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Variable Patterns of Remission from ADHD in the Multimodal Treatment Study of ADHD

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Abstract

OBJECTIVE: It is estimated that childhood ADHD remits by adulthood in approximately 50% of cases; however, this conclusion is typically based on single endpoints, failing to consider longitudinal patterns of ADHD expression. We investigated the extent to which children with ADHD experience recovery and variable patterns of remission by adulthood.

METHOD: Children with ADHD (*N*=558) in the Multimodal Treatment Study of ADHD (MTA) were administered eight assessments from 2-year (*M* age=10.44) to 16-year follow-up (*M* age=25.12). We identified participants with fully remitted, partially remitted, and persistent ADHD at each timepoint based on parent, teacher, and self-reports of ADHD symptoms and impairment, treatment utilization, and substance use and mental disorders. Longitudinal patterns of remission and persistence were identified that considered context and timing.

RESULTS: Approximately 30% of children with ADHD experienced full remission at some point during the 14-year follow-up period; however, a majority (60% of these) experienced recurrence of ADHD after the initial period of remission. Only 9.1% of the sample demonstrated recovery (sustained remission) by study endpoint and only 10.8% demonstrated stable ADHD persistence across study timepoints. Instead, most participants with ADHD (63.8%) had fluctuating periods of remission and recurrence over time.

CONCLUSIONS: The MTA findings challenge the notion that approximately 50% of children with ADHD outgrow the disorder by adulthood. Most cases demonstrated fluctuating symptoms between childhood and young adulthood. Although intermittent periods of remission can be expected in most cases, 90% of children with ADHD continued to struggle with residual ADHD through young adulthood. Clinical Trial Number: NCT00000388, *Multimodal Treatment Study of Children with Attention Deficit and Hyperactivity Disorder (MTA)*. https://clinicaltrials.gov/ct2/show/NCT00000388

Decades of research characterize Attention-Deficit/Hyperactivity Disorder (ADHD) as a neurobiological disorder typically first detected in childhood that persists into adulthood in approximately 50% of cases.[1–3] Substantial scientific work examines ADHD persistence, the extent to which children with ADHD continue to meet Diagnostic and Statistical Manual of Mental Disorders (DSM) criteria in adolescence and adulthood. However, less research investigates remission (loss of symptoms and impairment), recurrence, and recovery (sustained remission over time). Most ADHD longitudinal studies simply define remission as “failing to meet DSM criteria,” with few attempts to identify/define distinct subtypes and patterns of remission.[4–6] Understanding common trajectories of ADHD remission, recurrence and recovery is critical to informing provider, patient, and family treatment decisions.

In the most detailed efforts to our knowledge, Biederman and colleagues[7–8] demonstrated that 65–67% young adults (mean age 22) with childhood ADHD no longer met full DSM criteria. On the other hand, the vast majority (77–78%) had clinically elevated ADHD symptoms, impairment, and/or continuation of ADHD treatments. Thus, most participants classified as remitted based on traditional DSM guidelines still possessed impairing subthreshold ADHD symptoms or experienced "remission" only when receiving ADHD treatment (e.g., stimulant medication). Biederman and colleagues detected a subgroup of children with ADHD who appeared fully remitted in young adulthood (~22–23%), signifying possible recovery from ADHD. Yet the longitudinal course and optimal definition of full remission remains understudied.

Most longitudinal work on ADHD remission and persistence reports only a single-time snapshot of functioning, even though ADHD is considered a life-course disorder.[2,4–6,9,10] There is virtually no scientific information on the extent to which individuals sustain remission long-term (i.e., recover from ADHD symptoms and impairments), experience recurrence of ADHD post-remission (i.e., remission is temporary), or fluctuate between full remission, partial remission, and ADHD persistence (whether ADHD might be a waxing and waning disorder). If remission is typically temporary, practice guidelines should emphasize the need for continued ADHD screening/monitoring post-remission, with need for rapid response to symptom reemergence. If ADHD tends to wax and wane, factors modulating phenotypic expression must be identified and person-environment fit emphasized as a crucial framework for evaluation and treatment over time.

This study investigates longitudinal patterns of remission from ADHD in the Multimodal Treatment Study of ADHD (MTA) follow-up,[3,10–11] which utilized multi-informant assessment to measure ADHD symptoms, impairments, treatment utilization, and comorbidities across 16 years, spanning childhood through young adulthood. Using a thorough stepwise procedure, we 1) validated age-appropriate full remission symptom thresholds in childhood, adolescence, and young adulthood; 2) examined detailed symptom, impairment, comorbidity, and treatment utilization information to classify participants as fully remitted, partially remitted, or persistent at each of eight MTA follow-up assessments; and 3) outlined longitudinal patterns of symptom remission, recurrence, and recovery with attention to onset, duration, type (full or partial), and course of remission.

METHOD

The MTA[12] originally compared 14 months of pharmacological and psychosocial treatments for 579 children (7.0 to 9.9 years old) with DSM-IV ADHD-Combined Type. Baseline characteristics are provided in Supplement 1. Two years after baseline, 289 classmates were recruited as a local normative comparison group (LNCG). The MTA continued fourteen years of prospective follow-ups approximately biennially (8 assessments) until 16 years after baseline.[13–16]

Participants

The current subsample (*N*=558; 95.3% of original sample) includes participants with at least one follow-up assessment (beginning 2 years after baseline). Retention in adulthood

(completed 12-, 14-, or 16-year assessment) was 82% for the ADHD group (*N*=476) and 94% for the LNCG (*N*=272). On average, participants completed 6.21 of eight possible follow-ups (*SD*=2.25). Average age was 10.44 (*SD*=.87) at 2-year and 25.12 (*SD*=1.07) at 16-year follow-up. The subsample did not differ from the full sample on any baseline variable.

Procedures

Follow-up assessments were administered to participants and parents at 2, 3, 6, 8, 10, 12, 14, and 16 years post-baseline by bachelor's-level staff who were closely supervised and trained to be objective. Teacher ratings were obtained at childhood and adolescent assessments. For 2.3% of adult assessments, a parent was unavailable and ratings were collected from a non-parental informant (e.g., partner, sibling).

Measures

ADHD Symptoms.—Child and adolescent symptoms were measured using the SNAP completed by parents, teachers, and adolescents.[17–18] Symptoms in adulthood were measured using the Conners Adult ADHD Rating Scale (CAARS) completed by participants and parents.[19] Both instruments measure *DSM-IV-TR* ADHD symptoms. Respondents rated symptoms over the prior four weeks on a 0=not-at-all to 3=very-much scale. Scores of 2–3 indicated symptom presence, as is standard practice.[20]

Impairment.—In childhood and adolescence, impairment was measured using the parent-report Columbia Impairment Scale (CIS), which assesses 13 impairment domains on a 0–4 severity scale.[21–22] In adulthood, the parent- and self-report Impairment Rating Scale (IRS) measured impairment globally and in eleven domains from 0=no problem to 6=extreme problem.[23] For the current study, we validated CIS and IRS thresholds for "absence of impairment" (see Supplement 2) using normative data from the LNCG. These analyses indicated that for the CIS, absence of impairment was optimally defined as a "1" or lower on all CIS items. For the IRS, absence of impairment was optimally defined as a "2" or lower on all items (combining parent- and self-reports using an "OR rule").[24]

Mental Health and Substance Use Disorders.—The Diagnostic Interview Schedule for Children (DISC)[25] was administered using parent- and self-reports. Self-report began at the 6-year follow-up; the DISC was not administered at the 10-year follow-up. The DISC is a structured interview that queries the presence of DSM criteria using screening questions and supplemental probes. All disorders assessed by the DISC were documented. For a list of included disorders see Supplement 5.

Service Utilization.—The Services for Children and Adolescents Parent Interview (SCAPI)[26] was administered through the 10-year assessment. It collected between-assessment estimates of daily dose and number of days treated for ADHD medications, as well as psychosocial and educational intervention utilization (including frequency, duration, and type of services). Similar information was collected at 12 through 16-years using the Health Questionnaire, which queried therapy and medication, including doses, duration, and type of services.[11]

Analytic Plan

Defining Full Remission.—Our first task was to empirically validate a "full remission" symptom count threshold that 1) represents normative symptom count levels based on LNCG percentiles (normativity) and 2) maximizes sensitivity and specificity to detect childhood ADHD cases without residual impairments at follow-up (correct classification). We separately analyzed data from child (age<12), adolescent (age 12–17.99), and young adult (age≥18) follow-ups to consider developmentally-specific thresholds. After reviewing normativity and correct classification data for each developmental group, selection of final thresholds considered parsimony, theoretical clarity, and ease of use by clinicians.

We began with four face-valid candidate definitions for full remission using equivalent thresholds for inattention (IN) and hyperactivity/impulsivity (HI) symptom counts (i.e., 3, 2, 1, or 0 of both IN and HI). We did not test 4-, 5-, and 6-symptom remission thresholds given that: a) 5- and 6-symptom thresholds indicate the *presence* of elevated symptoms in the *DSM-5* ADHD "A criterion," and (b) the 4-symptom threshold has repeatedly demonstrated validity as a norm-based threshold for adolescent/adult ADHD symptom elevations.[1–2,27]

Each candidate definition used reports from all available informants, which were integrated using an "OR rule": if any informant endorsed a symptom, it was counted as present.[24] To prevent false negative symptom and impairment reports due to under-reporting by participants with ADHD,[3,27] we required those meeting the "remitted" definition (and "unimpaired" criterion) to have at least one other informant report to corroborate the lack of difficulties. Thus, for full remission, one must be below the symptom threshold according to combined information from all informants, including at least one besides self.

With respect to normativity, we calculated LNCG percentiles for each symptom count threshold and developmental group. In this analysis, we excluded 31 LNCG participants with a baseline diagnosis of ADHD. Empirical percentiles were calculated as m+.5k where m=percentage of LNCG scoring below threshold and k=percentage of LNCG scoring at threshold. Based on standard norming procedures for mental health symptom measures, scores below the LNCG 84th percentile were considered in the normal range.[28]

With respect to correct classification, Receiver Operating Curve (ROC) analyses provide an index of diagnostic accuracy (area under the curve, AUC) for each candidate symptom count threshold (true positives + true negatives/total sample) that optimizes both sensitivity and specificity.[29] Absence of impairment (see Supplement 2) was the ROC criterion (i.e., indicating symptoms were no longer clinically significant). Within each developmental period, when participants possessed multiple data points, we randomly selected one per participant for the ROC analyses.

Detecting Cases with Full Remission of ADHD.—We evaluated all cases for full remission of ADHD at each of eight follow-up assessments. We used a stepped procedure based on an "AND rule" that first required symptoms to fall below the full remission threshold according to all informants, then required absence of clinically significant impairment, and finally required discontinuation of all ADHD intervention for at least a month prior to the assessment (see Supplement 3). Exclusion of currently treated cases

from the full remission category does not imply confidence that treatment is in every case dampening symptom expression; rather, it conservatively assures that symptom remission is not due to active treatment. Services for non-ADHD difficulties were allowed. For each assessment, we classified remaining cases as “persistent” or “partially remitted.” We utilized a previously validated definition of persistence,[3,10] which applied the DSM-5 symptom threshold (5 or 6 symptoms of either Inattention or Hyperactivity/Impulsivity, depending on age) using the CAARS (or SNAP) and impairment threshold of “3 or higher” on the IRS (or CIS). Partially remitted cases met criteria for neither persistence nor full remission.

Consideration of Impairment Due to Other Disorders.—Following the stepped review procedure, we re-examined cases below the symptom threshold with continued impairment to estimate if this impairment was due to residual ADHD symptoms (leading to a classification of partial remission) or to mental health or substance use diagnoses (leading to a classification of full remission). Because the DISC does not address differential diagnosis, we assembled an expert clinical panel to review cases with clinically significant impairment that might be due to a problem other than ADHD. For each case, three board-certified child/adolescent psychiatrists and four licensed clinical psychologists reviewed mental health and substance use diagnoses, domains of impairment, ADHD symptom endorsements, and treatment utilization. They judged whether reported impairments were best explained by residual ADHD symptoms or a concurrent substance use or mental disorder. Most decisions (80.9%) were unanimous; no split vote had more than 2 dissenters. For further details, see Supplement 5.

Longitudinal Patterns of Remission, Recurrence, and Recovery from ADHD.—Recurrence was defined as meeting criteria for “persistence” (full recurrence) or “partial remission” (partial recurrence) after a period of full remission. We defined recovery as full remission of ADHD sustained for at least two consecutive assessments without a subsequent recurrence (full remission until study endpoint). On four occasions, a data point was missing but bookended with two episodes of full remission. Here, continuity of recovery was assumed but the missing data point was not counted when calculating the duration of full remission. In addition to the recovery pattern, three additional longitudinal patterns were defined. Stable persistence was persistent ADHD over the entire follow-up. A fluctuating pattern was defined by at least two changes to classification since baseline diagnosis of ADHD, in the absence of the recovery pattern. Stable partial remission was defined as displaying one classification change from persistent ADHD to partial remission that continued until study endpoint.

RESULTS

Defining Full Remission Symptom Threshold

LNCG percentile ranks indicated that across developmental periods, all candidate definitions for full remission represented symptom counts within the LNCG normative range of functioning (<84th percentile). AUC confidence intervals (see Table 1) indicated that across developmental periods, all four candidate definitions detected absence of impairment at a

level greater than chance (AUC>.5). A stepwise series of curves indicated an increasing ratio of sensitivity to specificity when moving from the 0- to 3-symptom threshold.

For childhood and adulthood, the 3-symptom threshold demonstrated optimal diagnostic accuracy (i.e., AUC value) and normativity (i.e., most LNCG had three or fewer ADHD symptoms in childhood [72.5%] and adulthood [81.0%]). Although the 2-symptom threshold demonstrated optimal diagnostic accuracy in adolescence, the 3-symptom threshold was ultimately preferred because normativity was stronger for the 3-symptom threshold (60.3% LNCG had 3 or fewer symptoms in adolescence vs. 51.3% for the 2-symptom threshold) and the 2- and 3-symptom thresholds did not significantly differ in AUC values (.681 versus .687; z=.54, p=.652). Adopting the 3-symptom threshold for all developmental periods permitted parsimony and ease of use.

Detecting Cases with Full Remission of ADHD

Table 2 outlines the stepped classification process and displays the proportion of fully remitted cases by assessment at each step. Across assessments, percentage of fully remitted cases ranged from 1.4% (2-year assessment) to 18.5% (10-year assessment). Percentage of partially remitted cases ranged from 37.2% (10-year assessment) to 51.4% (2-year assessment). Percentage of persistent cases (i.e., those who met DSM-5 criteria for ADHD) ranged from 39.7% (14- and 16-year assessments) to 55.9% (6-year assessment).

Longitudinal Patterns of Remission, Recurrence, and Recovery from ADHD

Table 3 displays longitudinal patterns of remission, recurrence, and recovery as percentages of the whole sample (ADHD group) and selected subgroups (e.g., those with at least one full remission period). In total, 31.4% (n=175) of the sample met criteria for full remission during at least one time point. Among 175 fully remitting cases, 59.4% (n=104) demonstrated full (29.1%) or partial (30.3%) recurrence of ADHD after the initial episode of full remission. Recovery from ADHD was detected for 9.1% (n=51) of the sample; additionally, 10.8% (n=60) of the sample were persistent at all time points, 15.6% (n=87) experienced partial remission that maintained through study endpoint, and 63.8% (n=356) demonstrated a pattern of fluctuating ADHD (see Figure 1). Four cases had insufficient information for longitudinal classification. Supplemental analyses (see Supplement 10) illustrate longitudinal classifications when full and partial remission statuses are collapses into one “remission” category. When structuring the data in this way, 48.5% meet criteria for the fluctuating status by study endpoint.

Among the 9.1% who demonstrated recovery by the final MTA assessment (age M=25.12, SD=1.07), median recovery period duration was four years. Onset of recovery came in adulthood for 76.5% (n=39), adolescence for 21.5% (n=11), and childhood for 2.0% (n=1) of the 51 classified as recovered. Figure 2 depicts sample cases for the fluctuating ADHD and recovery patterns.

DISCUSSION

Our goal was to understand the longitudinal course of ADHD remission from childhood to young adulthood. Results indicated that approximately one-third of children with ADHD

experienced full remission at some point during fourteen years of prospective longitudinal study. A majority of these fully remitting youth (~60%) experienced full or partial recurrence of ADHD after the initial period of full remission. Only 9.1% of the children with ADHD demonstrated recovery from ADHD (i.e., sustained remission to study endpoint; mean age 25) and only 10.8% demonstrated stable ADHD persistence across all timepoints. For most of the sample (63.8%), the follow-up period was characterized by fluctuating persistence and remission (full or partial) in the absence of recovery.

This study is consistent with previous findings that, at a single timepoint, most individuals who no longer meet ADHD DSM criteria still experience elevated symptoms or impairments or are actively treated with medication (see Table 2).[7–8] In the present study, full remission at a single assessment ranged from 1.4% to 18.5%. Young adult assessments corresponding temporally with Biederman and colleagues' estimates (i.e., 12- and 14-year assessments) demonstrated comparable full remission rates (18% vs 22–23%).[7–8] Expanding on previously reported MTA findings,[10] the present study indicates that 40–50% of the ADHD group met DSM criteria for ADHD at any given follow-up. However, remission was typically partial, rather than full. The high prevalence of partial remission is consistent with the finding of Hechtman et al. that many MTA ADHD group participants who failed to meet ADHD symptom criteria in adulthood still suffered significant impairments.[10] We also confirmed that most recoveries from ADHD begin in adulthood (see Table 3), although this finding could be partially an artefact of not having later assessments to detect recurrences.

The MTA's longitudinal perspective highlights that full remission at a single timepoint should not be conflated with recovery from ADHD. Only 9.1% of the MTA sample experienced recovery (i.e., sustained remission for multiple time points until study endpoint). After a period of full remission, recurrent ADHD symptoms were the rule, rather than the exception. Overall, results suggest that over 90% of individuals with childhood ADHD will continue to struggle with residual, though sometimes fluctuating, symptoms and impairments through at least young adulthood. Our more nuanced, longitudinal estimate of remission challenges claims that approximately half of children with ADHD outgrow their difficulties by adulthood.

On the other hand, very few participants (10.8%) were characterized by a stable pattern of ADHD persistence across the follow-up period. Among those who did not recover, most experienced either stable partial remission (15.6% of ADHD group) or fluctuating, waxing and waning ADHD symptoms (63.8% of ADHD group) from childhood to young adulthood. This finding echoes Lahey et al. who detected longitudinal symptom fluctuations in childhood ADHD that produced temporal instability in ADHD subtypes.[30] Our study was observational; therefore, we cannot draw definite conclusions about the causes of remission. However, we speculate about several possible sources of the waxing/waning. First, considering trait-state-error models of longitudinal data[31], these fluctuations may reflect a combination of individuals' genetic risks (i.e., traits), environmental factors (i.e., states), and measurement error. The high heritability of ADHD is well-established[32] and we speculate that genetic risks for ADHD might reflect a propensity for symptom expression that is dependent on environmental factors (e.g., changes in teachers, living arrangements, academic setting/level, type of employment, relationships with employment supervisors,

roommate(s), and significant others). For example, the MTA dataset previously revealed that adolescents with ADHD display temporary ADHD symptom spikes at the middle school transition.[33] Measurement error (e.g., regression to mean, informant bias) could have contributed to apparent symptom and impairment changes. Nevertheless, the fluctuating patterns detected here reveal ADHD to be a dynamic rather than static disorder. The extent to which environmental influences modulate symptom expression through neurobiological, basic cognitive, psychological, and/or behavioral mechanisms should be a future direction for research.

Our greatest limitation is that MTA follow-up discontinued at approximately age 25. Therefore, it is not clear how longitudinal trends will continue into middle and older adulthood. Similarly, it is unclear whether the recovery pattern reflects permanent remission. The MTA sample only recruited participants with ADHD-Combined Type. Results may not generalize to other ADHD subtypes/presentations. The literature lacked any empirical precedent for the boundary between full and partial remission. Our effort to define these categories attempted to balance false positive and false negative classifications while considering known methodological pitfalls and symptom/impairment norms in the MTA sample; however, alternative definitions that were considered (see Supplement 6) may have led to different estimates. Additionally, sensitivity analyses (see Supplement 8) suggested that missing data may have produced an underestimate of the fluctuating pattern (by up to 10%) and that source switching may have had a very slight impact on diagnostic fluctuations. During childhood and adolescence, impairment ratings were available only from parents. Some adolescents may have met impairment criteria if teacher or self-ratings were available. Similarly, teacher ratings were of necessity discontinued in adulthood; some symptoms present in post-secondary academic settings may have gone undetected. The DISC was not administered at the 10-year assessment; thus, we could not review comorbidities in impaired but asymptomatic cases for this time point. Decisions made by the expert clinical panel were likely imperfect because panel members were unable to query differential diagnosis during real-time clinical assessment.

We used empirically validated, absolute cut-points for symptom and impairment thresholds. Although reflective of diagnostic nosology, using cut-points to categorize continuous data can lead to statistical error. Furthermore, we did not test relative remission thresholds (i.e., within-subject reductions in symptom count), thresholds that defined remission as the absence of symptoms according to any available informant, or combination rules that require all informants to substantiate the presence of an ADHD symptom.[34] Analyses to validate the full remission definition should be replicated in additional, larger, more diverse samples prior to clinical application. Requiring an informant to substantiate self-reports of remitted ADHD may have produced some false negative full remission classifications. Whereas we required absence of ADHD treatment as a criterion for full remission, some treated cases may have experienced remission that was independent of therapeutic intervention. Some impairments may have reflected residual effects of eliminated symptoms. Furthermore, some remission periods may have represented residual benefits of discontinued medication or behavioral treatments; the full relation between treatment and remission will be explored in a future MTA investigation. Future work should replicate our findings, characterize

individuals who recover from ADHD, follow trajectories through older adulthood, and identify contributors to symptom fluctuations.

Conclusion

These findings emphasize that childhood-onset ADHD is a chronic but waxing and waning disorder with periods of full remission that are more often temporary than sustained. Results support a more informed perspective on ADHD, its impairment, and its tendency to fluctuate over time in symptoms and impairment-perhaps in response to environmental or health-related factors. Providers should expect recurrence of clinically elevated ADHD symptoms and impairments in most patients who experience remission—thus, continued periodic screening for recurrent symptoms and impairments should be standard practice after successful treatment. Given these findings, assessing factors that may influence symptom fluctuations (e.g., environmental fit, physical health) should be central to evaluation and treatment of ADHD across the lifespan. Future research should investigate malleable biological and environmental factors that trigger symptom fluctuations and might serve as targets for new classes of environmental or health interventions (e.g., modifications to factors that may catalyze and maintain symptomatic periods). Based on these findings, clinicians can communicate to families that most adolescents and young adults with ADHD (~90%) experience at least intermittent relief from their ADHD symptoms over time that may be modulated by personal or life circumstances.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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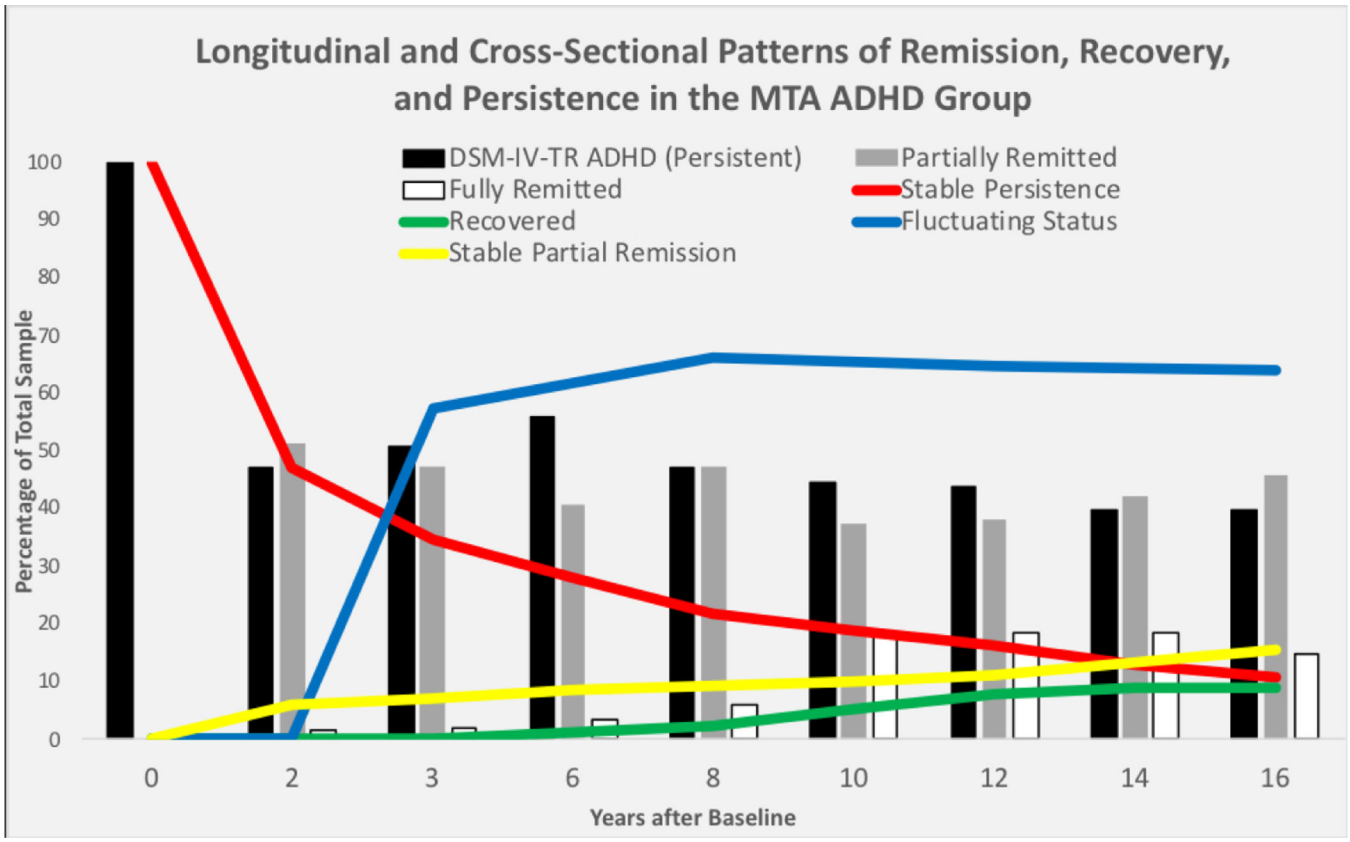

Figure 1.

Longitudinal and cross-sectional patterns of remission, recovery, and persistence in the Multimodal Treatment Study of ADHD

Note. Bar graphs indicate cross-sectional estimates for persistence, partial remission, and full remission; line graphs display longitudinal patterns by time point. We defined recovery as untreated full remission of ADHD that persisted for at least two consecutive assessments without being followed by an episode of recurrence (i.e., full remission continued until study endpoint). Therefore, the green line represents the percentage of participants who had experienced onset of recovery by the corresponding time point. Individuals were classified as displaying stable persistence if they demonstrated persistent ADHD for all assessments to date in the follow-up period. Therefore, the red line represents the percentage of participants who continued to demonstrate stable persistence at a given timepoint. Stable partial remission was defined as displaying one classification change from persistent ADHD to partial remission that maintained until study endpoint. Therefore, the yellow line represents the percentage of participants who had experienced onset of stable partial remission by the corresponding time point. A fluctuating pattern indicated at least two changes to cross-sectional classification since baseline diagnosis of ADHD, in the absence of the recovery pattern. Therefore, the blue line represents the percentage of participants who meet criteria for fluctuating status at a given time point (which precludes also meeting criteria for recovery at any future time point).

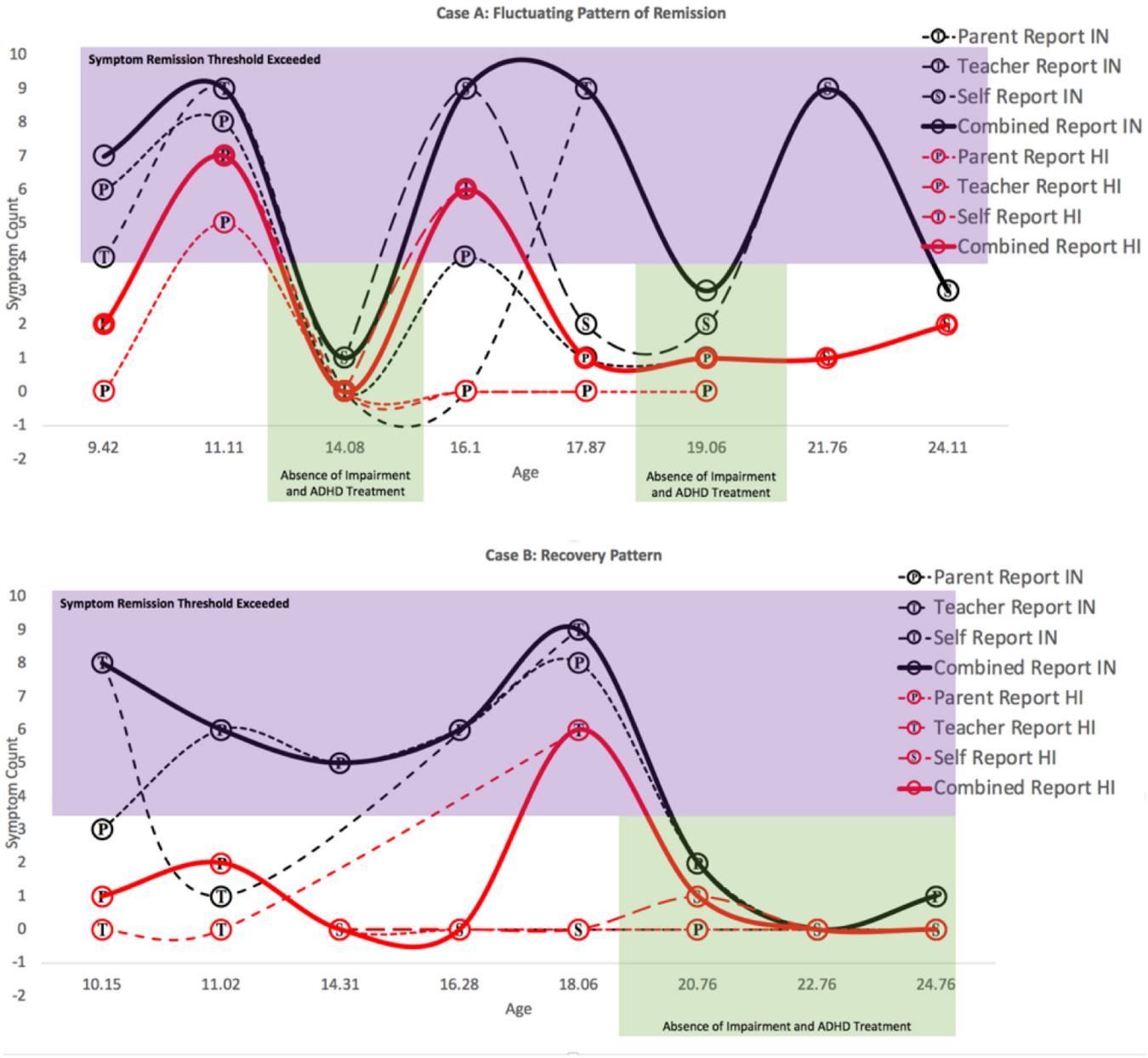

Figure 2.

Sample Cases with Fluctuating and Recovery Patterns of Remission

Note. Case A demonstrated clinically significant impairment during the 2-year (age 9.42), 3-year age 11.11), 8-year (age 16.10), 10-year (age 17.87), and 16-year (age 24.11) assessments and was treated with methylphenidate during the 8-year assessment (age 16.10) and with atomoxetine during the 14-year assessment (age 21.76). Case B demonstrated clinically significant impairment during the 2-year (age 10.15) through 10-year (age 18.06 assessment) and was treated with methylphenidate during the 2-year, 3-year, and 6-year assessments (ages 10.15 through 14.31), classroom behavioral intervention for ADHD at

the 3-year assessment (age 11.02), and attended a special school for ADHD at the 8-year assessment (age 16.28).

Table 1.

Comparison of Symptom Remission Thresholds in Childhood, Adolescence, and Adulthood

Threshold	Symptom Remission (%)	Normative Percentile†	AUC	SE	*p*	AUC 95% CI	Sensitivity (%)	Specificity	False Positive (%)	False Negative (%)
Childhood										
3 or fewer	18.5	72.5	.675	.041	<.001	.595–.755	49.2	85.8	14.2	50.8
2 or fewer	13.2	66.1	.658	.042	<.001	.576–.741	41.0	90.7	9.3	59.0
1 or fewer	10.0	54.4	.640	.043	<.001	.556–.723	34.4	93.5	6.5	65.6
0	5.3	23.1	.582	.043	.038	.499–.666	19.7	96.7	3.3	80.3
Adolescence										
3 or fewer	17.7	60.3	.681	.044	<.001	.595–.767	50.0	86.2	13.8	50.0
2 or fewer	12.7	51.3	.687	.045	<.001	.599–.776	46.2	91.3	8.7	53.8
1 or fewer	8.1	37.7	.670	.046	<.001	.529–.761	38.5	95.6	4.4	61.5
0	5.0	15.0	.623	.047	.004	.531–.714	26.9	97.7	2.3	73.1
Adulthood										
3 or fewer	40.3	81.0	.732	.027	<.001	.679–.786	71.8	74.7	25.2	28.2
2 or fewer	31.2	71.2	.721	.029	<.001	.665–.777	61.0	83.2	16.8	38.9
1 or fewer	20.3	49.0	.660	.031	<.001	.600–.721	42.0	90.1	9.9	58.0
0	7.4	16.8	.552	.031	.088	.491–.614	14.5	96.0	4.0	85.5

Note. AUC=Area Under the Curve; SE=standard error; CI= Confidence Interval; *p* represents statistical significance for the AUC test

†The Normative Percentile is based on age-matched data from the MTA's Local Normative Comparison Group (LNCG).

Table 2.

Case Classification at each Assessment Point

		Age		Step 1: Below Symptom Threshold		Step 2: Below Symptom Threshold + Absence of Impairment[a]		Step 3 (Full Remission): Below Symptom Threshold + Absence of Impairment + Absence of Treatment[b]		Partial Remission		Persistent ADHD	
Years after Baseline	**n**	***M***	***SD***	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
2	531	10.43	.86	85	16.0	29	5.5	8	1.4	273	51.4	250	47.1
3	485	11.73	.92	95	19.6	27	5.6	10	2.1	229	47.2	246	50.7
6	449	14.94	.96	65	14.5	20	4.5	15	3.3	183	40.8	251	55.9
8	429	16.79	.96	93	21.7	36	8.4	26	6.1	202	47.1	201	46.9
10	422	18.69	.93	157	37.2	82	20.1	78	18.5	157	37.2	187	44.3
12	420	21.05	1.09	193	46.0	80	19.0	77	18.3	159	37.9	184	43.8
14	438	23.17	1.09	208	47.5	86	19.6	80	18.3	184	42.0	174	39.7
16	418	25.12	1.07	196	46.9	64	15.3	61	14.6	191	45.7	166	39.7

Note. To define persistence we applied the DSM-5 symptom threshold using the CAARS (or SNAP) and impairment threshold of “3 or higher” based on the IRS (or CIS). Partially remitted cases were those who neither met criteria for persistence, nor criteria for full remission.

[a]Includes 18 cases that were re-introduced after determining that impairment was fully explained by another mental disorder or substance use.

[b]Absence of ADHD treatment was defined as absence in the past 30 days of medication, behavior therapy, and school services for ADHD.

Table 3.

Patterns of Full Remission, Recurrence, and Recovery from ADHD in the MTA ADHD Group (n=558)

	Subsample		Total sample (N=558)
	n	%	%
Full remission at any assessment	175	31.4	31.4
Full remission at any assessment (*n*=175)			
One assessment	85	48.6	15.2
Multiple assessments	90	51.4	16.1
Full remission at any assessment (n=175)			
No recurrence	42	24.0	7.5
Partial recurrence[a]	53	30.3	9.5
Full recurrence[b]	51	29.1	9.1
Unable to judge recurrence[c]	29	16.6	5.2
Years from Remission Detection to Recurrence Detection *M*(*SD*)	2.60	1.22	--
Recovery[e]	51	9.1	9.1
Duration of recovery period (*n*=51)			
Two years	18	35.3	3.2
Four years	17	33.3	3.0
Six years	7	13.7	1.3
Eight years	6	11.8	1.1
Ten or more years	3	5.9	0.5
Onset of recovery (*n*=51)			
Childhood (under 12)	1	2.0	0.2
Adolescence (12 to 17.99)	11	21.5	2.0
Adulthood (18 or over)	39	76.5	7.0

[a]Met criteria for partial remission after initial episode of full remission

[b]Met full criteria for ADHD after initial episode of full remission

[c]Recurrence could not be judged when remission solely occurred at final time point

[d]Demonstrated full remission of ADHD, followed by partial or full recurrence, followed by a second episode of full remission (i.e., ADHD, full Remission, Recurrence, full Remission).

[e]Recovery was defined as full remission that persisted for at least two consecutive assessments without being followed by a recurrence (includes both first episodes of remission or recurrent episodes that meet this criteria). Eight cases that were classified as recovered experienced full remission followed by partial or full recurrence, and finally a second period of full remission that led to recovery, whereas 42 experienced no recurrence after the initial episode of full remission.