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Four-Year Follow-Up of High versus Low Intensity Summer Treatment for Adolescents with ADHD

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ABSTRACT

Objective: Despite an emergence of psychosocial treatments for adolescent ADHD, their long-term effects are unknown.

Method: We examine four-year outcomes of a randomized controlled trial (N = 218) comparing high-intensity (HI; 412 h, $4,373 per participant) versus low-intensity (LI; 24 h, $97 per participant) skills-based summer intervention delivered to adolescents with ADHD at two secondary school transitions (6th/9th grade). Quantitative and qualitative analyses evaluated group×time and group×grade×time effects on 4-year outcomes.

Results: Relative to LI, a single dose of HI had modest but lasting effects on teen organization skills (d =.40) and ADHD symptoms (9th grade only: d =.27 to.31) at 4-year follow-up. There was no long-term incremental effect of HI (vs. LI) for parent-teen conflict, GPA, or parent use of contingency management. Treatment appeared most effective when delivered to older adolescents (i.e., 9th versus 6th grade), suggesting the long-term impact of ADHD treatment may increase with age. Qualitative data corroborated that the primary long-term benefit of HI (vs. LI) treatment was to organization skills; many of the remaining perceived benefits were to parent and teen psychological variables (i.e., increased self-esteem, self-awareness, parental optimism). HI offered no incremental benefit to long-term educational or clinical service utilization or costs.

Conclusions: Modest therapeutic benefits of adolescent ADHD treatment are maintained long term. However, HI treatment did not impact outcomes that could defray the intervention's high costs ($4,373) compared to LI treatment ($97).

Persistence of childhood ADHD is associated with negative adult outcomes including legal problems, financial dependence, substance abuse, mental health problems, and lower education level (Altszuler et al., 2016; Barkley et al., 2008; Kuriyan et al., 2013). Furthermore, ADHD imparts profound societal costs with a cumulative annual cost of illness of 42.5 USD billion in the U.S. and 13.4 USD billion to the U.S. Education system (Pelham et al., 2007; Robb et al., 2011). Despite these concerning outcomes, treatments for ADHD delivered in childhood do not demonstrate long-term effects (Multimodal Treatment of ADHD Study; Molina et al., 2009; MTA Cooperative Group, 1999; Swanson et al., 2017). Thus, continuation of treatment into adolescence and adulthood is critical.

Although there are no long-term effects of childhood ADHD treatments (Swanson et al., 2017), it is possible that maintenance is stronger for adolescent treatments. For one, adolescent functioning is a stronger predictor of adult ADHD outcomes than childhood functioning (Barkley et al., 2008). Thus, intervention delivered during adolescence may offer greatest opportunity to prevent negative adult trajectories. Second, relative to childhood, cognitive development in adolescence (Blakemore & Choudhury, 2006) may increase comprehension of, desire to utilize, and independent application of therapy skills, promoting maintenance of treatment effects. Third, negative life events in adolescence (e.g., teen pregnancy, dropout, addiction, legal problems) tend to derail the trajectories of adolescents with ADHD (Barkley et al., 2008). Therefore, promoting protective factors that reduce adolescent risk behaviors (i.e., positive parenting skills, academic engagement, positive-parent teen relationships; Molina et al., 2012; Sibley et al., 2014) could have a lasting impact. Presently, the long-term effects of ADHD treatment delivered in adolescence remain unstudied.

The Summer Treatment Program-Adolescent (STP-A; Sibley et al., 2011) is an eight-week intensive behavioral treatment program for adolescents with

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ADHD that was adapted from the children's Summer Treatment Program (Pelham et al., 2010). The STP-A targets academic, social, and behavioral skill development, employing contingency management to motivate adolescent skill practice in a summer camp context. Initial investigations of the STP-A's efficacy report pre-post improvements in note-taking skills, parent-teen relationships, and organization skills (Evans et al., 1994; Sibley et al., 2011, 2013), as well as high satisfaction by parents and teens (Sibley, Smith et al., 2012). These findings highlight several mechanisms of change within the STP-A, which may in turn promote change on outcomes such as school grades, service utilization, and disciplinary infractions. To fully address the broad impairments of adolescents with ADHD (Molina et al., 2009) an immersive intervention experience (i.e., the STP-A) may be necessary to establish lasting treatment effects. However, the STP-A is expensive to implement, which may limit its accessibility.

Questions of cost-benefit and ADHD treatment have not been examined in the critical period of adolescence. Notably, a middle or high school student whose needs cannot be met in general education settings are approved to utilize special education services, the annual cost of special education placement is 8008 USD (2020 US Dollars, USD; Chambers et al., 2003). If special education is insufficient to meet a student's needs, they risk transfer to alternative school settings or out of district placements. The per-individual cost of these placements is estimated at 35,883 USD per year (2020 USD; Chambers et al., 2003). Course failure during middle and high school also puts adolescents with ADHD at risk for grade retention (Kent et al., 2011), which costs 9196 USD per retention (Chambers et al., 2003). Students with ADHD are also at risk for major (i.e., suspensions, expulsions) and minor (i.e., meetings with principal or counselor) disciplinary actions, which are estimated to cost districts 104 USD and 39 USD respectively (Robb et al., 2011). Although intensive treatments, such as the STP-A, may be criticized as being unnecessarily intensive and expensive, high-intensity services may be necessary to offset the costs above. For example, in the MTA study (Jensen et al., 2005) an STP delivered in childhood was found to be cost-ineffective compared to medication management when considering only short-term effects. However, when examining prevention of long-term negative outcomes, the high-intensity STP package was more cost effective than medication management (Foster et al., 2007). As a result, calculating long-term cost savings to schools and families is critical to evaluating the value of intensive treatments for ADHD.

Previously, our team published a randomized controlled trial of the high intensity (HI) STP-A compared to a 90-min weekly low intensity (LI) intervention (youth organization skills training + behavioral parent training). Both treatments were administered the summer before two critical secondary school transitions that are associated with escalations in ADHD symptoms and impairments (6th and 9th grade; Kent et al., 2011; Langberg et al., 2008). Primary benefits of HI over LI were improved note-taking skills (d = .50), parent contingency management (d = .43), and parent-rated ADHD symptoms (d = .40-.46; ninth graders only). Per participant costs were 4373 USD for HI treatment and 97 USD for LI. We concluded that HI treatment was superior to LI in engagement and uptake of certain skills. However, the extent to which these moderate improvements on a selection of outcomes justify the STPA's high costs remained an open question until its long-term effects could be fully studied.

The current investigation is a four-year follow-up study of the STP-A trial (Sibley et al., 2018). Four years after baseline, participants, their parents, and their teachers provided ratings of symptoms and functional indices. Official grades were obtained from the school district. HI (n = 109) and LI (n = 109) trajectories on primary outcomes were compared from baseline through four-year follow-up (4FU). In addition, qualitative data was generated from open-ended questionnaires that queried parent and participant perceptions of the long-term impact of HI and LI interventions. We also examined HI vs. LI effects on costs incurred to schools (i.e., service utilization, educational outcomes, disciplinary actions) and families (i.e., clinical utilization of medication and therapy). We hypothesized that both quantitative and qualitative data would indicate long-term effects of the HI STP-A relative to LI intervention. We also hypothesized that the STP-A would lead to lower clinical and school service utilization, fewer dropouts, and alternative school transfers, as well as lower ADHD symptom persistence at 4-year follow-up.

Method

Participants

For a full description of the sample and setting please see Sibley et al. (2018). Rising sixth and ninth grade students with ADHD (N = 218) were recruited into the original study. Referred students were required to: (a) meet DSM-IV-TR (American Psychiatric Association, 2000) criteria for ADHD, (b) be matriculating to 6th or 9th grade, (c) display significant academic impairment (at least a "3" on a 0–6 teacher Impairment Rating Scale;

IRS, Fabiano et al., 2006), (d) have an estimated IQ > 75 on the Wechsler Abbreviated Scale of Intelligence-2nd Edition (WASI-II; Wechsler, 2011), and (e) have no history of an autism spectrum disorder. Youth with comorbidities were permitted to remain in the study. Participants were randomized to multimodal HI behavioral treatment that targeted adolescent ADHD symptoms, academic functioning, and family functioning (n = 109; 360 hours adolescent summer program + 12 h parent training + daily staff-parent communication + as needed school year consultation) or a control group that received standard low-intensity behavioral treatment (LI; n = 109; 12 h adolescent summer program + 12 h parent training + as needed school year consultation). Groups were matched on grade using stratified randomization. There were no significant differences between HI and LI on demographic or clinical variables indicating successful randomization (see Table 1). Relevant to the current investigation, there also were no BL group differences on educational placement, medication, or clinical therapy utilization, school disciplinary history, or any treatment outcome measures. However, there was significant group x grade interaction for parent-rated ADHD symptoms (p < .05). Specifically, 6th graders in the HI group possessed significantly lower ADHD symptoms than those in the LI group. In contrast, 9th graders in the HI group possessed significantly higher parent-rated ADHD symptoms than those in the LI group. At 4FU, retention was 85.3%. 4FU data was collected from 93 participants in the 6th grade cohort (4FU age M = 15.32, SD = .62) and 93 participants from the 9th grade cohort (4FU age M = 18.37, SD = .61). Retained and unretained participants at 4FU did not differ on any of the baseline characteristics listed in Table 1 (p > .25). Available data for full sample (N = 218) was as follows: parents = 80%, youth = 80%, school records = 78%, and teacher = 73% (n = 7 of assessed participants dropped out of school by 4FU making teacher ratings and school records not applicable). All participants had either parent or self-report data since collection of teacher ratings and school records required reconsent at 4FU.

Table 1. Characteristics of the sample at baseline.

	HI (N = 109)	LI (N = 109)
Baseline		
Grade (%)		
Rising 6th grader	51.4	51.4
Rising 9th grader	48.6	48.6
IQ *Mean* (*SD*)	95.3(12.3)	94.6(12.3)
Stimulant Medication (%)	45.9	45.9
% Male	76.1	71.6
Ethnicity (%)		
Hispanic Any Race	70.1	76.1
Black/African-American	17.8	15.6
Other	12.1	8.3
Parent Education (%)		
High School or Less	21.3	22.1
Some College	31.5	37.5
Bachelor's Degree	30.5	26.9
Graduate Degree	16.7	13.5
Parent Language (%)		
English Speaking	83.2	73.8
Non-English Speaking	16.8	26.2
Class Placement (%)		
Special Education	16.7	21.4
Regular Education	75.0	70.0
Advanced/Gifted	8.3	8.6
Oppositional Defiant Disorder (%)	33.9	34.9
Conduct Disorder (%)	1.2	8.3
Clinically Elevated Anxiety (%)	15.7	20.2
Clinically Elevated Depression (%)	18.5	18.3

Note: HI: high intensity; LI: low intensity

Procedures

All procedures complied with APA ethical standards and were approved by the Florida International University Institutional Review Board and the local school district. For detailed study procedures please see Sibley et al. (2018). Acute trial outcome and baseline demographic data are publicly available through the National Institute of Mental Health Data Archive (NDA) as part of the ADHD Teen Integrative Data Analysis Longitudinal (TIDAL) Dataset (Sibley & Coxe, 2020). Procedures were approved by the university's Institutional Review Board and local school district. Students were nominated by school staff and referred to the research team. At intake, informed parental consent and youth assent were obtained in the language of the parent's choice (English or Spanish). ADHD diagnosis was confirmed through a combination of parent structured interview (Computerized-Diagnostic Interview Schedule for Children; Shaffer et al., 2000) and parent and teacher symptom and impairment ratings.

Participants were permitted to utilize additional medication or psychosocial treatments during the study, which were monitored and controlled for in analyses as indicated. Participants completed baseline (BL), post-summer (POST), end of year (EOY), and four-year follow-up (4FU) assessments. Data were obtained from parents, youth, teachers, and school records. Parents and youth received 100 USD and teachers received 20 USD for completed assessments. No incentives were given for treatment participation.

For a full description of the HI and LI interventions, see Sibley et al. (2018). Youth assigned to HI received the 8-week STP-A from 8:00am to 5:00pm on weekdays (45 h per week). Parents attended a weekly 90-min parent training group during this time. Mechanisms of HI treatment were increasing organization, time management, and planning skills as well as parent use of

behavioral strategies to reinforce academic and behavioral targets. School district personnel and college student interns delivered the STP-A, which was held in a district school with bus transportation provided. School mental health specialists led parent training, organized and delivered a training to STP-A staff, and provided ongoing supervision to staff. At the end of each day, staff telephoned parents to provide a verbal summary of the adolescent's performance on daily treatment goals and coached parents on home contingency management based STP-A performance. A manualized 8-week organization skills group (1.5 hours per week; Sibley et al. 2018) and behavioral parent training was offered to LI participants. Parent and youth LI groups met simultaneously, one evening per week, at the STP-A school. School mental health specialists and local school district personnel led LI groups. At the end of each session, youth briefly joined parents to outline plans for skill practice. During the transitional year, HI and LI groups were eligible to receive school consultation using a manualized treatment based on existing interventions for adolescents with ADHD, though utilization of this service was very low (Sibley, Olson, et al., 2016).

Measures

At 4FU, participants repeated the measurement battery used in the original trial. They also provided qualitative data on their perceptions of the long-term impact of receiving study treatments. Finally, they provided consent for the research team to obtain academic, disciplinary, and service utilization records from the school district.

ADHD Symptoms

ADHD severity at 4FU was measured using a DSM-5 ADHD Rating Scale completed by parents and teachers that contains the DSM-5's adolescent-specific symptom modifiers (Sibley & Kuriyan, 2016). Respondents were asked to rate symptoms of ADHD as 0 (*not at all present*), 1 (*just a little*), 2 (*pretty much*), or 3 (*very much*). To calculate an index of symptom severity the average level (0–3) of each item on the ADHD subscales is obtained. The psychometric properties of the DSM-5 ADHD rating scale are very good, with empirical support for internally consistent Inattention (IN) and Hyperactivity/Impulsivity (H/I) subscales (Sibley & Kuriyan, 2016). In this sample, alpha ranged from .87 to .94. Symptom persistence was determined according to the recommendations of Sibley et al. (2012). Parent, teacher, and self-report of ADHD symptoms were combined using an item level "or" rule. The DSM-5 A-criteria threshold was applied based on the age of the participant at follow-up (i.e., 17 or older = 5 or more symptoms, 16 or younger = 6 or more symptoms).

Academics and Organization

Report cards were obtained directly from the school district at the end of each academic quarter. GPA for each quarter was calculated by converting academic grades (e.g., English, Math, Science, Social Studies) to a 5-point scale (i.e., 4.0 = A to 0.0 = F). Grades were not weighted for the difficulty of the class. GPA provides an objective and ecologically valid measure of school performance that is meaningful to parents and schools. The parent and teacher versions of the 24-item *Adolescent Academic Problems Checklist* (AAPC; Sibley et al., 2014) measure observable secondary-school specific organization problems and are validated for use in samples of adolescents with ADHD. The AAPC possesses two distinct factors, as well as a total score, with strong internal reliability and concurrent validity (Sibley et al., 2014). Total score on the AAPC was used as a measure of organization problems in this study. Alpha for this measure was .92 for both the parent and the teacher versions in current study.

Behavioral and Family Indices

The parent version of the Conflict Behavior Questionnaire-20 (CBQ-20; Robin & Foster, 1989) was used to assess the quality of the parent-teen relationship at each assessment. Respondents were asked to rate statements about the parent-teen relationship on a five-point scale from 1 (*strongly agree*) to 5 (*strongly disagree*). The CBQ-20 is a 20-item scale that was adapted from the 73-item CBQ. The CBQ-20 items are the CBQ items that best discriminated distressed from nondistressed families. It yields a single score that correlates .96 with the CBQ but is faster to complete than the long-form of the measure (Robin & Foster, 1989). In the current study, alpha ranged from .91 to .94 on this measure. The Parent Academic Management Scale (PAMS) is a 16-item checklist that measures the frequency with which parents monitor (e.g., check to see if your child wrote in a daily planner), assist with (e.g., help your child organize school materials), and reinforce (e.g., use a home academic contract) adolescent academics. Parents indicated the number of days in a typical school week (0 to 5) that they perform each activity. The PAMS possesses strong psychometric properties as evidenced by good internal consistency, concurrent validity, and predictive validity (Sibley et al., 2016). Given diversity in treatment targets for adolescents, targeted parental academic management strategies varied by family. Thus, the decision was made to use one strategy that was ubiquitous to parent training

(contingent use of home privileges) as an outcome measure in this trial.

Parent and Teen Perceptions of the STP-A

Parents and teens provided answers to two questions about long-term effectiveness of the treatment they received: (1) In your own words, please tell us how the program helped you (your teen) in the long-run, that is, over the last 4 years?; (2) In your own words, please tell us how the program helped your parent (you) in the long-run, that is, over the last 4 years? Parents and teens were encouraged to list as many responses to each question as they desired. Respondents could also opt-out of the question by selecting "It did not benefit me (my child) over the last four years." Responses were coded according to the procedures outlined in Merriam (1998). Research staff segmented responses into distinct units of data that represented the smallest possible pieces of information that were relevant to the question. Two coders were instructed to create categories that were relevant, exhaustive (place all data into a category), and mutually exclusive. The coders gave each category a name that matched its content and compared lists. Following independent category construction, coders compared the list of categories. The independent coders collaborated to create a final list of categories, each with an operational definition and key examples. In a final step, coders sorted each response using the finalized list of categories and their definitions. Coders were blind to group during the coding process. A reliability check was performed on 20% of responses. Inter-rater agreement was $k = .71$, indicating "good" agreement. Reports were combined across informants for analyses using an "or rule" (i.e., if either a parent or the teen response met criteria for a code, the benefit was counted as present).

Educational Outcomes and Costs

The Education History Questionnaire was developed for the Pittsburgh ADHD Longitudinal Study (Molina & Pelham, 2003) by adapting measures used in the PAARC (Pittsburgh Adolescent Alcohol Research Center) and CEDAR (Center for Education and Drug Abuse Research) studies. The Education History Questionnaire is a retrospective report from parents (supplemented by a self-report if parents were not available) regarding educational history for each year since the follow-up assessment (6^{th}-9^{th} or 9^{th}-12^{th}). For each year, respondents indicated the school(s) that participants attended, their placement (e.g., special education versus regular classroom), whether participants were retained, whether they received additional services, and estimates of disciplinary referrals. The school district provided records of student disciplinary incidents and student services utilization for each school year. Counts of each type of disciplinary incident (i.e., suspensions, sent to principle, parent-teacher conference, note home to parent) and service utilization (i.e., counseling session, referral to non-district service) were calculated. Costs of school services, disciplinary actions, special education placement, and retention were calculated according to the detailed Cost of Illness (COI) approach outlined by Robb et al. (2011). All costs were converted to 2020 dollars.

Clinical Service Outcomes and Costs

A comprehensive services survey assessed naturalistic ADHD medication use (stimulant or non-stimulant) and psychosocial therapy services received during the four-year follow-up phase (Kuriyan et al., 2014). Parents and teens completed the interview independently. Respondents indicated all treatment received during the four-year follow-up phase including, doses, administration schedules, settings taken, changes made since the last assessment, reasons for changes, and information about frequency of medication monitoring visits. Data were screened for discordant parent-teen reports, which were resolved by discussion. Based on available records, days medicated between FU and 4FU were calculated along with hours of psychosocial treatment received. Daily cost of ADHD medication was derived from existing estimates (Barner et al., 2011), while hourly psychosocial treatment costs were calculated based on standard fees for service in the county in which this study was conducted.

Analytic Plan

Longitudinal Symptom and Impairment Trajectories

Prior to analyses, the distributions of all dependent measures were examined to select appropriate statistical models and detect outliers. All outcomes used in linear mixed models (LMMs) were approximately normally distributed with no outliers found. Given the longitudinal nature of this study, the data were assumed to be missing at random (MAR), such that missing values are related to other variables in the model, including the same variable at previous waves (Schafer & Graham, 2002). Primary outcome analyses used LMMs; LMMs assume that data are at least MAR and include all participants with at least one observation in analyses (West et al., 2006), further minimizing the impact of missing data.

LMMs with random effects were conducted in SPSS 25 using an intent-to-treat design. A separate LMM was conducted for each outcome. Fixed effects of ADHD medication status (yes (1)/no (0); time varying

covariate), time, a dummy coded group variable with LI as the statistical reference group (HI group: yes/no), grade, and the interactions of group, grade, and time were included. Random intercepts were included in each model. Time at POST, EOY, and 4FU was coded as months after the BL assessment (i.e., BL = 0), with unique values for each participant. To model potential nonlinear effects of time, the natural logarithm of the continuous time measure was used in all mixed models. (Initial models included linear effects; comparison of BIC values indicated that the log-based models were preferred.) Since the time variable included values of 0 and log(0) is not defined, the transformed time value was calculated by including a small offset, e.g., log(time +.0001). Grade was dummy coded with 6th grade as the reference group ($6^{th} = 0$, $9^{th} = 1$). The full model for each outcome was:

$$Y_{ij} = \pi_{0i} + \pi_{1i}\ln(time) + \pi_{2i}(medication) + e_{ij}$$

$$\pi_{0i} = \beta_{00} + \beta_{01}(HI) + +\beta_{02}(grade) + \beta_{03}(HI * grade) + r_{0i}$$

$$\pi_{1i} = \beta_{10} + \beta_{11}(HI) + \beta_{12}(grade) + \beta_{13}(HI * grade)$$

$$\pi_{2i} = \beta_{20}$$

For the LMMs, the primary effects of interest were the group x time effect for HI vs LI (β_{11}) and the corresponding group x grade x time effects (β_{13}). The two-way interactions and their significance reflect average differences between the HI and LI groups at BL and in their trends over time, respectively. The three-way interactions indicate whether these group x time effects varied by grade. Follow-up analyses examined 4FU differences. These effects were estimated by re-centering the time variable at the mean 4FU value (i.e., mean 4FU value = 0). This makes the mean 4FU value equal to 0 for all participants (though not each participant's 4FU value) and makes all parameters related to the intercept of the model refer to values at the mean 4FU time. For these models, the group effect reflects group differences at mean 4FU, the group x time effect reflects the group differences in change over time, and the group x grade x time effect indicates whether the group x time effect varies by grade.

Qualitative Analyses

For qualitative analyses, after category construction and sorting (see **Measures**), binary logistic regression analyses were utilized to compare group (0 = LI, 1 = HI), grade ($0 = 6^{th}$, $1 = 9^{th}$), and group x grade differences in code endorsement (no = 0, yes = 1).

Educational and Clinical Service Outcomes and Costs

As a first step, univariate tests of group, grade, and group x grade effects on cost input variables were assessed. Based on their distributions, count variables (i.e., school counseling sessions, days medicated, hours of therapy, educational costs, clinical service costs) were either analyzed using Poisson regression or zero-inflated Poisson regression, binary variables (i.e., grade retention) were analyzed using logistic regression, ordinal variables (i.e., years in special education, years in alternative school) were analyzed using ordinal regression, and continuous variables (i.e., disciplinary incidents) were analyzed utilizing linear regression. For analyses using school district records (i.e., disciplinary incidents, school counseling sessions), each cost input variable was weighted based on the number of years that the participant possessed available records. A majority of participants (91%) had records available for all three school years. School costs were the sum of special education, alternative placement, grade retention, disciplinary, and school counseling costs. Treatment costs were the sum of medication and psychosocial therapy costs.

Results

ADHD Symptoms

There was a significant three-way interaction for group x grade x time indicating that 9th grade HI youth maintained BL to FU reductions in parent rated IN ($d = .27$) and H/I symptoms ($d = .31$) at 4FU compared to 9th LI grade youth. Consistent with BL to FU analyses, there were no HI vs. LI differences in ADHD symptom change over time at 4FU for sixth-grade students. As in the original trial, there were no significant HI vs. LI group x time interaction effects (see Table 2) for teacher rated ADHD symptoms. For ADHD symptom persistence (yes/no), the overall model was non-significant [$X^2(3) = 2.07$, $p = .558$]. The HI group (55.9%) and the LI group (65.5%) did not significantly differ in ADHD symptom persistence at 4FU ($b = -.41$, $SE = .43$, $p = .350$, $OR = .67$), nor was there a significant group x grade interaction ($b = -.01$, $SE = .62$, $p = .98$, $OR = .99$).

Academics and Organization

For parent rated organization problems (see Figure 1), there was a significant two-way interaction for group x time. Although HI youth did not demonstrate significantly greater reductions in organization problems for BL to FU ($d = .29$), HI youth demonstrated greater reductions at 4FU than LI youth ($d = .40$). Consistent

Table 2. Results of linear mixed models for main outcomes.

	Time		Group x Time		Group x Grade x Time		HI *M* (*SD*)		LI *M* (*SD*)		
			b	*p*	*b*	*p*	BL	4FU	BL	4FU	BL-4FU *d*
ADHD Symptoms											
Inattention Severity (P)	−.04	<.001*	.02	.053	−.02	.033*	1.60(.77)	1.20(.77)	1.88(.68)	1.37(.73)	−.15.27
6th							1.80(.67)	1.26(.85)	1.63(.80)	1.29(.73)	
9th											
H/I Severity (P)	−.03	<.001*	.02	.010*	−.02	.038*	1.09(.69)	.67(.54).64(.64)	1.26(.82).87(.69)	.81(.73).65(.66)	−.04.31
6th							1.07(.71)				
9th											
Inattention Severity (T)	−.05	<.001*	.00	.769	.00	.879	1.73(.76)	1.06(.90)	1.80(.68)	1.12(.74)	−.02
H/I Severity (T)	−.05	<.001*	.01	.372	−.01	.463	1.12(.88)	.58(.73)	1.08(.80)	.55(.65)	.02
Academics & Organization											
Organization Problems (P)	−.04	<.001*	.02	.012*	−.01	.454	1.51(.60)	1.10(.67)	1.52(.58)	1.22(.63)	.40
Organization Problems (T)	−.04	<.001*	.01	.459	−.01	.619	1.49(.62)	1.01(.73)	1.83(.53)	1.36(.66)	.04
Grade Point Average (SR)	.00	.621	−.01	.266	.01	.355	2.25(.63)	2.16(.74)	2.13(.68)	2.02(.75)	−.03
Behavior & Family Indices											
Parent-Teen Conflict (P)	−.02	.004	.01	.202	.00	.709	2.66(.85)	2.51(.88)	2.69 (.86)	2.60(.89)	.08
Contingency Use (P)	.02	.203	−.02	.511	−.02	.605	.82(1.51)	1.24(1.28)	1.24(2.04)	1.38(1.59)	−.15

P: Parent; T: Teacher; SR: School Records. *p <.05; Means are marginal estimates after controlling for medication as a covariate. Means are displayed separately by grade when group x grade x time interactions were present. For ADHD symptoms and organization problems, mean severity scores range from 0 = not at all to 3 = very much. For parent-teen conflict, mean scores range from 1 (low conflict) to 5 (high conflict). Contingency use represents the number of days in the past week that the parent used the strategy.

Figure 1. Informant perceived long-term benefits of treatment to teen.

with BL to FU analyses, there were no HI vs. LI group x time interaction effects (see Table 2) for teacher rated organization problems or grade point average.

Behavioral and Family Indices

Consistent with BL to FU analyses, there were no HI vs. LI group x time interaction effects (see Table 2) for parent-teen conflict. There also were no HI vs. LI group x time interaction effects for parent contingency management, indicating that significant BL to FU effects (d = .43) did not maintain at 4FU (d = –.15).

Parent and Adolescent Perceptions of the STP-A

Parents and teens provided a range of responses to open-ended questions resulting in nine identified long-term benefits to the teen (see Figure 1) and nine identified long-term benefits to the parent (see Figure 2). Tables 3 and 4 contains the definition and a key example of each code. Parents in the HI group (74.4%) were more likely to perceive at least one long-term benefit to the teen than parents in the LI group (41.7%; b = .88, SE = .45, p = .050, OR = .2.44). This effect was not significant for self-report (58.7% vs. 31.4%; b = .83, SE = .44, p = .057, OR = 2.27). Compared to the LI group, HI group informants were more likely to cite

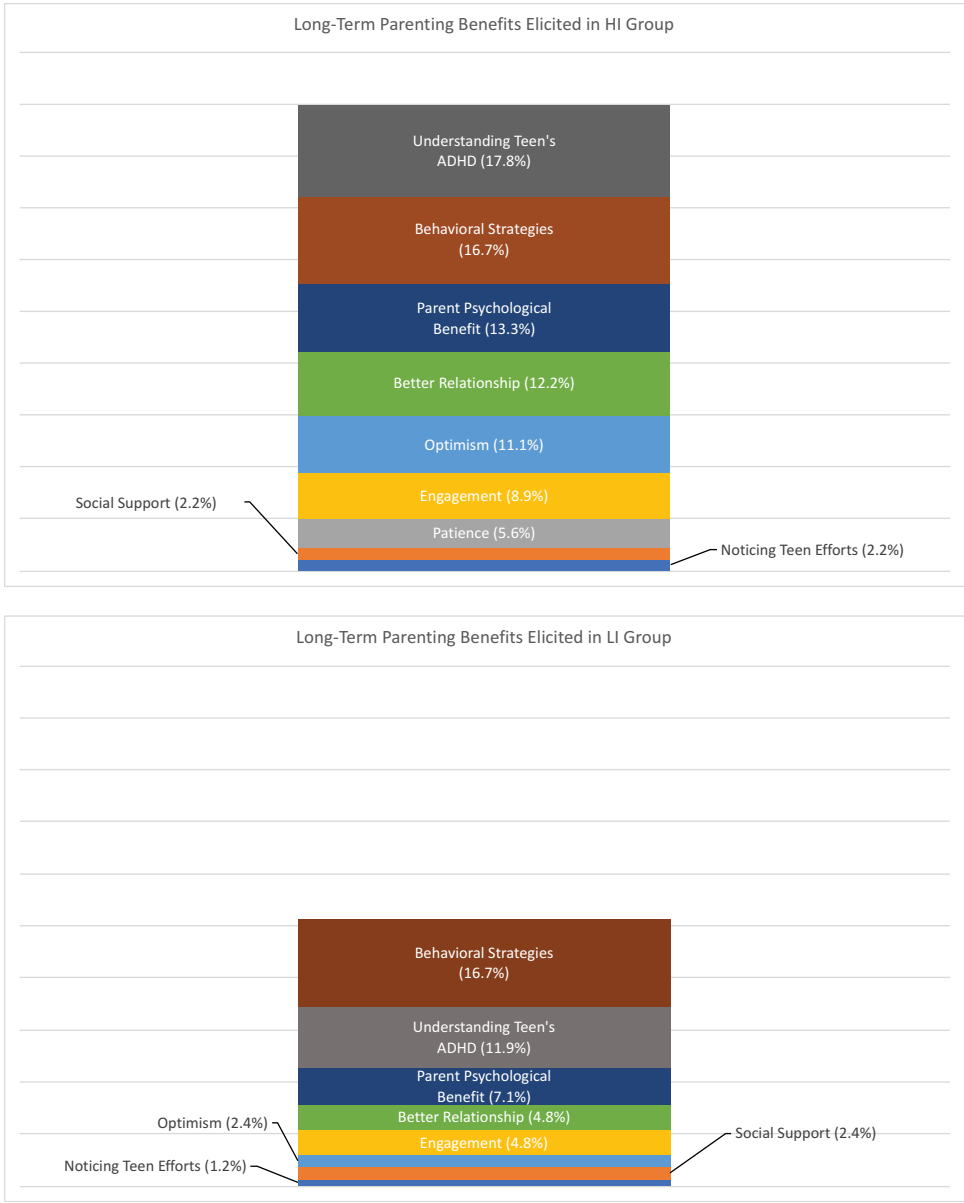

Figure 2. Informant perceived long-term benefit of treatment to parent.

Table 3. Qualitative codes for teen improvement in HI and LI groups.

Code	Definition	Example
General	Improvement is clearly indicated, but the nature of that improvement is not clear	Now I enjoy volunteering and doing things without anything in return.
Academics	Improvement in academic performance (e.g., grades, work productivity, focusing in class, homework).	I was able to turn in my work while reviewing it a couple times to check for mistakes. I'm able to maintain good grades.
Motivation	Increased task motivation (greater effort, goal-directedness, or willingness to work hard)	It helped embed into my mind the work ethic necessary for success.
Behavioral Control	Improvements in behavior that include impulsive behaviors, self-control of actions or emotions.	I'm calmer and less impulsive.
Organization, Time Management, Planning	Improvement in organization, time management, or planning problems or use of strategies.	It taught me how to use my time wisely. Now, when I do work I finish it in the time frame that they give me.
Normalization	Understanding that one is not alone in their ADHD-related struggles, that their difficulties are common.	It helped me realize there are other kids like me and that I shouldn't feel alone in having difficulty concentrating.
Interpersonal Skills	Improved performance or use of skills relating to interactions with others (i.e., family, adults, friends)	It helped me become very mature and gave me a funny personality.
Self-Esteem	Confidence in one's worth or abilities; self-respect	This program helped me by assuring that there is absolutely nothing wrong with me mentally and that I am just as smart as I want to be.
Self-Awareness	Knowledge of one's own character, feelings, desires	She acknowledges her attention challenges and is aware of the additional effort she needs to make in order to excel academically.
Note-taking	Improvement in note-taking	I took better notes, so I was able to study and get better test grades.

Table 4. Qualitative codes for parent improvement in HI and LI groups.

Code	Definition	Example
General	Improvement is clearly indicated, but the nature of that improvement is not clear	I was able to apply what I learned from the classes. It helped a lot.
Better Parent-Teen Relationship	Improved relationship with the teen indicated by closeness, warmth, positivity, or support	It has helped me be more connected with my son.
Patience	Patience with or compassion for teen (e.g,, understanding that improvement takes time, the teen is trying their best)	It helped us to be more patient and understanding.
Optimism	Hope and optimism for the future, confidence in teen's potential	Reinforced my confidence in his abilities.
Understanding Teen's ADHD	Increased knowledge of how the teen works, how ADHD works, or what teen needs to be successful	The program was a great way to understand and continue to help my son in his inattentive problems.
Behavioral Strategies	Increased use of behavioral strategies that may include improved monitoring, contingency management, increasing explicitness of expectations	(My parent) is checking my grades more.
Parent Psychological Benefit	Reduction in parental anxiety, stress, or improved well-being	The program allowed my mom to not be so stressed about me and my school work.
Engagement	Higher level (frequency, intensity, new actions) of parenting involvement (behavioral strategies trumps this code)	Now I advocate more for my child.
Noticing Teen Efforts	Greater parental recognition of teen efforts and good behaviors	Now I'm always giving him positive feedback about school and always tell him (daily) how proud I am of how he's changed and how well he's doing.
Social Support	Feeling greater support from other parents	It helped to learn from other parents what it's like to raise children with ADHD. Helped me feel a sense of community.

teen long-term gains in organization, time management and planning (24.7% vs. 50.5%; b = 1.00, SE = .45, p = .026, OR = 2.70). No group x grade interactions were present for teen long-term benefits. There were no significant group differences in the percentage of parents who recognized at least one long-term parenting benefit (HI = 65.6%, LI = 44.0%; b = .47, SE = .44, p = .280, OR = 1.61). There also were no significant differences in the percentage of teens who articulated at least one long-term parenting benefits in the HI group (25.3%) compared to LI group (15.5%; b = .12, SE = .54, p = .83, OR = 1.12). A significant group x grade interaction indicated that for sixth grade youth (but not for ninth grade youth), HI parents (27.7%) were more likely than LI parents (9.8%) to experience improved understanding of the teen's ADHD symptoms (b = 2.03, SE = .97, p = .035, OR = 7.69). There were no other group or group x grade differences in parenting benefits.

Educational Outcomes and Costs

Table 5 lists educational outcomes by group and grade. There were no significant group or group x grade effects for years in special education or alternative school, disciplinary incidents, or grade retention. There was a significant group x grade effect for school counseling sessions indicating that 6th grade youth in the HI group utilized significantly more counseling sessions than 6th grade youth in the LI group. This effect was not present for ninth grade youth. Educational costs were not significantly lower for HI youth (M = 11,996, USD SD = 20,683 USD) compared to LI youth (M = 8965, USD SD = 11,917 USD), nor was there a significant group x grade interaction.

Clinical Service Outcomes and Costs

Table 5 lists clinical service outcomes by group and grade. There were no significant group or group x grade differences in medication or therapy utilization. Clinical service costs were not significantly lower for HI youth (M = 1726, USD SD = 2981 USD) compared to LI youth (M = 1842, USD SD = 2504 USD), nor was there a significant group x grade interaction.

Discussion

The primary aim of this paper was to determine whether there is a long-term incremental benefit of HI versus LI treatment for adolescent ADHD. Over the course of the four-year follow-up period, HI participants demonstrated increasing improvements to their organization skills when compared with the LI group (FU group x time d = .29; 4FU: group x time d = .40). At 4FU, ninth graders who received HI also sustained greater reductions in ADHD symptom severity relative to their LI peers (group x time d = .27 to .31). However, there was no long-term incremental effect of HI (vs. LI) for parent-teen conflict, GPA, or parent use of contingency management. Qualitative data supported quantitative results that the primary incremental long-term benefit of HI (vs. LI) treatment was to organization skills. In addition, compared to LI participants, parents of sixth grade HI participants reported increased understanding of the teen's ADHD symptoms. Overall, the modest long-term incremental benefits of the costly HI treatment ($4773 vs 97 USD for LI) did not translate into reduced educational or clinical service utilization or costs during the follow-up period. Below we discuss

Table 5. Educational and clinical service outcomes and costs.

	Group			Group x Grade				
	HI	LI	p	6th: HI	6th: LI	9th: HI	9th: LI	p
Educational								
Years of Special Education (*M, SD*)	.82(1.26)	.86(1.27)	.876	.68(1.15)	.89(1.26)	.97(1.37)	.82(1.29)	.813
Retention % (n)	3.2 (3)	4.8 (4)	.484	4.0 (2)	7.3 (3)	2.3 (1)	2.4 (1)	.766
Years of Alternative Education (*M, SD*)	.10(.47)	.01(.12)	.237	.05(.31)	.00(.00)	.16(.59)	.03(.17)	– [a]
School Counseling Sessions (*M, SD*)	11.83(22.79)	8.31(15.79)	.180	14.17(23.25)	7.44(9.14)	9.32(22.32)	9.23(20.76)	**<.001**
Major Disciplinary (*M, SD*)	.85(2.65)	.68(1.49)	.611	.74(2.76)	.64(.91)	.96(2.55)	.72(1.94)	.835
Minor Disciplinary (*M, SD*)	13.00 (17.14)	12.97 (11.99)	.991	15.20(21.45)	12.93(14.03)	10.80(10.38)	13.01(9.44)	.326
Clinical								
Days of Medication	268.82(433.52)	374.64 (482.22)	.564-.636	386.12 (486.96)	340.58 (485.00)	142.26(328.85)	410.71 (483.87)	.275-.349
Hours of Therapy	9.18(27.38)	4.53(13.13)	.707-.895	8.29(19.50)	3.25(6.53)	10.13(34.17)	5.88(17.66)	.447-.933
Costs								
Educational	$11,996 ($20,683)	$8965 ($11,917)	.385-.395	$9152 ($14,463)	$8554 ($10,709)	$15,156 ($25,722)	$9337 ($13,030)	.538-.974
Clinical	$1726($2981)	$1842($2504)	.416-.483	$1918($2859)	$1927($2543)	$1512($3129)	$1765($2494)	.750-.905

M = mean, SD = standard deviation, HI = high intensity, LI = low intensity; [a]no p-value was available for this test because the 6th grade LI cell had zero variability. Zero-inflated Poisson regression models yield two p-values: one for the binomial distribution and one for the count distribution.

the nuances of these findings and their implications for adolescent ADHD treatment recommendations.

The Multimodal Treatment of ADHD (MTA) study is the landmark long-term study of childhood ADHD treatment (MTA Cooperative Group, 1999). By three-year follow-up, the three active treatment conditions (medication, HI behavioral intervention, combined medication + HI behavioral intervention) converged with the community control condition, indicating no long-term benefit of psychosocial or medication treatment delivered in childhood (Jensen et al., 2007). By contrast, our long-term study of a similar dose of adolescent behavioral treatment indicates approximately 75% maintenance of ADHD symptom effects at four-year follow-up for ninth grade participants (Sibley et al., 2018) compared to an active (rather than community) control group. Furthermore, the incremental impact of HI (vs. LI) treatment on organization skills increased over the course of the follow-up period, from d = .29 at the end of the acute trial to d = .40 three years later. These findings support the possibility that adolescence offers a unique opportunity to sustain long-term effects from behavior therapy for ADHD. In line with this hypothesis, the older cohort (ninth graders) witnessed greater acute and long-term benefit of HI compared to the younger cohort (sixth graders) who received identical treatment. Older youth with ADHD possess greater cognitive maturity (Shaw et al., 2013), perhaps offering sufficient executive function abilities and self-motivation to independently apply treatment skills.

Qualitative analyses (see Table 3) indicated that a majority of perceived LI and HI treatment benefits were beyond the scope of our quantitative measurement battery; many were psychological, rather than behavioral in nature. These invisible benefits of treatment were not directly targeted by the interventions but may have an important impact on the way one accepts, manages, and stays optimistic in the face of ADHD long term. Compared to LI, HI treatment appeared to be an important opportunity for parents of younger adolescents to understand how ADHD influences teen functioning. However, this increased parental knowledge did not appear to create meaningful parent behavioral changes.

Several responses in the qualitative interviews suggested that some participants desisted stimulant medication as a direct result of attending the STP-A. As one youth stated in their qualitative survey, the STP-A "made me want to stop taking medication." As a separate parent confirmed, the STP-A made her son "a lot more oriented in time management; with little tricks here and there, he was able to stop taking medication." Although the group x grade effect on medication utilization was non-significant, differences in medication use (see Table 5) appeared to confirm this trend; on average, the older HI cohort utilized medication for approximately 200 fewer days during the follow-up period than their LI counterparts (142 days vs. 341 days; d = .66). This pattern is consistent with the MTA, which demonstrated reduced medication utilization in the HI behavioral treatment group at three-year follow-up (Jensen et al., 2007). The high school years are a common period for the desistence of ADHD medication, as teens with ADHD increase autonomy (Brinkman et al., 2018). Perhaps improved organization skills boosted a self-perception that teens could manage their symptoms without medication. It is important to note that all main outcome analyses controlled for a time varying effect of medication use; thus, even with their reduced reliance on medication, ninth graders in the HI group outperformed their LI peers on organization skills and ADHD symptom reduction. At a cost of 3.88 USD per day for long-acting stimulants (Barner et al., 2011), it would take an average of approximately 3 years of medication desistance to recoup the additional costs of the HI STP-A compared to LI. Thus, there could be a long-term cost saving to some families if the STP-A eliminates the need for continued stimulant treatment in certain cases.

Despite the cost saving potential of reduced medication use for certain families, there was no incremental impact of HI on overall educational or clinical service costs. Thus, the higher costs associated with HI's incremental benefit did not reduce the disorder's burden on school or clinical resources. Ultimately, if schools or clinics were interested in funding a version of STP-A to reduce long-term costs, a single dose of the HI STP-A would not result in a net cost savings compared to the LI approach. Similarly, investing in a single course of the STP-A does not lead to a meaningful reduction in three-year clinical service costs for most youth. The difference in intervention cost of 4,373 USD for HI treatment and 97 USD for LI treatment suggests that future studies should include a cost-effectiveness analysis as a primary aim to determine whether the higher cost of HI treatment can be justified by the long-term outcome improvements. A cost-effectiveness analysis would compare the cost per unit of outcome improvement (rather than cost savings in education and treatment) to summarize the tradeoff between superior outcomes and higher costs. A cost-effectiveness analysis was not a primary aim of the current study.

If resources were unlimited, and a parent's primary goal was to create as much change as possible for a youth with ADHD, would the modest improvement in organization skills and ADHD symptom severity be worth the costs of HI intervention? Could the possible

impact on parental knowledge of ADHD and/or use of medication further justify this cost for certain families? The answer depends on how much a payee values these benefits relative to the financial and personal costs of HI treatment (i.e., time, effort, money). Our findings indicate that delivering an HI intervention to high school aged youth maximizes the known long-term effects of ADHD treatment; however, several questions remain unanswered: (1) what is the impact of repeated administrations of psychosocial ADHD treatment? Would youth demonstrate continued incremental improvement with multiple courses, or would they experience diminishing gains (as with stimulant medication; Swanson et al., 1999); (2) is it simply impossible for ADHD treatment to produce long-term impact on functional outcomes? Is impairment only managed when medication or psychosocial treatment are actively received? The answers to these questions are necessary to offer fully-informed treatment guidelines for child and adolescent ADHD.

The limitations to this study are as follows. First, our original design did not include a no treatment control group; therefore, we cannot ascertain the long-term value of standard LI treatment compared to no treatment, or the cost-effectiveness of LI. Second, the original limitations of this trial still apply (Sibley et al. 2018): (1) it is impossible to mask parents and adolescents to treatment group (teachers and research coders were masked) and (2) this study was conducted with a local sample, which was largely Hispanic and African-American; it may not generalize to all adolescents with ADHD. Finally, although participants were randomly assigned to LI versus HI groups, there were some differences between these groups at baseline. While these differences were statistically controlled for in all longitudinal analyses, further research may be needed to fully demonstrate the causal nature of group membership on change over time.

In sum, this study suggests that relative to an active control group, a single dose of HI treatment has a modest but lasting effect on teen organization skills and ADHD symptoms at four-year follow-up. Treatment was particularly effective when delivered to older adolescents in this sample (i.e., ninth graders versus six graders), suggesting that the long-term impact of ADHD psychosocial treatment may increase with age. Although HI did not offer long-term cost savings for school districts or spending on clinical services, it is possible that a defrayed need for stimulant medication over a three-year period could justify the costs of the STP-A for certain families. Future research on psychosocial adolescent ADHD treatment should include quantitative measures of the qualitative themes detected in our analyses (e.g., self-concept, parent attitudes toward ADHD). These indices may be personally meaningful, but unstudied, mechanisms of psychosocial treatment. There is a great need for additional studies of the long-term effects of psychosocial and medication treatments for ADHD. To understand the optimal course of treatment across development, studies that investigate multiple administrations of treatment over several years are also needed. Treatment recommendations should consider a lifespan approach and emphasize the unique value of treatment in adolescence to produce maintenance of effects.

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