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Improved but Still Impaired: Symptom-Impairment Correspondence Among Youth With Attention-Deficit Hyperactivity Disorder Receiving Community-Based Care

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Abstract

Objective—To explore correspondences between the trajectories of symptoms and impairments in youth with attention-deficit hyperactivity disorder (ADHD) being treated by in primary care settings.

Methods—Parents of youth (n = 1976) rated their child's symptoms of inattention and hyperactivity/impulsivity, and impairment across a variety of domains. Multilevel models were estimated to characterize the trajectories of symptoms and impairment and to determine whether changes in symptom dimension trajectories corresponded to changes in impairment trajectories over time.

Results—Results indicated that symptom dimensions initially improved, then leveled off, and then decreased minimally. However, impairment domains remained largely stable (i.e., neither improved nor worsened). Improvement in inattention symptoms were associated with improved ratings of writing impairment, and improved ratings of hyperactivity/impulsivity symptoms were associated with improved relationship with peers.

Conclusions—Youths with ADHD who are treated by their community pediatrician tend to initially improve in their symptom presentation, although this symptom reduction plateaus and is not associated with corresponding improvements in most areas of impairment.

Keywords

ADHD; community-delivered treatment; primary care setting; symptom-impairment correspondence

Attention-deficit hyperactivity disorder (ADHD) is the most common mental health disorder of childhood.¹ Children and adolescents with ADHD exhibit developmentally inappropriate levels of inattention, hyperactivity, and impulsivity symptoms that result in functional impairments, or areas of daily life that are negatively impacted, across a wide array of functional domains. Relationships with peers and parents,² academic achievement,³ and participation in age-appropriate activities, such as sports and extracurricular activities,⁴ can all be negatively impacted by ADHD symptoms. These difficulties are chronic and have a substantial negative impact on daily life functioning.⁵

Fortunately, there are well-substantiated, evidence-based interventions for targeting ADHD-related symptoms and impairments. Behavior modification at home and school, medication management with psychostimulants, and the combination of these are considered well-established, evidence-based treatments for ADHD that have demonstrated improvements in symptom reduction and reduced impairment.⁶⁻⁹

Evaluating the impact of ADHD treatment on both symptoms and impairments is essential to understand treatment outcome for several reasons. First, ADHD-related symptoms and impairments, although related, have been shown to be distinct constructs,^{10,11} indicating that improvement in one may not necessarily be associated with a direct improvement in the other. Also, it is impairments, not symptoms, which families find most distressing and often cite as the impetus for seeking treatment.^{12,13} Moreover, long-term outcomes and prognosis for children diagnosed with ADHD are oftentimes tied to impairments, rather than symptoms.¹⁴ Finally, recent evidence has revealed that, in many cases, improvement in symptoms seems to be unrelated to reliable improvement in impairment,¹⁵⁻¹⁷ indicating that current treatments may not be adequately addressing the full range of ADHD-related deficits.

However, despite increasing evidence that evaluating both components of ADHD outcome is essential, implementation of this multifaceted assessment has failed to gain widespread use in either clinical or research practices. Although recent guidelines encourage clinicians to measure both symptoms and impairments to effectively assess and treat ADHD,¹⁸ impairment is often not the focus of most treatment providers. This is likely because most ADHD assessment measures focus on symptoms, and not impairment.¹⁹ Moreover, although symptom reassessment may indicate improvement, very few empirical studies to date have explored the degree to which ADHD symptom improvement corresponds with improvement in impairments.

To the best of our knowledge, only 2 previous studies have investigated the association between ADHD symptom improvement and improvements in impairment in youth with ADHD.^{16,17} Using a reliable change index, which classifies children based on the direction and magnitude of clinically significant change (i.e., improvers, no-changers, deteriorators), both studies compared clinically significant change in ADHD symptoms with corresponding changes in ADHD-related impairment. Owens et al¹⁶ explored correspondence in a sample of school-age children (Grades K-6) with ADHD using a pre-post evaluation after a 1-year school-based behavioral treatment. Parents rated their child's symptoms (combined average of inattention and hyper-activity/impulsivity subscales of the Disruptive Behavior Disorders

Rating Scale²⁰) and multiple domains of impairment (academic performance, classroom functioning, family functioning, self-esteem, and relationships with peers, siblings, parents, teachers) using the Impairment Rating Scale.¹³ They found that 50% to 74% of youth who evidenced a reliable change in symptoms had a corresponding reliable change in overall average impairment. However, inspection of specific domains of impairment revealed correspondences between symptom improvement and improvement in certain domains of impairment (i.e., peer relations and academic domains) were below 50%, indicating that the majority of children whose symptoms improved did not have corresponding improvement in these impairment domains.¹⁶

Karpenko et al¹⁷ found a similar pattern of results using data from children ages 7 to 9 years receiving any treatment (medication treatment only, behavioral treatment only, and combination) in the context of the Multimodal Treatment Study of children with ADHD.²¹ Namely, although symptom improvement was associated with corresponding improvements on several impairment domains (overall, family functioning, peer functioning, homework problems), the percentages of youth who demonstrated this correspondence was rather low (21%–62%). Taken together, these previous studies conclude that the majority of children who would be considered “treatment successes” by symptom ratings would not have been similarly categorized if using ratings of impairment to determine treatment success.^{16,17} That is, although there is evidence that symptom and impairment improvements do seem to correspond to a degree, less than half of youth demonstrate reliable change in both symptoms and impairment, indicating that there is a substantial proportion of children for whom symptom improvement does not correspond to clinically significant improvement in impairment domains.

Although these studies address important gaps in the literature, a few notable limitations are evident that this study intends to address. First, since neither study used community-based samples with community-delivered treatments, these previous studies focus on treatments which differ both in form (i.e., psychosocial) and magnitude (i.e., study-delivered treatments) from treatment received by most children diagnosed with ADHD. Medication management is the most common treatment option and has been suggested in recent guidelines for pediatricians as an effective first line treatment for many school-age children.¹⁸ These guidelines stem from a large literature supporting stimulant medication as highly efficacious in reducing symptoms of ADHD within a relatively brief period of time.^{7,15} However, although large effect sizes are consistently demonstrated when outcome is measured as reduction in symptoms, medication management does not typically produce large effects when measuring reductions in impairments.¹⁵ Moreover, the majority of children receiving treatment for ADHD are receiving medications prescribed by community pediatricians,^{22,23} which differs in form substantially from the way medications are prescribed in study-delivered treatment.²⁴ No studies to date have examined how symptom improvement impacts impairment when treatment is delivered by community-based pediatricians.

Additionally, within ADHD, there is considerable heterogeneity in symptom presentation. Using overall ratings of symptom improvements to determine treatment response reduces the ability to parse out improvements across the 2 ADHD symptom domains (inattention and

hyperactivity/impulsivity). Also, by categorizing youth to indicate improvement, much of the variance in improvement across both symptoms and impairment are lost. Therefore, a dimensional approach may best explicate the complex association between symptoms and their associated impairments. Recent evidence indicates that the distinct symptom domains in ADHD may have unique patterns of impact on impairments. For example, symptoms of inattention have been shown to be most strongly related to academic impairments,^{25,26} whereas symptoms of hyperactivity/impulsivity or other correlates of ADHD (oppositional symptoms) may be better predictors of social difficulties.^{25,26} However, whether treatment-related improvement in the specific ADHD symptom domains corresponds to improvement in impairments in related domains is not known. For example, given the association between inattentive symptoms and academic impairment, does improvement in inattentive symptoms correspond with improvement in ratings of academic impairment?

This study aims to address important gaps in the current literature: (1) Does symptom improvement correspond to improvements in functioning for youth with ADHD treated by community-based pediatricians? and (2) Does treatment-related change in the distinct ADHD-related symptom domains uniquely predict change in specific areas of impairment? Using data collected as part of routine clinical care by primary care providers, this study assessed how community-delivered ADHD treatment impacted symptoms and impairments over time (up to 5 years) in youth aged 3 through 17. Based on previous findings,²⁵ it was hypothesized that reductions in inattentive symptoms would correspond with reductions in academic impairment, whereas changes in hyperactive/impulsive symptoms would correspond with changes in social impairment.

METHODS

Participants

Participants were patients registered between October 2008 and December 2012 on an internet-based portal for evidence-based assessment of attention-deficit hyperactivity disorder (ADHD) (myADHDportal.com).²⁷ The portal allows primary care providers to enroll a patient on the internet-based portal if concerns about ADHD are evident. Through the portal, parent and teacher Vanderbilt Rating Scales are then administered in accordance with the American Academy of Pediatrics guidelines for effective assessment of ADHD.¹⁸ After an assessment is performed and if the provider prescribes treatment, the provider sets up the internet-based portal to prompt parents to complete ADHD ratings periodically to monitor patients' treatment response. The periodicity of this monitoring (e. g., weekly, monthly, quarterly) is determined by the provider when the patient is registered for treatment and can be modified by the provider at any point during treatment. For this study, participants were selected if they were between the ages of 3 and 17 at the initial assessment. Also, since this study is investigating the impact of treatment on parent-reported symptoms and impairments, only participants who began medication treatment within 3 months of the initial ADHD assessment and had at least one completed follow-up parent rating scale were included. Finally, patients whose parents reported previous diagnoses of intellectual disability, pervasive developmental disorder, or autism spectrum disorders were excluded as these conditions uniquely impact treatment recommendations and domains of interest in the

present investigation. The resulting sample included 1976 patients (71% male; mean age = 9.37, $SD = 2.99$). At the time of ADHD assessment, parents of 13% of the sample reported that their child had a diagnosis of a learning disability, and 32% indicated that their child had taken medication for ADHD previously. This retrospective review of health records was approved by the local institutional review board.

Measures

Vanderbilt Attention-Deficit Hyperactivity Disorder Parent Rating Scales—The Vanderbilt ADHD Parent Rating Scale (VADPRS²⁸) is a parent-report behavioral rating scale. The scale includes the 18 symptoms of ADHD defined by the DSM-IV-TR, as well as several symptoms screening for comorbid oppositional defiant disorder and internalizing symptoms (anxiety and depression). Items are rated on a 4-point scale ranging from 0 (“never”) to 3 (“very often”). ADHD symptom dimensions were created by averaging items within the 2 ADHD symptom domains: Inattention (9 items; baseline Cronbach's $\alpha = .91$) and Hyperactivity/Impulsivity (9 items; baseline Cronbach's $\alpha = .93$). Mean scores for the oppositionality subscale (22 items; baseline Cronbach's $\alpha = .92$) and internalizing subscales (7 items; baseline Cronbach's $\alpha = .87$) were also calculated. In addition, 7 items assess for impairment in academic (reading, writing, mathematics) and personal (relationship with peers, relationship with siblings, relationship with parents, participation in organized activities) domains. Impairment items are rated on a 5-point scale from 1 (“excellent”) to 5 (“problematic”) and were analyzed individually as described below.

Demographic Questionnaire—At the initial assessment, all parents completed a brief demographic questionnaire. Variables of interest for this study included child's sex and history of learning disability diagnosis or other diagnoses that met study exclusionary criteria (e.g., intellectual disability, autism spectrum diagnosis).

Data Analytic Plan

To assess correspondence between ADHD symptoms and ADHD-related impairments over time, multilevel modeling was conducted using MPlus, version 7.²⁹ Longitudinal hierarchical linear modeling was the necessary statistical method due to the nonindependent and nested nature of the response variable data (i.e., repeated response variable measurements over time [Level 1] nested within individuals [Level 2]). Each patient's ratings were used to model the change in ADHD symptoms and impairment over time (i.e., slope) and to establish each individual's deviation from the group mean slope. Individual variation in ADHD symptom slopes and impairment slopes are then used to explore the predictive hypothesis: Does variation in slope for ADHD symptoms predict variation in slope for impairment?

In our initial models (i.e., Level 1), we examined whether symptoms and impairments changed over time (Fig. 1). For each outcome (inattentive symptoms, hyperactive/impulsive symptoms, impairment), a predictor variable indicating time was tested, examining the slope for the group as a fixed effect and each individual's variation from the group slope as a random effect. Notably, each rating that was entered into the portal represents a follow-up time point, and “time” in the models referred to the number of days since the initial

assessment (assessment was coded as Day 0). Since symptoms and impairment may demonstrate a nonlinear pattern of change, quadratic and cubic effects were also explored in each model. A quadratic effect (i.e., time²) refers to a line that has 1 shift in direction (e.g., plateau effect), whereas a cubic effect (i.e., time³) would indicate a line with 2 directional shifts. Linear, quadratic, and cubic fixed effects were retained in Level 1 models if they significantly contributed to the model (i.e., $p < .05$). Since a primary hypothesis of this study was the impact of individual variation in slopes for ADHD symptoms on individual variation in slopes for impairments, random effects were retained even if they did not reach statistical significance.

After specifying slopes in the Level 1 models, individual variations in ADHD symptom and impairment trajectories were used to examine the predictive hypotheses at Level 2 (Fig. 1). Separate multilevel models were estimated to determine whether the slope of ADHD symptom change significantly predicted the time-related slope of change in impairment.

All models were estimated using maximum likelihood estimation, which is robust to nonnormality and is therefore an appropriate method for handling multilevel missing data. All models were estimated controlling for differences in age, presence of learning disability, symptoms of internalizing disorders, and oppositional symptoms since each of these variables could potentially affect treatment response. These variables were entered as time-invariant covariates using baseline data.

RESULTS

Across the sample, parents completed anywhere between 1 and 65 (mean = 6.09, SD = 6.09) follow-up assessments to monitor treatment response over the course of treatment (range = 1–1914 days, mean = 246.38 days, SD = 244.26 days). Approximately 25% of patients were followed for up to 2 months, an additional 25% for up to approximately 6 months, an additional 25% for nearly 1 year, and the remaining 25% were followed for more than 1 year. Independent group t tests compared youth with fewer than 365 days of data to those with 366 days or more on baseline variables to test whether those providing more data were different from those patients providing less data. No significant differences between groups were found for sex ($\chi_{(1)} = .399, p = .53$), learning disability ($\chi_{(1)} = 1.71, p = .19$), baseline levels of anxiety ($t_{(1461.24)} = 1.60, p = .11$), age ($t_{(1974)} = .26, p = .80$), or baseline parent-ratings of impairments in relationship with parents ($t_{(1461.24)} = 1.60, p = .11$), siblings ($t_{(1461.24)} = 1.60, p = .11$), peers ($t_{(1461.24)} = 1.60, p = .11$), or participation in organized activity ($t_{(1461.24)} = 1.60, p = .11$). However, youth with fewer than 365 days of follow-up data available had significantly higher (i.e., more severe) baseline parent-ratings of oppositional symptoms ($t_{(1732)} = 2.96, p < .01$), inattentive symptoms ($t_{(1974)} = 4.89, p < .001$), hyperactive/impulsive symptoms ($t_{(1617.76)} = 4.15, p < .001$), and higher parent-ratings for impairments in reading ($t_{(1913)} = 2.80, p < .01$), writing ($t_{(1924)} = 3.45, p < .01$), and mathematics ($t_{(1904)} = 2.39, p < .05$).

Level 1 Models

Level 1 models estimated changes in attention-deficit hyperactivity disorder (ADHD) symptom dimensions and areas of impairment over time. These Level 1 fixed-effect models

describe group mean slopes, or the slope in ADHD symptoms averaging all the individual patient slopes. The overall trend for both hyperactive/impulsive and inattentive symptom dimensions across all models was similar, showing significant linear, quadratic, and cubic trend component significance. Specifically, these slopes included a modest significant linear decrease ($p < .001$), a minimal significant quadratic increase ($p < .001$), and a minimal significant cubic decrease ($p < .001$). This pattern of results suggests an average trajectory in which ADHD symptoms initially improve then level off (Fig. 2).

The average fixed-effect slopes for each area of impairment were slightly more varied. As seen in Table 1, fixed-effect estimates for linear and quadratic change in the impairment items were nonsignificant, indicating that, on average, impairment levels remained static over time. Notably, very minimal decreases at the cubic level were found to be statistically significant for all impairment domains except relationship with parents and siblings (Table 1). Figure 2 is a graphical depiction of the growth curves for each model. Importantly, to improve interpretability, these graphs use raw data, not model predicted estimates. Also, the graph is limited to the first year after assessment because the majority (75%) of data is available for this period of time.

Level 2 Models

After exploring average trends over time in Level 1, we tested whether there was significant individual variation in slopes over time. Significant variation in individual slopes (i.e., random effects) was found for both ADHD symptom domains and all impairment domains. Therefore, it was possible to estimate whether variation in ADHD symptom change predicted change in impairment trajectories.

With few exceptions, the pattern of results showed that reductions in symptoms did not predict corresponding reductions in areas of impairment. That is, time-related changes in symptoms were not related to time-related changes in impairments for symptoms of inattention (linear effect estimates range, 0.31–2.36, $p > .05$) or hyperactivity/impulsivity (linear effect estimates range, –0.93 to 0.46, $p > .05$). There were 2 exceptions to this pattern, where a significant positive estimate indicated a direct association between change in ADHD symptoms and change in impairment. First, decreases in inattentive symptoms were associated with decreases in writing impairment (linear effect estimate = 1.97, $p < .05$). Second, decreases in hyperactivity/impulsivity symptoms were associated with decreases in impaired peer relationships (linear effect estimate = 0.91, $p < .05$).

DISCUSSION

For children with attention-deficit hyperactivity disorder (ADHD), it is often functional impairments, rather than symptoms, that are associated with long-term outcomes,¹⁴ and recent published guidelines accordingly emphasize the importance of evaluating both symptom reduction and reduction in impairment when determining treatment outcome.¹⁸ However, very few studies to date have explored the extent to which improvements in symptoms that occur after treatment correspond to improvements in impairments.^{16,17} Furthermore, no study has examined the relationship between symptom domain (i.e., hyperactivity/impulsivity and inattention) improvement and various domains of impairment.

In an effort to build on these previous studies, this study examined symptom-impairment correspondence (per parent report) for youth with ADHD treated by their community providers.

Results suggested that ADHD symptoms tend to improve with community-delivered treatment over time, although, notably, this trajectory levels off after initial improvement. In contrast, specific areas of impairment did not significantly improve with treatment. Furthermore, symptom improvement did not correspond to improvements in impairment for the majority of impairment domains (reading, mathematics, relationship with parents, relationship with siblings, participation in organized activities). Notable exceptions were that decreases in inattentive symptoms corresponded with initial improvements in writing, and reductions in hyperactivity/impulsivity symptoms were associated with initial improvements in peer relationships. Taken together, these findings suggest that youth with ADHD who are treated by their community pediatrician with medication management tend to initially improve in their symptom presentation, although this symptom reduction plateaus and is not associated with corresponding improvements in most domains of impairment.

That symptoms of inattention and hyperactivity/impulsivity improve with community-delivered medication treatment is consistent with a large body of previous literature. Specifically, well-controlled laboratory trials have long demonstrated the short-term efficacy of stimulant medication on reducing symptoms of ADHD.³⁰ Furthermore, the few studies to explore the impact of sustained medication treatment delivered in community settings have found that initial symptom improvement attenuates over time.^{15,21}

Also consistent with previous work,^{15,21} trends in improvements across impairment domains over time are absent across most functional impairment domains, offering further support for the notion that medication treatment does not sufficiently address impairments in daily functioning. One unexpected finding among impairment trajectories was the significant cubic trend, which would imply that youth who are treated for longer periods of time may experience some minimal improvements in the domains of reading, writing, mathematics, relationships with peers, and participation in organized activities. However, these findings should be interpreted with caution because only 25% of the sample had follow-up data beyond the first year of treatment. Although further study is warranted, our findings indicate that functional impairment remains largely unaffected by medication treatment delivered by community-based pediatricians.

Beyond exploring trends in symptom dimensions and impairment domains over time for youth treated by community providers, a key question this study sought to answer was the extent to which symptom-impairment correspondence was evident. By evaluating these trajectories in the same multilevel model, it was possible to estimate whether changes in symptom dimensions over time predicted corresponding changes in impairment trajectories. A lack of support for this correspondence was demonstrated for the majority of impairment domains. In line with the few previous studies that have looked at correspondence in a categorical manner,^{16,17,21} these results add fuel to growing skepticism that reductions in symptoms translate to improved functioning.

A few exceptions to this pattern were evident, although it is notable that even with a large sample size, findings were found to be significant at only the $p < .05$ level. First, inattentive symptom changes were associated with changes in writing impairment. There is some evidence that stimulant medication may improve motor skills in youth with ADHD,³¹ which may be reflected in handwriting. Also, the strong association between inattention and academic impairment is well-established.^{25,26}

Changes in the hyperactivity/impulsivity domain were associated with changes in parent-reported relationships with peers. Although previous work has suggested that oppositional behaviors contribute independently to difficulties with peer relationships,²⁵ many of the behaviors that children with ADHD exhibit that their peers find aversive (e.g., impulsive aggression, interruptions/intrusions, lack of adherence to game rules) may be related to impulsive and overactive behaviors.³² These findings highlight the complex difficulties children with ADHD face in interpersonal relationships.

Despite these few promising exceptions, symptom-impairment correspondence was not found for the majority of impairment domains. Although reductions in symptoms may have a positive impact on certain symptom-specific behaviors, such as being better able to hear instructions and attend to activities, the full scope of ADHD-related deficits do not seem to be sufficiently addressed by medication treatment delivered in the community.²¹ For youth with academic difficulties, for example, proficiency with organizational skills, note taking, studying, planning ahead, and other complex learning skills are not addressed solely by medication treatment. Other modalities of treatment (e.g., academic skills training) are necessary to improve academically. Moreover, even when youth demonstrate significant ADHD symptom reductions in university-based medication trials using rigorous dosing and monitoring regimens, youth with ADHD usually are still not achieving “normalized” functioning that is comparable with that of their peers.²¹ Additionally, there are likely other factors contributing to child impairment, such as parent psychopathology, chaotic home environment, and impoverished school settings that are not affected by medication. It may be that many youth require combined treatment (i.e., medication and psychosocial interventions) to address specific areas of impairment.

There are several potential limitations to this study. First, although the Vanderbilt Scales are widely used and have demonstrated acceptable psychometric properties for the symptom scales,³³ the psychometric strength of the impairment items has not yet been established. Future investigations of symptom-impairment correspondence would likely be strengthened by using multiple items from well-validated measures of functional impairment to capture a more comprehensive picture of the impact of symptom improvement.

Another limitation of this study is the use of naturalistic, community-based data collection (i.e., provider collected ratings and scheduled appointments as needed). Such community-based studies have high rates of missing data. To address this, we used analytic techniques that allowed us to include all available data, regardless of loss to follow-up. Also, such community-based research limits collection of potentially important variables. For example, specific details about actual treatment received (e.g., concurrent behavioral treatment, medication type, dose, adherence) are not available. Since the majority of patients in this

study were treated for less than a year, this study is not able to examine the impact of sustained medication treatment on symptoms and impairment over long periods of time. Similarly, since reduced impairment has been shown for behavioral treatments that are implemented consistently over long durations and with a high “dose” of treatment,³⁴ the impact of medication treatment may similarly be related to treatment that is consistent and sustained. However, since primary care providers conducted follow-up appointments according to their own clinical judgment, it is possible that more follow-up visits were completed for those patients whose parents reported more persistent impairments. Although this is certainly a possibility, youth in this study were within the age range when annual well-visits are typical, and it is highly likely that providers using the myADHDportal.com intervention²⁷ were aware of guidelines emphasizing continual follow-up care for all youth prescribed medication for ADHD.¹⁸

Additional limitations pertain to the ratings of ADHD symptoms and impairment. Teacher ratings, although collected through the internet-based portal (myADHDportal.com),²⁷ were not analyzed as part of this study. Future studies should explore correspondences between change in teacher-rated ADHD symptoms and teacher-rated impairments, especially because it is well established that teacher reports add valuable information to understanding children's ADHD symptoms and impairments.²⁵ A further limitation related to ratings is that parents may have been biased in ratings of their child's impairment because they were aware of treatment status. However, this type of bias would most likely favor improvement, so it is reasonable to assume the impact of rater bias was minimal.

As this is the first study to look at sustained treatment delivered in the primary care setting over long periods of time, future studies should continue to explore these associations while addressing the limitations of this study. In addition, there may be baseline characteristics of youth that suggest differential treatment response and adherence.²¹ For example, ADHD symptom severity may predict medication response,³⁵ and lack of efficacy of treatment may lead to higher rates of drop out.³⁶ A further limitation of this study that warrants future work is the impact of severity and treatment response on sample bias. Since attrited youth were not reassessed, this study cannot determine whether patients who attrited represent youth with more severe symptoms or youth who improved and remained improved, so their provider stopped collecting rating scales after significant patient improvement. Determining features of this subset of youth will be important for maximizing treatment benefit in the future.

It is clear from this and other studies that the majority of youth with ADHD are not receiving the type of sustained combination treatment that is recommended to address their chronic condition¹⁸ and improve long-term outcomes. Specifically, findings from this study would suggest that typical treatment provided by community-based pediatricians is not having a significant impact on daily life functioning of youth with ADHD. Given these somewhat disheartening findings, providers are faced with the difficult dilemma of determining how best to treat their patients with ADHD. There are a number of evidence-based behavioral treatments that have been shown to reduce impairments both alone and in combination with medication management.^{8,9} Although no studies exist evaluating behavioral or combination treatment sustained for longer than 14 months,⁷ substantial

significant improvements across a wide array of domains of impairment have been demonstrated for both behavioral and combined treatments.^{8,9} Therefore, this study highlights the importance of including behavioral or combined treatment approaches to achieve the best outcome for youth with ADHD. This is consistent with current care recommendations in the primary care setting, which indicate that medication treatment “and/or” behavioral interventions in the home and school setting be implemented.¹⁸ Furthermore, the tendency of symptom improvement to plateau suggests that continued reassessment over long periods of time will help providers monitor symptoms and impairments to determine whether treatment adjustments should be made to optimize the child's functioning.

However, limitations around time constraints and reimbursement schedules make offering comprehensive behavioral health services challenging in the primary care setting.^{37,38} Also, adequate psychosocial treatments are often not available in many communities. Therefore, this study underscores the vital importance of continued research into innovative methods for improving access to effective treatments for youth with ADHD.

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Figure 1.

Conceptual model. S1, the random linear effect of impairment over time; S2, the random linear effect of hyperactive/impulsive symptoms over time; S3, the random linear effect of inattentive symptoms over time; S4, the random quadratic effect of impairment over time. Time, days from initial assessment.

Figure 2.

Growth curves using raw data (not model predicted values) for symptom dimensions and impairment domains. Data are artificially restricted to the first 360 days after initial assessment to represent the follow-up period with the most data.

Table 1

Level 1 Fixed Effects and SEs for Analysis Assessing Impact of Time on Impairment Trajectories

Growth Trend	Reading	SE	Written Expression	SE	Mathematics	SE	Relationship With Parents	
Linear trend	−0.267	1.001	2.615	1.834	1.522	3.652	0.665	
Quadratic trend	0.096	0.054	−0.025	0.093	0.043	0.173	−0.013	
Cubic trend	−0.002*	<0.001	−0.002*	<0.001	−0.002*	<0.001	<i>a</i>	

Growth Trend	SE	Relationship with Siblings	SE	Relationship with Peers	SE	Participation in Organized Activities	SE
Linear trend	1.926	1.068	0.834	1.534	0.845	−0.194	0.869
Quadratic trend	0.090	−0.022	0.043	−0.032	0.043	0.069	0.042
Cubic trend		<i>a</i>		−0.001*	<0.001	−0.002*	<0.001

^a Cubic trends were nonsignificant during model building and were therefore excluded from the final models.

* $p < .001$.