by co-leaders. In most groups, co-leaders consisted of a clinical psychologist and a graduate student in clinical psychology.

Group Counseling (GC). Group counseling was chosen as the comparison group because it reflected the type of groups run in schools. Although groups typically run in

these schools had shorter and less frequent sessions, counselors agreed to hold eight weekly group sessions equal in length to the IPT-AST groups in that school. Counselors also agreed to meet with adolescents for a pre-group session, a mid-group session in which they could invite their parents to join, and four booster sessions during the six-month follow-up period. No limits were given on the techniques to be used in GC groups in order to have GC reflect practices as normally delivered in schools. Some counselors ran manual-based, structured groups while others ran groups that were more flexible. There were 16 GC groups, ranging in size from 2-8 youth. The majority of groups were run by a single group leader.

Measures

Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977). The CES-D is a 20-item measure that assesses depressive symptoms over the past week. An example item from the CES-D is, *"I felt sad."* Participant responses range from 0 to 3, from *"Rarely or none of the time"* to *"Most or all of the time."* Scores range from 0-60, with higher scores indicating higher symptomatology. The CES-D has been shown to have high internal consistency, reliability, and validity in adolescent (Roberts, Andrew, Lewinsohn, & Hops, 1990) and adult (Weissman, Sholomskas, Pottenger, Prusoff, & Locke, 1977) samples. A score of 16 or above has been found to have both high sensitivity and high specificity for major depressive disorder in adults (Beekman et al., 1997) and has been considered the cutoff score indicating elevated depressive symptoms. While various cutoff scores have been identified for adolescents, we utilized the adult criterion as we had in prior studies in order to identify the greatest number of youth with elevated depressive symptoms (Young et al., 2016). The CES-D was administered to both

adolescents and their mothers at each assessment. Cronbach's alpha for the CES-D
administered to mothers across time ranged from 0.90-0.92. Cronbach's alpha for the
adolescent CES-D across administrations ranged from 0.85-0.91. The measure is
included in the Appendix.

Data analysis

The current study had three aims: (1) Assess whether initial levels of maternal
depressive symptoms were correlated with initial levels of adolescent depressive
symptoms; (2) Assess whether initial maternal depressive symptoms predicted or
moderated rates of change in adolescent depressive symptom outcomes in two depression
prevention programs (IPT-AST and GC) through active intervention and 24-month
follow up; (3) Assess whether maternal depressive symptoms (CES-D) changed over the
course of the intervention and how maternal outcomes correlated with simultaneous
change in adolescent depressive symptoms across time in the two interventions.

Aim 1. To achieve the first aim, we examined the relationship between maternal
and adolescent depressive symptoms pre-prevention. When investigating the adolescents'
main outcomes, we discovered that there was a large decline in adolescents' CES-D
scores from the screening to the baseline evaluation (which occurred on average 7.37 (*SD*
= 1.66) weeks later) before any intervention was delivered. These reductions suggested
that symptom improvement began for some adolescents after completing the consent
process and psychodiagnostic evaluations (Young et al., 2016). Therefore, we
investigated the correlation between maternal and adolescent initial levels of depression
in three ways: adolescents' screening CES-D and mothers' baseline CES-D, adolescents'
baseline CES-D and mothers' baseline CES-D, and adolescents' CES-D change scores

(difference between screening and baseline CES-D) with mothers' baseline CES-D.

These correlations allowed us to investigate whether youth whose mothers had higher

depressive symptom severity experienced less spontaneous improvement. We

investigated associations between depressive symptoms in mothers and their adolescents

across interventions (to investigate associations regardless of assigned intervention) and

between interventions.

With a sample size of 167, we had 71.9% power to detect a correlation of 0.20,

89.6% power to detect a correlation of 0.25, 97.5% power to detect a correlation of 0.30,

and 99.6% power to detect a correlation of 0.35. Standard effect size thresholds

considered correlation estimates of 0.10, 0.25, and 0.37 as small, medium, and large,

respectively (Cohen, 1988); therefore, we had over 80% power to detect a medium effect,

which would be considered a clinically meaningful correlation (Cicchetti, 1994, 2008).

Aim 2. To achieve the second aim, we built on prior analyses that investigated the

main outcomes of the interventions in the current RCT through the 6-month follow-up

(Young et al., 2016) and through the 24-month follow-up (Young et al., 2018, Under

Review) using hierarchical linear modeling (HLM). As had been done in previous

analyses (Young et al., 2018, Under Review), we utilized a piecewise model through the

24-month period which best fit the data and accounted for two phases of change: 1)

baseline through the booster session period corresponding to 6-month follow-up and 2) 6-

month follow-up through the remainder of the 24-month follow-up period. The 3-level

HLM accommodated for multiple levels of clustering in the data (i.e., repeated measures

per adolescent and multiple adolescents within each group in each intervention). Group

was treated as a random effect in the second level and school was held as a fixed effect in

all analyses. In the HLM model, the focus was on change over time, with differences between interventions corresponding to a time by intervention interaction that quantified if there was a difference in rate of change over time between the interventions. In this model, the moderation assessment was made by including the three-way interaction of maternal depression by time by intervention per phase of change (baseline through 6-month follow-up and 6-month follow-up through 24-month follow-up). The model included all lower order terms (i.e., main effects and two-way interactions) of the three-way interaction. The moderation effect was considered significant if the interaction term was significant (Kraemer et al., 2002) corresponding to a significance level below the set alpha level of $\alpha = 0.05$. We also investigated the significance of the lower order terms to assess for prediction effects. Prediction assessments were made by removing the three-way interaction from the model, only if it was not significant, and including the two-way interaction of maternal depressive symptoms by time per phase of change. As with the assessment of moderation, the proposed predictor was considered significant if the interaction of predictor by time was significant corresponding to a set alpha level of $\alpha = 0.05$ (Kraemer et al., 2002).

Cohen's (1988) power tables provide guidance on the estimation of power for the above analyses. Assuming that the moderator variables were measured without error, we needed a sample size of 55 to have 80% power to detect a medium effect with an alpha of 0.05. To detect a large effect, we needed a sample size of 26. While demographic variables such as age and gender are measured without error, the risk status variables had reliability indices closer to 0.90. Aiken and West (1991) argued that the sample size required to reach a power of 80% with an alpha value of 0.05 is slightly more than

doubled when reliabilities dropped from 1.0 to 0.80. According to these standards, our sample size of 167 was more than sufficient to detect a medium effect size for a moderator.

While HLM was flexible in handling missing data, pattern-mixture models were used to assess whether important estimates were dependent on missing data patterns (Hedeker & Gibbons, 1997). With the pattern-mixture approach, separate intervention effects were estimated for specified missing data patterns. A differential intervention effect attributable to the patterns would have indicated an informative missing data mechanism. Model-based estimates did not yield any evidence to suggest an informative missing data mechanism; therefore, missing data were treated as missing-at-random.

To investigate the presence of moderation effects, the first step was to rescale the maternal baseline CES-D scores as deviations from the overall mean using grand mean centering. Centering in HLM was used to provide stability to model estimation and to provide a meaningful zero point (Blanton & Jaccard, 2006; Enders & Tofighi, 2007). Because of the previously cited drop in scores between the screening and baseline evaluation in adolescents, the adolescent screening CES-D was included as a covariate in all analyses. HLM models required multivariate normality of the residuals. As such, a square root transformation was necessary for the CES-D, as per the analysis in the main outcomes paper (Young et al., 2016; Young et al., 2018, Under Review).

To quantify the prediction and moderation effects, we derived a correlation coefficient between baseline maternal depressive symptoms and change in adolescent depressive symptoms per phase of change (baseline through 6-month follow-up and 6-month follow-up through 24-month follow-up) estimated by multiplying the pooled slope

coefficient by the ratio of the estimated pooled standard deviation for mother's baseline depressive symptoms divided by the estimated pooled standard deviation for change in adolescent depressive symptoms. These analyses extended the simple linear regression formulation to the longitudinal data, a method discussed by Lipsitz and colleagues (2001).

Aim 3. In the third aim, we first examined total change in maternal depressive symptoms over the course of the intervention. We paralleled the prior analyses that investigated the main outcomes of the interventions in the current RCT piecewise in two phases of change using hierarchical linear modeling (HLM) (Young et al., 2018, Under Review), with the outcome being the maternal CES-D score. The first phase of change investigated outcomes during the active intervention (baseline through the completion of booster sessions at 6-month follow-up) and the second phase of change examined 6-month follow-up through 24-month follow-up. Maternal CES-D scores required a square-root transformation to normalize the residuals.

We then used multivariate multilevel modeling to explore the relationship between the simultaneous rates of change on the CES-D in adolescents and mothers, using square-root transformations for both adolescent and maternal CES-D scores. We paralleled the method used by Baldwin et al. (2014) for our analysis of simultaneous change. Because the data in our sample were longitudinal, the repeated observations within an individual were correlated. Additionally, because we had two simultaneous outcomes per time point (maternal depressive symptoms and adolescent depressive symptoms), the two measures were correlated. The random effects accommodated the individual change over time separately for the maternal depressive symptom scale and the

adolescent depressive symptom scale as well as for the correlation within each dyad (i.e., mother and adolescent pair at each time point) (Singer & Willet, 2003). Statistical assessment of the respective correlation coefficients was based on the produced variance-covariance matrix of the random effects, which yielded pairwise Wald Chi-square statistics for the significance of each term in the variance-covariance matrix. The Wald Chi-square statistics were considered significant below the set alpha level of $\alpha = 0.05$.

We assessed intervention differences and investigated effects across all subjects through the entire 24-month follow-up period using the piecewise model, where the first phase investigated the active intervention (baseline through the 6-month follow-up) followed by 6-month follow-up through 24-month follow-up. The models were fit using SAS 9.4.

Results

Aim 1

Table 1 displays mean scores for adolescent and maternal depressive symptom (CES-D) scores. We investigated the correlation between initial levels of maternal and adolescent depressive symptoms in three ways (maternal baseline CES-D and adolescent screening CES-D, maternal baseline CES-D and adolescent baseline CES-D, and maternal baseline CES-D and adolescent CES-D change scores), as displayed in Table 2. We first investigated these correlations in the overall sample, and subsequently investigated the correlations within each intervention. We failed to find a correlation between adolescents' screening CES-D and maternal baseline CES-D scores ($r = .02$, $p > .10$). Conversely, we found a significant positive correlation between maternal baseline CES-D and adolescent baseline CES-D scores ($r = .17$, $p < .05$), signifying a small to medium effect size. For maternal baseline CES-D and adolescent CES-D change scores, we assessed the relationship for the change in adolescent CES-D scores from the screening to the baseline evaluation. We found that the magnitude of the adolescent CES-D change score was inversely related to maternal baseline CES-D scores ($r = -.17$, $p < .05$); higher depression in mothers was associated with smaller change scores in adolescents. This effect was in the small to medium range. The strength of the correlations of maternal baseline CES-D scores with adolescent CES-D scores (at screening, baseline, and CES-D change scores) was not moderated by intervention ($p > .40$), which is reflective of the relatively similar correlations between the two interventions as illustrated in Table 2. Although the correlations did not differ significantly by intervention condition, the relationship between maternal baseline CES-

D scores and adolescent baseline CES-D and between maternal baseline CES-D scores and adolescent CES-D change scores were somewhat larger in the GC condition than the IPT-AST condition.

Aim 2

Effects of maternal CES-D scores on rates of change of adolescent depressive symptom outcomes through each phase are summarized in Table 3. Regarding moderation, baseline maternal depressive symptoms measured continuously on the CES-D did not moderate rates of change in adolescent depressive symptoms through either phase: baseline through 6-month follow-up or 6-month through 24-month follow-up. Additionally, baseline maternal depressive symptoms did not moderate rates of change when investigating the effects across the entire 24-month longitudinal model.

Regarding prediction, baseline maternal depressive symptoms measured continuously on the CES-D did not predict rates of change in adolescent depressive symptoms during the active phase of the intervention (baseline through 6-month follow-up). Baseline maternal depressive symptoms had a marginally significant prediction effect during the second phase of change (6-month through 24-month follow-up) ($p =$ .08). In order to interpret and graph this effect, we produced model-based estimates of the amount of reduction in the adolescent CES-D score at three levels of baseline maternal depressive symptoms (one standard deviation (*SD*) below the average, the average, and one *SD* above average). We refer to the levels of baseline maternal depressive symptoms as low, average, and high, respectively. The use of model-based estimates allowed us to graphically present the results, which guided our interpretation and understanding of the effect (Figure 1).

During the follow-up phase, adolescents whose mothers had low levels of baseline depressive symptoms had an estimated increase of 1.62 ($SE = 0.96$) points on the CES-D (corresponding to a worsening of symptoms during the follow-up phase). At the average level of baseline maternal depressive symptoms, adolescents experienced an estimate increase of 0.47 ($SE = 0.70$) points on the CES-D during follow-up (also corresponding to worsening of symptoms). For adolescents whose mothers had high levels of baseline maternal depressive symptoms, the adolescents experienced an estimated reduction on the CES-D of 0.68 ($SE = 0.95$) points during follow-up, corresponding to an improvement in symptoms. Therefore, the marginal prediction effect corresponds to higher levels of maternal baseline depressive symptoms predicting greater reductions in adolescents' depressive symptoms during follow-up. Across the entire 24-month study period, baseline maternal depressive symptoms did not significantly predict of rates of change in adolescent depressive symptoms.

In addition to the prediction/moderation effects, correlation coefficients were assessed to better understand the associations between maternal baseline CES-D scores and change in adolescent's CES-D scores at each phase of change. Correlation coefficients for these effects are found in Table 3. Positive correlation coefficients indicate that higher maternal baseline CES-D scores corresponded to less change in adolescent depressive symptoms during the respective phase. On the other hand, negative correlation coefficients indicate that higher baseline maternal CES-D scores corresponded to greater change in adolescent depressive symptoms during the respective phase. During the active phase of the intervention (baseline through 6-month follow-up), correlations both between and within intervention conditions were small and non-

significant. During the follow-up phase (6 to 24-month follow-up), we found that there was a significant negative correlation ($r = -0.17$, $p < .05$) between baseline maternal depressive symptoms and change in adolescent depressive symptoms for those in the IPT-AST condition. This indicated that for adolescents in IPT-AST, the higher mothers' baseline depressive symptoms, the greater the average reduction in adolescents' depressive symptoms during the follow-up phase. The correlation in the GC condition during follow-up was negligible and not significant ($r = -0.01$, $p > .05$). However, the difference in the correlation coefficients between IPT-AST and GC was small, leading to the non-significant moderation effect.

Post-Hoc Analyses for Aim 2

Prior studies (such as the POD study) investigated the effects of a depression diagnosis in mothers on intervention outcomes in their children. Since we did not collect data on maternal depression diagnoses, we were interested in investigating the effects of elevated maternal CES-D scores as a proxy for clinical levels of depression. As previously cited, a score of 16 or above on the CES-D has generally been accepted to indicate elevated levels of depression in adults (Beekman et al., 1997). As such, post-hoc analyses investigated whether there were differential rates of change in adolescent depressive symptom outcomes for those with elevated levels of maternal CES-D scores (CES-D $\geq$ 16 coded as YES; $N = 45$) compared to those with lower levels of maternal CES-D scores (CES-D < 16 coded as NO; $N = 117$). Regarding moderation, we found no significant moderation effect for elevated levels of maternal CES-D scores from baseline through 6-month follow-up ($F(1,143) = 0.18$, $p = .67$) or 6-month through 24-month follow-up ($F(1,143) = 1.07$, $p = .30$). Hence, the rate of change for adolescents whose

mothers had elevated CES-D scores over time was not differentially impacted by intervention assignment. Regarding prediction, we found no predictive effect from baseline through 6-month follow-up ($F(1,144) = 1.10$, $p = .30$). We found a marginal prediction effect for elevated levels of maternal CES-D scores from 6-month through 24-month follow-up ($F(1,144) = 2.81$, $p < .10$). Similar to our findings discussed above, there was an on-average estimated increase of 0.84 ($SE = 0.83$) points on the adolescent CES-D during the follow-up phase for those with low baseline maternal CES-D scores (below 16), corresponding to a worsening of symptoms. For those with high maternal CES-D scores (≥ 16), the estimated reduction was 1.71 ($SE = 1.37$) points. This finding is in line with our earlier finding that showed that higher levels of baseline maternal depressive symptoms predicted greater reductions in adolescents' depressive symptoms during follow-up. Table 4 displays estimated change (back-transformed) in CES-D scores for adolescents of mothers with elevated and non-elevated CES-D scores.

Aim 3

Our focus in Aim 3 was to determine whether maternal depressive symptoms changed over the course of the study period and whether there was a relationship between the simultaneous change in maternal and adolescent depressive symptoms.

Change in Maternal Depressive Symptoms

Using a piecewise model, we first examined change from baseline through 6-month follow-up and change from the 6-month follow-up through the rest of the longitudinal period (24-month follow-up). Across both interventions, there was a significant decrease in maternal depressive symptoms from baseline to 6-month follow-up ($t(150) = 2.70$, $p < .01$). Mothers of youth in GC reduced on-average 0.93 ($SE=1.03$)

points which was not significantly different from 0 ($t(150) = -1.47$, $p = .14$). Mothers of

youth in IPT-AST experienced a significant decrease in depressive symptoms from

baseline through 6-month follow-up ($t(150) = 2.62$, $p < .01$), reducing on-average 1.78

(SE=0.96) points on the CES-D. The difference in the amount of change between GC and

IPT-AST was 0.85 (*SE*=1.33) points, which was a non-significant difference ($t(150) =$

0.74, $p = .46$).

During the follow-up phase, there were continued significant reductions in

maternal depression scores across both interventions ($t(150) = 1.98$, $p < .05$). For GC we

found a non-significant reduction in CES-D scores over time (GC: $t(150) = 1.04$, $p = .30$),

corresponding to a reduction of 1.07 *(SE = 0.99)* points. In IPT-AST, there was a

significant reduction in maternal CES-D scores of 2.27 *(SE = 0.90)* points during the

follow-up phase ($t(150) = 2.02$, $p < .05$). The difference in the amount of change between

GC and IPT-AST was 1.20 (*SE* = 1.23) points corresponding to a non-significant

difference in rates of change during the follow-up period ($t(150) = 0.63$, $p = .53$).

Over the entire study period, mothers in both conditions experienced significant

reductions in CES-D scores (GC: $t(150) = 2.58$, $p = .01$; IPT-AST: $t(150) = 4.89$, $p <$

.01). Mothers of youth in GC had an on-average reduction of 2.00 *(SE = 0.99)* points

over the entire study period, whereas mothers of youth in IPT-AST experienced an on-

average reduction of 4.04 (*SE* = 0.89) points. The difference in total change for IPT-AST

compared to GC was 2.04 (*SE* = 1.23) points, which was not significant ($t(150) = 1.43$, p

= .15). Change in maternal depressive symptoms is summarized in Table 5 and the mean

profiles for both maternal and adolescent CES-D scores can be seen in Figure 2.

Relationship between Simultaneous Change in Maternal and Adolescent Depressive

Symptoms

Figure 3 illustrates the relationship between the average slopes over the entire

longitudinal period for both the maternal and adolescent depressive symptom scales for

each individual. As seen in Figure 3, there was considerable variability within each

intervention arm in the respective on-average relationship between maternal CES-D and

adolescent CES-D slopes. As was evident in the figure, within both intervention arms,

there appeared to be a small but positive relationship between rates of change in maternal

CES-D scores and rates of change in adolescent CES-D scores.

Using a piecewise multivariate HLM, we found a significant correlation ($r = 0.37$

($SE = 0.15$), $z = 2.52$, $p = .01$) between an adolescent's change in depressive symptoms

and the respective mother's change in depressive symptoms over time across the first

phase of change (baseline through 6-month follow-up). Additionally, we saw a

significant correlation ($r = 0.31$ *($SE = 0.12$)*, $z = 2.55$, $p = .01$), between an adolescent's

change in depressive symptoms with the respective mother's change in depressive

symptoms over the second phase of change (6-month through 24-month follow-up).

Correlations per intervention arm during the first phase of change were 0.44 *($SE = 0.21$, z

$= 2.11$, $p = .04$)* for GC and 0.29 ($SE = 0.21$, $z = 1.40$, $p = .16$) for IPT-AST which were

not statistically significantly different ($\chi^2(3) = 2.60$, $p = .46$). Correlations per intervention

arm during the second phase of change were 0.39 ($SE = 0.19$, $z = 2.02$, $p = .04$) for GC

and 0.26 ($SE = 0.14$, $z = 1.65$, $p < .10$) for IPT-AST which were not statistically

significantly different ($\chi^2(3) = 1.41$, $p = .70$).

Post-Hoc Analyses for Aim 3

The STAR*D study (Pilowsky et al., 2008) found that children of mothers who experienced $\geq$ 50% improvement in depressive symptoms at the 3-month follow-up assessment had greater reductions in their own depressive symptoms than children of mothers who experienced < 50% improvement. Based on these findings, we were interested to see whether mothers of adolescents who experienced depressive symptom reduction of $\geq$ 50% through the booster sessions (baseline through 6-month follow-up) experienced greater change in their own symptoms as compared to mothers of adolescents who did not experience meaningful clinical change during the course of the intervention. First, we investigated the difference in maternal depressive symptom change using linear contrasts between mothers of adolescents who did or did not experience meaningful change at at each phase of change across intervention conditions: during active intervention, follow-up, and across the entire 24-month period. We found no significant differences in the amount of change in maternal depressive symptoms during the active intervention (t(149)=0.48, p = 0.63), follow-up period ((t(149)=-0.34, p = 0.74), or across the entire longitudinal period ((t(149)=0.17, p = 0.86) for mothers of adolescents with $\geq$ 50% reduction in CES-D scores and mothers of adolescents with < 50% reduction in CES-D scores, when looking at all mothers regardless of intervention condition.

We further investigated the subgroups of mothers of adolescents who did or did not experience meaningful clinical change. Estimates of the amount of change within each group ($\geq$ 50% change and < 50% change) are shown in Table 6 both across and within intervention. As illustrated in Table 6, we found that, across intervention, mothers of adolescents with meaningful change on the CES-D experienced marginally significant

improvements during the active intervention and continued, but not significant, improvements during the follow-up phase. Across the entire 24-month period, these mothers experienced significant symptom reduction ($p < .01$), reducing on average 3.35 points on the CES-D over the entire study period. For mothers of adolescents who did not experience meaningful change, we found that these mothers did not experience significant improvements at the early or late phases of change, but experienced significant improvement across the entire 24-month period ($p < .01$), reducing on average 2.94 points over the entire study period.

We then examined whether clinically meaningful change moderated intervention outcomes, and whether there were differences in rates of change in these two groups of mothers by intervention condition. We did not find evidence of moderation during the active intervention ($t(148)=0.86$, $p = 0.36$), follow-up period ($t(148)=0.01$, $p = 0.91$, nor over the entire longitudinal period ($t(148)=0.92$, $p = 0.35$). For mothers of youth who experienced meaningful change on the CES-D, we found no significant intervention effects. For mothers of youth who did not experience meaningful change, we found no differences by intervention for the active intervention or follow-up phase, but found that across the entire longitudinal period, mothers of youth in IPT-AST who experienced <50% change experienced greater improvements than mothers of youth who experienced <50% change in GC ($p = .04$).

Discussion

The current study examined the relationship between maternal and adolescent depressive symptoms across two adolescent depression prevention programs (IPT-AST and GC) in three ways. The study first investigated whether baseline levels of maternal and adolescent depressive symptoms were related. Next, the study aimed to determine whether baseline maternal depressive symptoms moderated or predicted rates of change in adolescent depressive symptom outcomes, both through the active phase of the interventions (baseline through 6-month follow-up) and through 24-month follow-up. Lastly, the study examined whether maternal depressive symptoms improved over the course of the interventions and whether they changed concurrently with adolescent depressive symptoms through both the active intervention and follow-up period. The findings for each of these three aims are discussed below.

Relationship between Baseline Maternal and Adolescent Depressive Symptoms

Due to the nature of the screening process, we measured initial parental depressive symptoms once (at the consent visit, which occurred temporally between the adolescent's screening and baseline visit) and initial adolescent depressive symptoms twice (at both the screening and baseline visits). We found that baseline maternal depressive symptoms were not correlated with adolescent depressive symptoms at the screening assessment. Given that these assessments were made at different time points (on average, nearly two months apart), this finding is not surprising. Unfortunately, we were unable to collect maternal CES-D scores at the screening assessment, and cannot know whether screening scores for adolescents and their mothers would have been associated at this time point.

As hypothesized, we found a small but significant positive correlation between adolescent and maternal depressive symptoms at baseline, demonstrating that higher levels of depressive symptoms in adolescents were associated with higher levels of depressive symptoms in mothers. This finding is in line with much of the previous literature in intervention research which has found similar associations (i.e., Kennard et al., 2008; Wilkinson et al., 2013), with the exception of the TORDIA study in which such associations were not found (Perloe et al. 2014). The connection between depressive symptoms in mothers and their children has been well documented in non-intervention studies as well (i.e., Goodman et al., 2011). The current study provided further evidence for the link between adolescent and maternal depression, suggesting that children of mothers with higher levels of depressive symptoms were more likely to have higher levels of depressive symptoms themselves (and vice versa).

As discussed earlier, we found a large decline in adolescent CES-D scores from the screening to baseline evaluations before any intervention was delivered. While we are not sure the exact mechanism of this early decline in depressive symptom scores, other prevention studies have found similar effects (i.e., McCarty et al., 2013; Wijnhoven, Creemers, Vermulst, Scholte, & Engels, 2014). We hypothesize that the consent process and diagnostic evaluations were therapeutic interventions (Young et al., 2016), as they provided psychoeducation, normalized adolescents' symptoms, and provided support from a trained clinical evaluator, which might have led to symptom reduction. As a part of this first aim, we chose to investigate how this change may have been related to initial maternal depressive symptoms. We found that the magnitude of the early change in adolescent CES-D scores from the screening to baseline evaluation was inversely related

to initial maternal CES-D scores (see correlations in Table 2). This indicates that adolescents whose mothers had higher levels of depressive symptoms had smaller improvements in CES-D scores following the consent and eligibility evaluation process, suggesting less spontaneous improvement. These findings suggest that adolescents whose mothers had higher levels of depression may have depressive symptoms that are more entrenched and less easily changed than adolescents of mothers with lower levels of depression, and may have a greater need for prevention interventions.

The Impact of Baseline Maternal Depressive Symptoms on Adolescent Depressive Symptom Change

Examining Moderation: Contrary to our hypothesis, baseline maternal depressive symptoms did not moderate rates of change in adolescent depressive symptoms outcomes through either phase of change (baseline through 6-month follow-up or 6-month follow-up through 24-month follow-up), or through the entire study period (baseline through 24-month follow-up).

During the first phase of change, the lack of moderation findings is noteworthy. As discussed earlier, we found that youth in IPT-AST experienced significantly greater rates of improvement in depressive symptoms than those in GC through 6-month follow-up (Young et al., 2016). The finding that maternal depressive symptoms did not moderate rates of change in depressive symptoms through 6-month follow up indicates that the greater rates of improvement in IPT-AST were not weakened in the presence of maternal depressive symptoms measured continuously or dichotomously (CES-D scores $\geq$ 16). Of note, the lack of moderation findings during the second phase of change (6-month through 24-month follow-up), similarly indicate that the greater reductions in CES-D

scores for adolescents in GC were not weakened in the presence of maternal depressive symptoms measured continuously or dichotomously. These finding are contrary to our hypothesis that the greater effects of IPT-AST would be lessened in the presence of maternal depressive symptoms. This hypothesis was based on findings in the literature that maternal depression has emerged as a moderator of outcomes in both the treatment and prevention literature.

Most relevant to the current study, in the Prevention of Depression (POD) study (Beardslee et al., 2013; Brent et al., 2015; Garber et al., 2009; Weersing et al., 2016), the presence of a maternal depression diagnosis moderated outcomes such that the effects of a cognitive behavioral prevention program on incident depression in adolescents were lessened in the presence of a currently depressed parent. When a parent was not currently depressed, youth in the CB program had fewer depressive diagnoses than those in usual care; this difference dissipated when a parent was actively depressed at baseline. However, in line with our findings, the POD study found that maternal depression diagnosis did not moderate self-reported adolescent depressive symptom outcomes as measured by the CES-D, and youth in the CB program experienced greater reductions in CES-D scores than did those in the usual care condition. Thus, moderation effects may be specific to adolescent depression diagnoses and not evident when examining rates of change in depressive symptoms.

The POD study was different from the current study in a number of ways. First, it assessed parental depression using a structured clinical interview (SCID-I; First, Spitzer, Gibbon, & Williams, 2002) to evaluate depression diagnoses, whereas the current study only looked at depressive symptoms. Second, the POD study was both a selective and

indicated prevention program and included youth who had at least one parent who had experienced a depressive episode during the past three years or had three or more depressive episodes during the child's life, as well as identified youth with elevated symptoms of depression. As such, the parents of youth in the POD study may have had higher levels of depressive symptoms than those in our study, as we did not specifically select for parents with depression. Because we did not formally assess for maternal depression diagnosis, we investigated in post-hoc analyses whether elevated maternal CES-D scores ($\geq$16) moderated adolescent outcomes as a proxy for depression diagnosis. Similar to the continuous analyses, elevated maternal depressive symptoms did not moderate outcomes. Finally, the POD study compared the cognitive-behavioral prevention intervention to usual care which often meant no services. In the current study, GC was an active control condition. Thus, it is possible that there would have been evidence of moderation if we had looked at adolescent diagnoses as an outcome rather than CES-D scores, examined maternal depression diagnostically, and/or if IPT-AST had been compared to a less active control condition. However, the current findings, as well as those from the POD study, suggest that initial levels of maternal depression do not moderate rates of change in depressive symptoms, and that the effects of these preventive interventions on depression symptom outcomes are robust to maternal depression.

Examining Prediction: Since we failed to find moderation effects, we further investigated whether initial maternal depressive symptoms predicted adolescent outcomes through both phases of change. We found that initial maternal depressive symptoms did not predict rates of change for adolescent depressive symptoms during the first phase of change (baseline through 6-month follow-up) when measured continuously or

dichotomously in post-hoc analyses. The lack of prediction findings through the 6-month follow-up suggests that the effects of both IPT-AST and GC were robust to the presence of maternal depressive symptoms, even when they were elevated.

Baseline maternal depressive symptoms emerged as a marginally significant predictor of rates of change during the follow-up phase of change (6-month through 24-month follow-up). During the follow-up phase, higher initial maternal depressive symptom scores measured continuously predicted greater rates of change in adolescent depressive symptoms. In order to better understand this effect, we produced model-based estimates of the amount of change on the adolescent CES-D score (Figure 1). At low levels of baseline maternal depressive symptoms, adolescents experienced a slight worsening of symptoms during follow-up, while those whose mothers had average or high levels of baseline maternal depressive symptoms experienced an improvement in follow-up. The improvement was greatest for adolescents of mothers with higher baseline symptoms. Similarly, post-hoc analyses found that elevated levels of maternal depressive symptoms assessed dichotomously (i.e., CES-D $\geq$16 or CES-D $<$ 16) had a marginal prediction effect in the same direction; adolescents whose mothers had high levels of baseline depressive symptoms experienced reductions in CES-D scores during the follow-up, while those with mothers who had low levels of baseline maternal depressive symptoms experienced an increase in symptoms.

This finding is different from what we might have expected based on the previous intervention literature, in which greater maternal depressive symptoms was typically associated with worse outcomes for youth (i.e., Kennard et al., 2008). There are a few possible explanations for this unexpected finding. The first is that that this is a prevention

study which included longitudinal follow-up, whereas the Kennard study was a treatment study which only looked at short-term outcomes. The marginal prediction effect in this study is during the follow-up phase; unlike the Kennard study, there was no evidence of a prediction effect in the short-term. Another possible explanation is that, as found in Aim 1, baseline maternal and adolescent depressive symptoms had a small but significant positive correlation. As such, adolescents whose mothers had higher levels of depressive symptoms had higher depressive symptoms themselves. Therefore, these adolescents may have had more room to improve and therefore experienced greater reductions than adolescents of mothers with lower levels of depressive symptoms during the follow-up period. Relatedly, adolescents with mothers with higher initial depression scores also experienced less spontaneous improvement in their own CES-D scores from screening to baseline, resulting in higher baseline scores and more subsequent room for improvement. As can be seen in Figure 1, we found that during the active intervention, adolescents experienced greater improvement at lower levels of baseline maternal depressive symptom severity (i.e., adolescents of mothers with low baseline depressive symptoms experienced more change than adolescents with high baseline depressive symptoms). It is important to note that this effect was not significant, as we did not find a prediction effect during the active intervention; however, this provides some evidence that adolescents whose mothers had higher levels of baseline depressive symptoms had more room to improve during the follow-up.

When further investigating this effect, we found a significant negative correlation between baseline maternal CES-D scores and rates of change of adolescent CES-D scores in IPT-AST during the follow-up phase (Table 3), indicating that higher baseline

maternal CES-D scores were associated with greater rates of improvement in adolescents during follow-up. While the correlation was significant only for IPT-AST and not for GC, we did not find a moderation effect as the difference in rates of change between the two interventions was small. As can be seen in Table 4, adolescents in IPT-AST whose mothers had high initial depressive symptoms experienced a small reduction in symptoms during the follow-up phase, while those whose mothers had low depressive symptoms experienced an increase in symptoms. As discussed above, it is possible that those adolescents whose mothers had higher levels of depressive symptoms had more room for symptom improvement during the follow-up phase.

Taken together, our findings suggest that both IPT-AST and GC were beneficial for youth regardless of maternal depression status. Both IPT-AST and GC appeared to be powerful interventions that withstood the presence of maternal depressive symptoms, even when these symptoms were elevated. Future studies would benefit from including maternal depression diagnoses to determine whether this lack of moderation effects persists even in the face of more significant maternal depression. In addition, it would be important to examine whether maternal depression moderates other outcomes, such as rates of adolescent depression onset during the follow-up period. Finally, this study would have benefitted from a no-intervention control group to better understand the differential impact of the interventions across time. Future studies should include a no-intervention control group, as well as an active control comparison, to better assess intervention effects and moderation of these effects.

Relationship between Change in Maternal and Adolescent Depressive Symptoms

We found that maternal depressive symptoms decreased significantly over the course of the 24-month longitudinal period (Table 5). Through both phases of change and looking across the entire 24-month period, we found significant reductions in maternal depressive symptoms across time. We further investigated the changes in maternal depressive symptoms by intervention, and found that during both the active intervention phase and the follow-up, mothers of youth in IPT-AST experienced significant reductions in depressive symptoms, while mothers of youth in GC experienced non-significant reductions in depressive symptoms. Across both phases of change, the difference between the two interventions was not significant. When investigating the entire 24-month longitudinal period, we found that while the magnitude of change was greater for IPT-AST than GC, the difference between the two interventions was not significant.

The finding that mothers in IPT-AST experienced significant reductions in depressive symptoms across both phases of change is notable. As discussed earlier, in the larger RCT we found that while adolescents in IPT-AST experienced significant improvements in depressive symptoms through 6-month follow-up, the benefits dissipated across 24-month follow-up. As can be seen in Figure 2, in the current study, it appears that mothers in IPT-AST continue to experience improvements over time in depressive symptoms even during the follow-up period.

As a post-hoc analysis, we were interested in comparing symptom reduction in mothers of adolescents who did and did not experience clinically meaningful change in depressive symptoms ($\geq 50\%$) through the booster sessions. This question was based on the findings from the STAR*D study, in which improvement in children was only found

amongst mothers who experienced a reduction of at least 50% of their depressive symptoms.

Contrary to the findings in the STAR*D study, we failed to find significant differences in maternal depressive symptom improvement between mothers of adolescents who did or did not experience clinically meaningful change ($\geq 50\%$) through the active intervention, follow-up, or the entire longitudinal period. Despite the lack of significant differences in rates of change between these two groups, there was some indication that mothers of adolescents who experienced clinically meaningful change during the active intervention experienced marginally significant reductions in symptoms during this time; mothers of adolescents with less change during the intervention had non-significant improvements in their own CES-D scores during this phase. Thus, the direction of effects in the current study are similar to what was found in STAR*D, though the differences were not significant. Across the entire study period, we found that mothers in both groups experienced significant reductions in their own depressive symptoms. Therefore, it appears that across our study, mothers experienced improvements in depressive symptoms regardless of the magnitude of improvement in their children, and that this was particularly true across the entire follow-up period. It is important to note that the current study differs from the STAR*D study in numerous ways including who was the focus of the intervention (mothers vs. adolescents), a focus on treatment versus prevention, and differences in the length of the follow-up. All of these differences may contribute to these disparate findings.

We further investigated whether there were differences in rates of change by intervention for mothers of youth who either did or did not experience clinically

meaningful change. Amongst mothers of youth who experienced clinically meaningful change, we found that mothers experienced improvements in their own depressive symptoms and there were no differences by intervention. Amongst mothers of youth who did not experience this meaningful change, we found a significant intervention effect: while mothers of youth in both interventions improved, mothers of youth in IPT-AST had greater reductions in depressive symptoms than mothers of youth in GC across the 24-month longitudinal period. Therefore, for mothers of youth in IPT-AST, even if their children did not experience clinically meaningful change in depressive symptoms, mothers demonstrated significant improvements across the study period. It is possible that some other mechanism contributed to these greater effects in these mothers. For instance, it is possible that the communication skills learned in IPT-AST helped to benefit the adolescent-mother relationship, which in turn may have led to improvements in maternal depressive symptoms. However, this is speculation and given that clinically meaningful change did not moderate intervention effects, we must interpret this finding with caution.

Our finding that maternal depressive symptoms improved across time adds to the body of literature which has found that when one part of the mother-child dyad participates in an intervention, the other experiences improvements in symptoms (i.e., Kennard et al., 2008; Pilowsky et al., 2008). While we had hypothesized that we would see a decrease in maternal symptoms, our findings were still striking, as maternal depression was not specifically targeted in our study and we saw sizable change in mothers' depressive symptoms across interventions. Notably, these improvements

persisted across a two year follow-up period, even when adolescents were not experiencing consistent reductions.

Regarding concurrent change trajectories, we found a significant medium-sized correlation between rates of change in adolescent and maternal depressive symptoms during both the first and second phases of change. There were no differences across the two interventions in these associations at either phase of change. This finding adds to a growing body of literature demonstrating that youth depression outcomes were associated with mothers' depression outcomes (i.e., Kennard et al., 2008; Perloe et al., 2014; Wilkinson et al., 2013). In these studies, as adolescents improved across time, parents also experienced improvement in depressive symptoms. However, these previously cited studies were treatment studies. This study is the first to our knowledge to show this association in depression prevention programs. Our findings, in conjunction with the previous studies cited, suggest that intervening with one part of a depressed (or sub-clinically depressed) mother-child dyad might lead to improvements in the other. As such, preventive interventions for youth may have a "trickle-up" effect, and have benefits for their parents as well.

Limitations

The current study has several limitations. First, maternal and adolescent depressive symptoms were measured in our study using only self-report data (CES-D). While the larger RCT conducted structured clinical interviews on youth, we only have self-report data for mothers. While the CES-D had been shown to have high reliability in assessing depressive symptoms, self-report data might not reflect the most objective or accurate picture of an individual's mental health. Future studies investigating the

moderating effects of maternal depression in IPT-AST would benefit from the inclusion of a structured clinical interview to assess maternal depression diagnoses in addition to maternal depressive symptoms. Additionally, the current study did not assess the effects of maternal depression on adolescent incident depression outcomes across the two interventions.

While our study provides further evidence for the association between maternal and youth depression outcomes, we do not have evidence to demonstrate that improvement in youth depressive symptoms led to symptom reduction in their mothers. The lack of demonstrated causality has been a limitation in most of the research on mother-youth depression (i.e., Perloe et al., 2014; Weissman et al., 2006), as the myriad of possible confounding variables makes testing of causality extraordinarily difficult. For instance, in our study, it is possible that improvements in mothers' symptoms had an effect on their children's symptoms (reverse causation). Several studies in the literature, including the STAR*D trial (Pilowsky et al., 2008) have attempted to understand the directionality of the effects but have had inconclusive results. Therefore, future studies should attempt to address this challenge and design methodologically rigorous studies to investigate causality.

Additionally, as noted before, GC was found to be a powerful control group. Our study did not include a no-intervention control group or wait-list condition. As such, we were not able to determine how maternal depressive symptoms would have changed across time if their children had not been enrolled in a depression prevention program. Without this type of comparison condition, it is unclear whether the changes in maternal depression symptoms are attributable to the prevention programs or simply reflect

regression to the mean. Future studies would benefit from including a no-intervention control group to compare reductions in maternal depressive symptoms across time with active interventions such as IPT-AST. Additionally, we did not collect data on treatment utilization in mothers. As such, we do not know how much of the improvement in maternal depressive symptoms was related to mothers seeking their own treatment rather than improvements in their children's depression.

Summary and Conclusions

Despite these limitations, the findings from the current study contribute to the growing body of literature investigating the impact of maternal depressive symptoms on adolescent depressive symptom outcomes. Our study found that maternal and adolescent depressive symptoms were related, and that mothers with higher depressive symptoms had children with higher symptoms. Contrary to much of the previous literature, our study failed to find significant moderation or prediction effects, indicating that the effects of our interventions (IPT-AST and GC) were robust to the presence of even elevated maternal depressive symptoms. We found that maternal depressive symptoms improved over the course of the prevention interventions, even though maternal depression was not directly targeted by these programs. Lastly, our results indicated that mothers improved in tandem with their youth who participated in these depression prevention programs. These findings add further evidence to the literature that shows that as one part of the mother-child dyad improves, the other improves as well. Taken together, these findings add to the current understanding of the relationship between maternal and adolescent depressive symptom outcomes, and have important implications for the prevention and treatment of depression.

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Table 1
Descriptive Statistics for CES-D Scores

Adolescent CES-D Scores					
Timepoint	**N**	**Minimum**	**Maximum**	**Mean**	**Standard Deviation**
Screening	167	16	44	23.91	6.68
Baseline	167	0	40	15.19	8.54
6-month	155	0	37	10.54	7.71
12-month	155	0	43	10.86	9.21
18-month	142	0	47	10.54	9.42
24-month	144	0	41	10.12	9.34
Change Screening to Baseline	167	-42	17	8.72	9.24
Maternal CES-D Scores					
Timepoint	**N**	**Minimum**	**Maximum**	**Mean**	**Standard Deviation**
Baseline	162	0	48	11.34	10.08
6-month	142	0	44	9.87	10.28
12-month	141	0	44	8.78	9.97
18-month	127	0	56	8.61	9.90
24-month	132	0	45	7.27	8.73

Table 2

Pearson Correlation for Initial Levels of Depressive Symptoms

	Overall Sample N = 162	GC N = 73	IPT-AST N = 89
Adolescent Screening CES-D and Maternal Baseline CES-D	.02	-.02	.09
Adolescent Baseline CES-D and Maternal Baseline CES-D	.17*	.21#	.12
Adolescent CES-D change score and Maternal Baseline CES-D	-.17*	-.22#	-.10

*Significant at $p < .05$, #trend at $p < .10$

Table 3

Effects of Maternal CES-D on Adolescent Depressive Symptom Outcomes

Timepoint	Prediction Effect			Moderation Effect			
	F	*P*	Estimated Correlation	*F*	*P*	Estimated Correlation (GC)	Estimated Correlation (IPT-AST)
Baseline – 6-month	1.12	.29	0.09	0.15	.70	0.02	0.09
6 – 24 month	3.06	.08	-0.14	2.16	.14	-0.01	-0.17*
Baseline – 24-month	0.34	.56	-0.05	0.78	.38	0.01	-0.07

Note: Degrees of freedom for the *F*-statistic are ndf=1, ddf=144 for prediction effects and ndf=1, ddf=143 for moderation effects. Significance for correlation coefficients are denoted as: # $p < .10$, * $p < .05$, ** $p < .01$.

Table 4

Estimated Reduction of Adolescent CES-D Scores for the Overall Sample and for
Adolescents of Mothers with Elevated and Non-Elevated CES-D Scores

	Amount of Change Estimates		*p* value	Cohen's d (95% CI)
	GC (SE)	IPT-AST (SE)		
Overall Sample				
Short-Term Change (Baseline – 6 month)	-2.92 (1.01)	-5.76 (0.99)	.02	.37 (0.06 - 0.68)
Follow-up Change (6 month – 24 month)	-1.65 (0.91)	+2.19 (0.98)	.01	.39 (0.08 - 0.70)
Overall Change (Baseline – 24 month)	-4.57 (1.24)	-3.58 (1.17)	.85	.03 (-0.28 - +0.34)
Maternal CES-D ≥ 16 (*N* = 45)				
Short-Term Change (Baseline – 6 month)	-1.73 (2.26)	-3.87 (1.58)	.31	.31 (-0.20 - +0.81)
Follow-up Change (6 month – 24 month)	-0.81 (1.98)	-0.27 (1.44)	.70	.12 (-0.39 - +0.62)
Overall Change (Baseline – 24 month)	-2.54 (3.16)	-4.14 (2.23)	.69	.12 (-0.39 - +0.62)
Maternal CES-D < 16 (*N* = 117)				
Short-Term Change (Baseline – 6 month)	-4.31 (1.30)	-6.78 (1.24)	.11	.30 (-0.06 - 0.66)
Follow-up Change (6 month – 24 month)	-1.81 (1.21)	+3.05 (1.13)	<.01	.59 (0.22 - 0.95)
Overall Change (Baseline – 24 month)	-6.12 (1.50)	-3.73 (1.41)	.22	.23 (-0.13 - 0.59)

Table 5

Estimated Reduction of Maternal CES-D Scores Across Time

Intervention	Estimate	Std Error	T-value	*P*
Baseline Through 6 Month Follow-up				
GC	0.93	1.03	1.47	0.14
IPT-AST	1.78	0.96	2.62	0.01
CONTRAST GC vs IPT-AST	0.85	1.33	0.74	0.46
Overall Sample (GC + IPT-AST)	1.35	0.75	2.70	0.01
6 Month Through 24 Month Follow-up				
GC	1.07	0.99	1.04	0.30
IPT-AST	2.27	0.90	2.02	0.04
CONTRAST GC vs IPT-AST	1.20	1.23	0.63	0.53
Overall Sample (GC + IPT-AST)	1.67	0.72	1.98	< 0.05
Total Change Baseline Through 24 Month Follow-up				
GC	2.00	0.99	2.58	0.01
IPT-AST	4.04	0.89	4.89	< 0.01
CONTRAST GC vs IPT-AST	2.04	1.23	1.43	0.15
Overall Sample (GC + IPT-AST)	3.02	0.71	4.85	< 0.01

Table 6

Estimated Reduction of Maternal CES-D Scores at Varying Levels of Adolescent Symptom Improvement

Maternal CES-D: Adolescents with ≥ 50% Change					
	Amount of Change			Statistical Significance		
	GC + IPT-AST	GC	IPT-AST	GC + IPT-AST	Intervention Difference	Cohen's D (95% CI)
Baseline – 6 month	-2.28 (1.30)	-2.61 (1.97)	-1.94 (1.54)	.08	.78	.09 (-0.52- +0.69)
6 – 24 month	-1.08 (1.30)	-0.33 (2.00)	-1.83 (1.49)	.41	.53	.19 (-0.42- +0.79)
Baseline – 24 month	-3.35 (1.15)	-2.94 (1.77)	-3.76 (1.32)	< .01	.70	.12 (-0.49- +0.72)
Maternal CES-D: Adolescents with < 50% Change					
	Amount of Change			Statistical Significance		
	GC + IPT-AST	GC	IPT-AST	GC + IPT-AST	Intervention Difference	Cohen's D (95% CI)
Baseline – 6 month	-1.36 (0.96)	-0.29 (1.31)	-2.43 (1.34)	.16	.24	.25 (-0.16-+0.66)
6 – 24 month	-1.58 (0.97)	-1.00 (1.29)	-2.17 (1.35)	.10	.52	.14 (-0.27-+0.55)
Baseline – 24 month	-2.94 (0.87)	-1.29 (1.18)	-4.59 (1.20)	< .01	.04	.44 (+0.02-+0.85)

Note: In GC, 23/76 (30.3%) of adolescents experienced ≥ 50% change; in IPT-AST, 36/91 (39.6%) experienced ≥ 50% change. Cohen's D refers to between intervention effects.

Figure 1. Estimated reduction of adolescent CES-D scores during the active and follow-up phases at different levels of baseline maternal depressive symptoms.
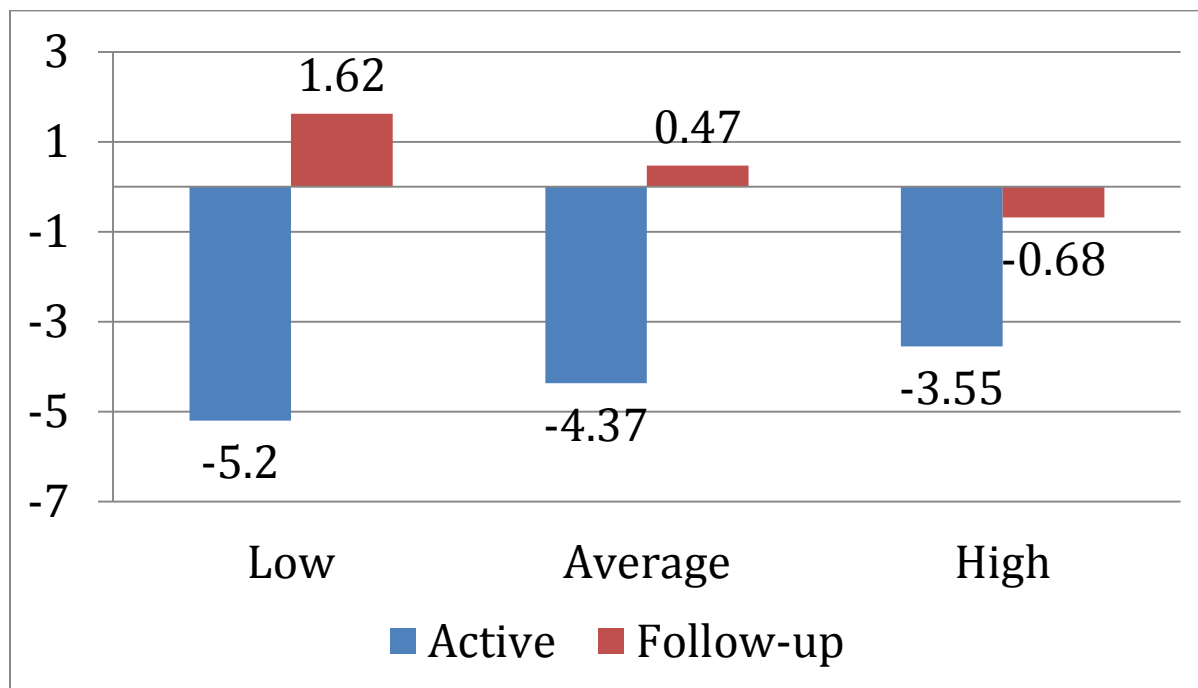
Figure 2. Mean profiles for maternal and adolescent CES-D scores over time.
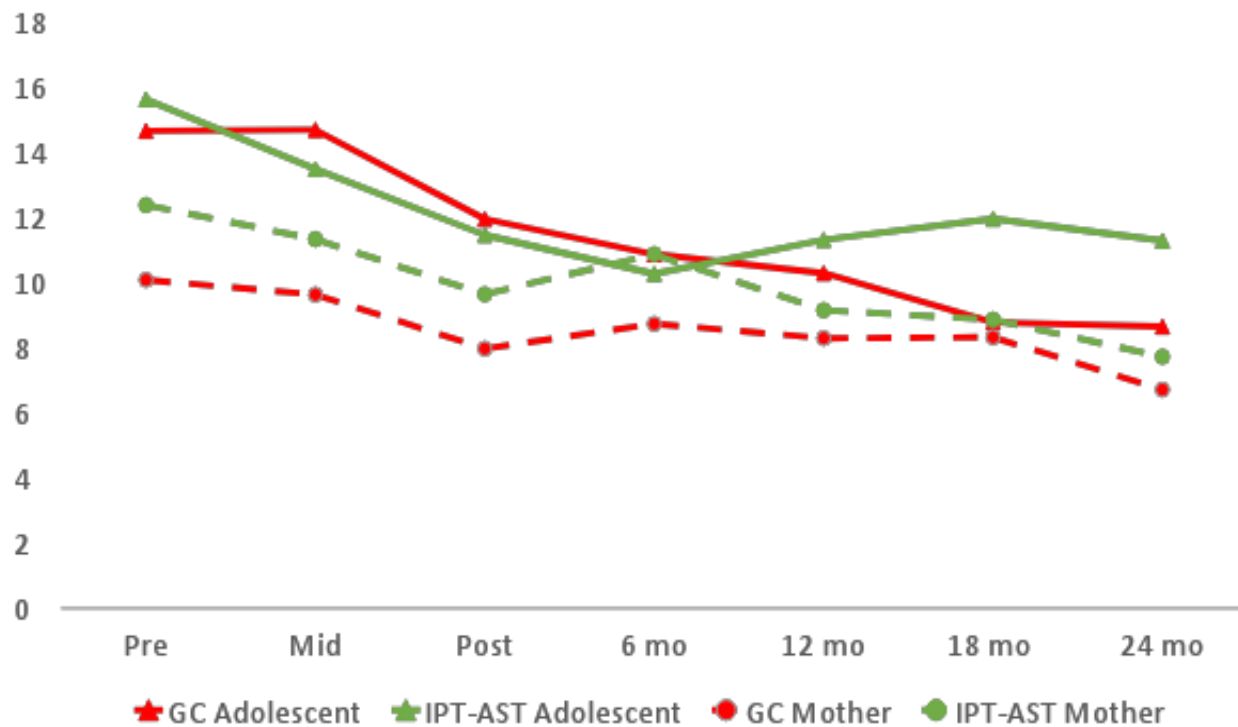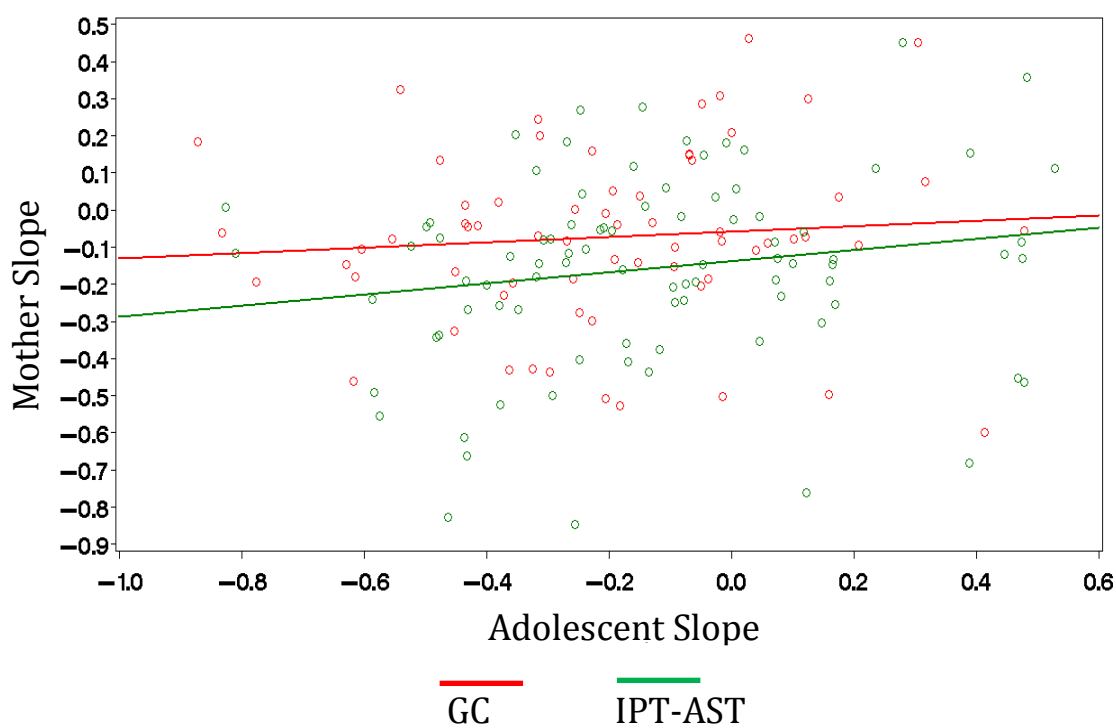
Figure 3. Relationship between average slopes for maternal and adolescent CES-D scores over 24-month longitudinal period.

List of Appendices

Appendix A. Center for Epidemiologic Studies Depression Scale (CES-D).
CES-D
<u>**Instructions**</u>
For the following 20 items, please place an **X** in the box that best describes how you have felt over the past week:

	Rarely or none of the time (less than 1 day)	Some or a little of the time (1-2 days)	Occasionally or a moderate amount of time (3-4 days)	Most or all of the time (5-7 days)
1. I was bothered by things that usually don't bother me.	0	1	2	3
2. I did not feel like eating; my appetite was poor.	0	1	2	3
3. I felt that I could not shake off the blues even with help from my family or friends.	0	1	2	3
4. I felt that I was just as good as other people.	3	2	1	0
5. I had trouble keeping my mind on what I was doing.	0	1	2	3
6. I felt depressed.	0	1	2	3
7. I felt that everything I did was an effort.	0	1	2	3

8. I felt hopeful about the future.	3	2	1	0
9. I thought my life had been a failure.	0	1	2	3
10. I felt fearful.	0	1	2	3
11. My sleep was restless.	0	1	2	3
12. I was happy.	3	2	1	0
13. I talked less than usual.	0	1	2	3
14. I felt lonely.	0	1	2	3
15. People were unfriendly.	0	1	2	3
16. I enjoyed life.	3	2	1	0
17. I had crying spells.	0	1	2	3
18. I felt sad.	0	1	2	3
19. I felt that people dislike me.	0	1	2	3
20. I could not get "going".	0	1	2	3