

Nail Biting in Children With ADHD: Exploring Its Clinical Correlates, Psychiatric Comorbidities and Association With Other Body-focused Repetitive Behaviors

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Research Article

Keywords: ADHD, nail biting, body-focused repetitive behaviors, comorbidity

Posted Date: July 5th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10132371/v1>

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Additional Declarations: No competing interests reported.

Version of Record: A version of this preprint was published at BMC Psychology on August 10th, 2026. See the published version at <https://doi.org/10.1186/s40359-026-05343-2>.

Abstract

Objective

This study investigated whether children with ADHD who engage in nail-biting (NB) differ clinically and cognitively from those who do not, focusing on body-focused repetitive behaviors (BFRBs), psychiatric comorbidities, and cognitive profiles.

Methods

In this retrospective study, 250 children aged 8–12 with ADHD were grouped by the presence ($n = 100$) or absence ($n = 150$) of NB. Additional BFRBs, comorbidities, and cognitive performance (WISC-R), as well as symptom severity (RCADS-P, CPRS-R:S), were assessed.

Results

Compared to children with ADHD without nail biting, those with ADHD and nail biting showed higher rates of co-occurring BFRBs and anxiety disorders, elevated RCADS-P anxiety scores, and lower performance on verbal WISC-R subtests.

Conclusion

NB and co-occurring BFRBs in children with ADHD are linked to greater anxiety and reduced verbal cognitive abilities, potentially indicating a distinct clinical subtype.

1. INTRODUCTION

Attention-Deficit/Hyperactivity Disorder (ADHD) is one of the most prevalent neurodevelopmental disorders of childhood, characterized by inattention, hyperactivity, and impulsivity (APA, 2022). Studies have found the prevalence of ADHD to be around 5%. (Polanczyk et al., 2014; Popit et al., 2024). Individuals with ADHD frequently exhibit high rates of psychiatric comorbidities, particularly anxiety disorders, as well as various behavioral problems (Koyuncu et al., 2022; Drechsler et al., 2020).

BFRBs are a group of involuntary, repetitive motor activities that may lead to self-inflicted damage and functional impairment. These behaviors often involve attempts to modify or remove parts of the body and are considered disruptive and distressing (Okumuş, H. G., & AKDEMİR, D., 2023). Behaviors such as hair pulling, skin-picking, NB, cheek-chewing, lip-biting, thumb-sucking, finger-cracking, and teeth grinding are commonly classified as BFRBs in the literature (Stein et al., 2016). Trichotillomania and skin-picking disorder are categorized under obsessive-compulsive and related disorders in the DSM-5, whereas NB and other BFRBs do not have a distinct classification (APA, 2022). However, in recent years, research on this

topic has increased, exploring its etiopathogenesis and associations with psychiatric disorders (Selles et al., 2018).

BFRBs are highly prevalent in the general population (Houghton et al., 2018; Siddiqui et al., 2012; Moritz et al., 2024). NB, a type of BFRB, is particularly common among children and adolescents. A study investigating these behaviours in children and adolescents found the prevalence of NB to be 37%, identifying it as the most commonly observed BFRB (Winebrake et al., 2018). Beyond its high prevalence, NB has also been linked to emotional and behavioral difficulties. A study examining NB behavior and problem behaviors in a community sample found that children who engaged in NB exhibited higher levels of anxious/withdrawn traits and displayed more problem behaviors (Oh et al., 2020).

In the literature, studies examining BFRBs and psychiatric comorbidities have primarily focused on depression, anxiety, and obsessive-compulsive disorder (Benzina et al., 2021). However, there is a limited number of studies exploring the relationship between ADHD and BFRBs, particularly NB. There is one study investigating comorbidity in children referred to psychiatry for NB. The prevalence of ADHD was found to be 74.6%, making it the most frequently observed comorbid condition (Ghanizadeh, 2008).

Neurocognitive research on BFRBs has highlighted impairments in executive functions, particularly in cognitive flexibility and inhibitory motor control. Cognitive flexibility, often assessed through reversal learning tasks, refers to the ability to adapt behavior in response to changing environmental contingencies (Izquierdo & Jentsch, 2012). Studies have shown that individuals with BFRBs, especially trichotillomania, demonstrate significant deficits in cognitive flexibility compared to healthy controls, while findings related to other executive domains, such as working memory or attention shifting, are less consistent (Flessner et al., 2015). Additionally, abnormalities in response inhibition—defined as a top-down failure to suppress motor impulses—have been investigated, though results remain inconclusive in child and adolescent populations (Brennan et al., 2016). Furthermore, delay discounting, a measure of impulsive decision-making reflecting the devaluation of delayed rewards, has been associated with the severity of NB behaviors, suggesting its potential relevance in BFRB pathophysiology (Murphy & Flessner, 2017). Overall, current findings indicate that neurocognitive dysfunctions—particularly in behavioral inhibition and decision-making processes—may underlie BFRBs. Given that these neurobiological mechanisms are also implicated in the etiopathogenesis of ADHD, understanding the relationship between ADHD and NB—one of the most common BFRBs in children and adolescents—becomes particularly important. A review of the literature has not identified any studies that simultaneously examine the prevalence and duration of NB in ADHD, along with its association with other co-occurring BFRBs and psychiatric comorbidities.

This study aims to compare the demographic, clinical, and psychometric properties in children with ADHD with and without NB. Given that individuals with BFRBs are thought to experience difficulties in emotion regulation and elevated stress levels (Alexander et al., 2018), it is hypothesized that these children will exhibit higher rates of anxiety disorders. Considering the underlying neurocognitive mechanisms associated with BFRBs, it is anticipated that the ADHD with NB group would exhibit a more impaired cognitive profile.

2. MATERIALS AND METHODS

Study Design and Ethics

This retrospective case-control study was conducted with the approval of the Clinical Research Ethics Committee of Ankara Etlik City Hospital (Date: 07/05/2025, No: AEŞH-BADEK1-2025-092) and was carried out in accordance with the Declaration of Helsinki. Given the retrospective design based solely on the review of existing medical records, the Ethics Committee waived the requirement for informed consent to participate.

Participants, Inclusion and Exclusion Criteria

A total of 5,857 pediatric patients presenting to two Child and Adolescent Psychiatry outpatient clinics between June 2023 and March 2025 were screened through medical record review. Eligible patients were aged 8–12 years, met DSM-5 criteria for ADHD, had no prior psychotropic exposure, had WISC-R scores > 70, and had completed RCADS-P and CPRS-R:S during diagnostic evaluation, with documented information on NB and other BFRBs. NB was identified according to the criteria described in the Data Collection section. Sequential exclusions included age ($n = 2,816$), ineligible diagnoses or confounding comorbidities ($n = 1,256$), missing WISC-R data ($n = 621$), incomplete psychometrics ($n = 529$), and absent BFRB information ($n = 385$). The final sample comprised 150 ADHD patients without NB and 100 with NB. Figure 1 depicts the study flow.

Figure 1

Participant Screening and Inclusion Criteria

Note

ADHD = Attention Deficit Hyperactivity Disorder, NB = nail-biting, RCADS-P = The Revised Children's Anxiety and Depression Scale—Parent Version, CPRS-R:S = Conners Parent Rating Scale-Revised Short Form, WISC-R = Wechsler Intelligence Scale for Children-Revised.

Data Collection

Hospital records were used to collect data on age, gender, parental age and education, family history of physical or mental illness, socioeconomic status, clinical diagnoses and comorbidities, the presence and duration (in months) of NB and other BFRBs, and psychometric measures (WISC-R, CPRS-R:S, RCADS-P). As noted, diagnoses were based on expert psychiatric evaluation rather than structured interviews and were supplemented by baseline psychometric assessments conducted before any pharmacological or psychotherapeutic intervention.

There is no universally accepted standard for defining nail biting as pathological. In line with previous studies, and to ensure clinical relevance, nail biting was considered present when the behavior occurred at least three days per week for more than three months and was observed in at least two settings

(Ghanizadeh & Shekoohi, 2011; Hansen et al., 1990). The Wechsler Intelligence Scale for Children–Revised (WISC-R) is routinely administered to children with ADHD to assess cognitive capacity and consists of Verbal and Performance subtests. Verbal subtests (Information, Similarities, Arithmetic, Vocabulary, Comprehension, and Digit Span) evaluate language-based reasoning, general knowledge, verbal comprehension, and auditory working memory, whereas Performance subtests (Picture Completion, Picture Arrangement, Block Design, Object Assembly, and Coding) assess visual–spatial processing, nonverbal reasoning, perceptual organization, and processing speed and may provide indirect information about executive functions. Full-scale IQ scores were calculated from verbal and performance indices. All WISC-R subtest and IQ scores were age-standardized according to the Turkish normative data, allowing comparison across participants of different ages. The Turkish standardization of the WISC-R was conducted by Savaşır and Şahin in 1982.

The Conners' Parent Rating Scale–Revised: Short Form (CPRS-R:S), developed by Conners in 1998, assesses ADHD symptom domains across defiance, cognitive difficulties/inattention, and hyperactivity, as well as an ADHD index. Its Turkish adaptation and psychometric validation were conducted by Kaner et al. 2013.

The Revised Child Anxiety and Depression Scale–Parent Version (RCADS-P), developed according to DSM-IV criteria, measures anxiety disorders and depressive symptoms, including separation anxiety disorder (SAD), social phobia disorder (SPD), performance anxiety (PA), generalized anxiety disorder (GAD), panic disorder (PD), obsessive–compulsive disorder (OCD), and major depressive disorder (MDD), along with the composite scales Total Anxiety (TA) and Total Anxiety and Depression (TAD) (Chorpita et al., 2000). The Turkish validity and reliability study was conducted by Görmez et al. (2017) These psychometric assessment tools are administered before any pharmacological or psychotherapeutic intervention during the initial diagnostic phase. As such, they reflect the patient's baseline psychological profile.

Statistical Analysis

All analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 26.0. Descriptive statistics summarized demographic and clinical characteristics; categorical variables were reported as frequencies and percentages, and continuous variables as means with standard deviations and medians with interquartile ranges (IQR). Group comparisons for categorical variables used the Chi-square or Fisher's exact test. Normality was assessed with the Kolmogorov–Smirnov test and indicated non-normal distributions; therefore, the Mann–Whitney U test was applied to RCADS-P and CPRS-R:S scores. Analysis of covariance (ANCOVA) was used to compare WISC-R scores between groups, adjusting for internalizing symptoms (RCADS-P Total Anxiety and Depression) based on prior evidence linking anxiety and depression to ADHD and BFRBs. Cohen's *d* values, calculated using pooled standard deviations, estimated effect sizes (0.20 small, 0.50 medium, 0.80 large). Variables showing significant group differences were entered into binary logistic regression models to predict NB, with highly collinear subscales excluded. Statistical significance was set at $p < .05$. Given the exploratory and hypothesis-driven nature of the analyses, formal correction for multiple comparisons was not applied to avoid inflating the risk of Type II error; however, the principal findings were associated with large effect sizes

(Cohen's d up to 1.27) and significance levels well below conventional thresholds ($p < .001$), reducing the likelihood that they reflect Type I error.

3. RESULTS

Baseline demographic and clinical characteristics of the ADHD without nail-biting ($N = 150$) and ADHD with nail-biting ($N = 100$) groups are presented in Supplementary Table 1. Children in the ADHD with nail-biting group were older than those without nail-biting (mean $\pm$ SD, 11.1 ± 1.4 vs. 10.0 ± 1.59 years, $p < .001$), whereas the proportion of girls was similar between groups (42.0% vs. 44.7%, $p = .677$). The nail-biting group was also in higher school grades and had older parents, while no group differences were observed for parental education levels, socioeconomic status, or parental psychiatric illness (all $p > .05$).

Comparisons of other body-focused repetitive behaviors are presented in Supplementary Table 2. Thumb sucking, lip/cheek biting, and teeth grinding/bruxism were significantly more prevalent in the ADHD with nail-biting group (all $p < .05$). Among children who exhibited these behaviors, the mean duration of lip/cheek biting was shorter in the nail-biting group (4.7 ± 2.8 vs. 6.6 ± 2.4 months, $p = .022$), whereas teeth grinding/bruxism persisted for a longer period (15.6 ± 9.9 vs. 8.0 ± 3.4 months, $p = .030$). No group difference was observed in the duration of thumb sucking ($p = .892$).

Examination of BFRB patterns indicated that most participants ($N = 112$) exhibited no BFRBs, constituting the largest subgroup. NB alone ($N = 29$) and the combination of NB with teeth grinding/bruxism ($N = 21$) were the next most frequent patterns, whereas other combinations involving thumb sucking, lip/cheek biting, and teeth grinding were comparatively rare (see Supplementary Fig. 1).

Symptom comparisons are shown in Table 1. RCADS-P total scores were significantly higher in the ADHD with NB group ($p < .001$), indicating greater anxiety burden, whereas most CPRS-R:S subscales did not differ between groups; only cognitive problems/inattention scores were modestly higher in the ADHD without NB group ($p = .038$).

Table 1
Comparison of RCADS-P and CPRS-R:S Subscales Scores Between Groups

	ADHD Without Nail-Biting (N = 150)		ADHD With Nail-Biting (N = 100)		Statistics*			r	Cohen d
	Mean	Mdn	Mean	Mdn	U	Z	p		
	(SD)	(IQR)	(SD)	(IQR)					
RCADS-P									
SAD	51.85 (11.18)	49.00 (16.25)	61.63 (13.77)	59.00 (25.00)	4345.0	-5.640	< .001	.357	.764
SPD	47.61 (11.01)	49.00 (16.00)	56.40 (13.18)	57.50 (16.75)	4593.0	-5.193	< .001	.328	.695
GAD	54.11 (12.47)	52.50 (17.00)	66.71 (14.46)	71.00 (25.75)	3939.5	-6.385	< .001	.404	.883
PD	43.93 (12.88)	42.00 (18.25)	54.22 (14.17)	56.00 (18.75)	4451.0	-5.447	< .001	.344	.734
OCD	51.24 (11.89)	49.00 (18.00)	60.06 (13.12)	61.00 (20.00)	4629.5	-5.129	< .001	.324	.686
MDD	49.47 (12.71)	46.00 (20.50)	67.44 (14.60)	73.00 (22.00)	2781.5	-8.455	< .001	.535	1.266
Total Anxiety	49.51 (13.79)	48.00 (22.00)	62.76 (14.98)	63.00 (24.75)	3922.0	-6.394	< .001	.404	.884
Total Anxiety & Depression	49.39 (13.82)	49.00 (23.00)	64.94 (15.09)	67.00 (25.75)	3377.0	-7.376	< .001	.466	1.055
CPRS-R:S									
Oppositional Behavior	10.36 (5.89)	10.00 (11.00)	9.52 (5.11)	10.00 (8.00)	7011.5	-0.876	.381	-	-
Cognitive Problems /Inattention	12.31 (5.43)	14.00 (7.00)	10.42 (6.33)	12.50 (12.00)	6342.5	-2.078	.038	.131	.265
Hyperactivity	8.77 (5.82)	9.00 (11.00)	8.37 (5.34)	8.00 (9.75)	7241.5	-0.462	.644	-	-
ADHD Index	23.89 (9.54)	25.50 (12.00)	21.25 (11.04)	22.00 (22.00)	6559.5	-1.681	.093	-	-

Note. ADHD = Attention Deficit Hyperactivity Disorder, SD = standard deviation, Mdn = median, IQR = Interquartile range, RCADS-P = The Revised Children's Anxiety and Depression Scale—Parent Version, SAD = Separation Anxiety Disorder, SPD = Social Phobia Disorder, GAD = Generalized Anxiety Disorder, PD = Panic Disorder, OCD = Obsessive Compulsive Disorder, MDD = Major Depressive Disorder, CPRS-R:S = Conners Parent Rating Scale-Revised Short Form. *The Mann-Whitney U test was used.

Table 2 presents the comparison of WISC-R scores between children with ADHD with NB and those without NB, controlling for internalizing symptom severity using ANCOVA with RCADS-P Total Anxiety and Depression scores as a covariate. The ADHD with NB group showed significantly lower Full-Scale and Verbal IQ scores, with group differences driven primarily by Vocabulary and Comprehension, whereas Information, Similarities, and Arithmetic did not differ between groups. Performance IQ was also lower in the ADHD with NB group, with significant effects for Picture Completion and Picture Arrangement, while Block Design, Object Assembly, and Coding showed no significant group differences.

Table 2
Comparison of WISC-R Scores Between Groups

	ADHD Without Nail-Biting (N = 150)		ADHD With Nail-Biting (N = 100)		Statistics*				
	Mean (SD)	Mdn (IQR)	Mean (SD)	Mdn (IQR)	U	Z	p	r	Cohen d
Full-Scale IQ	97.76 (8.34)	98.00 (10.00)	93.40 (7.53)	94.00 (9.75)	5226.5	-4.063	< .001	.257	.543
Verbal IQ	48.98 (5.36)	49.00 (7.25)	47.16 (4.97)	48.00 (6.00)	6145.5	-2.423	.015	.153	.349
Information	9.53 (2.24)	10.00 (3.00)	9.74 (2.29)	10.00 (3.00)	7019.5	– .867	.386	-	-
Similarities	9.65 (2.67)	9.50 (3.00)	9.70 (2.61)	10.00 (4.00)	7353.0	– .264	.792	-	-
Arithmetic	9.63 (2.25)	9.00 (3.00)	9.39 (2.65)	10.00 (3.00)	7210.5	– .521	.602	-	-
Vocabulary	10.04 (2.12)	10.00 (2.25)	8.93 (2.36)	9.00 (3.00)	5424.5	-3.742	< .001	.237	.477
Comprehension	10.13 (2.52)	10.00 (4.00)	9.40 (2.30)	9.00 (3.00)	6286.5	-2.184	.029	.138	.295
Performance IQ	48.78 (5.25)	48.00 (6.00)	46.24 (5.03)	46.00 (7.00)	5484.0	-3.607	< .001	.229	.501
Picture Completion	10.11 (2.46)	10.00 (4.00)	8.94 (2.51)	9.00 (3.75)	5579.5	-3.454	.001	.219	.459
Picture Arrangement	9.87 (2.48)	10.00 (4.00)	8.55 (2.29)	8.00 (3.00)	5238.0	-4.070	< .001	.257	.533
Block Design	9.65 (2.67)	9.50 (3.00)	9.70 (2.61)	10.00 (4.00)	7353.0	– .264	.792	-	-
Object Assembly	9.58 (2.55)	9.50 (3.00)	9.32 (2.39)	10.00 (3.75)	7229.5	– .486	.627	-	-

Note. ADHD = Attention Deficit Hyperactivity Disorder, SD = standard deviation, Mdn = median, IQR = Interquartile range, WISC-R = Wechsler Intelligence Scale for Children-Revised, IQ = Intelligence Quotient. * The Mann-Whitney U test was used.

	ADHD Without Nail-Biting		ADHD With Nail-Biting		Statistics*				
	(N = 150)		(N = 100)		U	Z	p	r	Cohen d
	Mean (SD)	Mdn (IQR)	Mean (SD)	Mdn (IQR)					
Coding	9.58 (2.47)	9.00 (3.00)	9.73 (2.59)	10.00 (4.00)	7156.5	-.618	.537	-	-
Note. ADHD = Attention Deficit Hyperactivity Disorder, SD = standard deviation, Mdn = median, IQR = Interquartile range, WISC-R = Wechsler Intelligence Scale for Children-Revised, IQ = Intelligence Quotient. * The Mann-Whitney U test was used.									

Psychiatric diagnoses differed significantly between ADHD with and without NB groups (Supplementary Fig. 2). Speech disorders, particularly speech sound disorder, anxiety disorders (including SAD, SPD, and performance anxiety), and obsessive–compulsive disorder were more prevalent in the ADHD with NB group, whereas no between-group differences were observed for oppositional defiant disorder, conduct disorder, specific learning disorders, tic disorders, nocturnal enuresis, depressive disorders, generalized anxiety disorder, panic disorder, or specific phobia (all $p > .05$).

A binary logistic regression analysis was conducted to examine whether age, cognitive symptoms (CPRS-R:S), internalizing psychopathology (RCADS-P), and specific cognitive performance variables (WISC-R subtests) significantly predicted the presence of NB behavior in children with ADHD. Only the variables that showed significant group differences in prior comparative analyses were included in the logistic regression model. Due to high intercorrelations among the RCADS-P subscales, only the total internalizing score (RCADS-P Total Anxiety and Depression) was entered into the model to avoid multicollinearity. Similarly, because the WISC-R total, verbal IQ, and performance IQ scores were highly correlated with their respective subtests, only specific subscale scores were included to provide a more granular assessment of cognitive functioning.

Table 3
Logistic Regression Analysis of Factors Associated with the Presence of Nail Biting in Children Diagnosed with ADHD

		B	SE	Wald	df	p	Exp(B)	95% Confidence Interval for Exp (B)	
								Lower	Upper
Model 1	(Constant)	1.581	1.928	.672	1	.412	4.859		
	Age (years)	.379	.111	11.570	1	< .001	1.461	1.174	1.818
	CPRS-R:S-Cognitive Problems /Inattention	– .066	.030	4.883	1	.027	.936	.883	.993
	RCADS-P-Total Anxiety & Depression	.071	.012	34.891	1	< .001	1.073	1.048	1.099
	WISC-R-Vocabulary	– .257	.081	10.067	1	.002	.774	.660	.907
	WISC-R-Comprehension	– .168	.073	5.326	1	.021	.846	.733	.975
	WISC-R-Picture Completion	– .251	.073	11.951	1	< .001	.778	.675	.897
	WISC-R-Picture Arrangement	– .301	.078	15.039	1	< .001	.740	.636	.862

Note. ADHD = Attention Deficit Hyperactivity Disorder, SE = standard error, CPRS-R:S = Conners Parent Rating Scale-Revised Short Form, RCADS-P = The Revised Children's Anxiety and Depression Scale—Parent Version, WISC-R = Wechsler Intelligence Scale for Children-Revised. Independent variables associated with the presence of nail biting (dependent variable) were assessed using logistic regression analysis.

The logistic regression model was significant ($\chi^2(7) = 128.30, p < .001$) and showed adequate fit (Hosmer–Lemeshow $\chi^2(8) = 6.39, p = .603$), explaining 40.1% (Cox & Snell R^2) and 54.3% (Nagelkerke R^2) of the variance, with an overall classification accuracy of 78.4%. Older age (OR = 1.46) and higher RCADS-P Total Anxiety and Depression scores (OR = 1.07) were independently associated with NB, whereas higher CPRS-R:S Cognitive Problems/Inattention scores were inversely related (OR = 0.94). Lower performance on WISC-R Vocabulary (OR = 0.77), Comprehension (OR = 0.85), Picture Completion (OR = 0.78), and Picture Arrangement (OR = 0.74) was also associated with increased odds of NB (all $p < .05$).

4. DISCUSSION

This study aimed to investigate the relationship between BFRBs, cognitive performance, psychiatric comorbidities, and internalizing symptoms in children diagnosed with ADHD with and without NB. By

comparing these two groups, we sought to determine whether NB is associated with distinct cognitive and clinical profiles within the ADHD population. Our findings revealed several significant differences between the ADHD with NB and ADHD without NB groups.

An analysis of sociodemographic data revealed that the ADHD with NB group was significantly older than the ADHD without NB group. Snyder and Friman (2012) reviewed the literature on NB and concluded that the prevalence increases in four- to six-year-olds and peaks during puberty. Our study results may reflect the age-related increase in prevalence as children approach puberty.

Children in the ADHD with NB group exhibited a higher prevalence of other BFRBs, including thumb sucking, lip or cheek biting, and teeth grinding (bruxism), with statistically significant differences in their occurrence and duration- except for the duration of thumb sucking. There is a high degree of co-occurrence among BFRBs, with multiple BFRBs often reported by the same individual. (Christenson et al., 1999; Simeon et al., 1997). This may be attributable to common underlying neurobiological mechanisms and similar phenomenological characteristics shared among BFRBs (Olfson et al., 2020). In the literature, NB, thumb-sucking, lip or cheek biting, and teeth grinding are also classified as oral parafunctional habits that tend to co-occur (Mehdipour et al., 2023). This phenomenon may be explained by studies suggesting that sensory processing differences contribute to the development of BFRBs, with the hypothesis that abnormalities in oromandibular sensory processing may lead to the co-occurrence of these behaviors (Dunn, 1997; Houghton et al., 2019). In the literature, data on the onset age and duration of thumb sucking, lip and NB, and bruxism are limited. However, thumb sucking and bruxism are behaviors that can emerge at an earlier age and are more easily noticeable, making them more likely to attract parental attention sooner. However, since lip and cheek biting is less noticeable and may require self-reporting by the child, it is likely to be identified later. This delay in recognition may also explain the shorter reported duration of the behavior.

Overall cognitive performance, as assessed by the WISC-R, was significantly lower in the ADHD with NB group. Specifically, children with NB had lower Full-Scale, Verbal, and Performance IQ scores, with significant deficits observed in the Vocabulary, Comprehension, Picture Completion, and Picture Arrangement subtests. There are few studies investigating the cognitive characteristics of children with BFRBs. A literature review reveals that no study to date has utilized intelligence quotient (IQ) assessments to examine cognitive functioning in this population. In a study examining executive functions in adults with BFRBs, the BFRB group demonstrated significantly poorer cognitive flexibility than the the control group (Flessner et al., 2015). The WISC-R Vocabulary and Comprehension subtests, which showed significantly lower scores in the ADHD with NB group, are primarily designed to assess verbal knowledge, abstract reasoning, and social judgment. Although these subtests do not directly measure cognitive flexibility, as tasks like reversal learning or set-shifting do, lower performance in these areas may still be associated with reduced cognitive flexibility (Sattler, 2008). Another study also demonstrates that deficits in motor inhibition—an essential component of executive functioning—are present in individuals with BFRBs (Chamberlain et al., 2007). In our sample, both the Picture Completion and Picture Arrangement subtests yielded lower scores in the ADHD with NB group compared to the ADHD-only group. While these subtests are not direct measures of executive functions, their demands on perceptual reasoning, planning, and

response regulation suggest an indirect association with cognitive flexibility and inhibitory control. The Picture Arrangement task, which requires organizing visual information into a coherent sequence, may be particularly sensitive to difficulties in set-shifting and the suppression of impulsive choices. Similarly, lower performance on the Picture Completion subtest may reflect deficits in sustained attention, flexible scanning strategies, and the inhibition of automatic responses (Sattler, 2008). These findings support the hypothesis that the ADHD with NB group may exhibit a more impaired cognitive profile, particularly in domains related to executive functioning. However, there are some confounding factors to consider. When comparing comorbidities, speech disorders and anxiety disorders were found to be more prevalent in the ADHD with NB group. These conditions may impact on verbal cognitive performance, potentially influencing the observed differences. In particular, anxiety has been shown to impair verbal working memory and verbal task performance through worry-related interference with attentional and working memory resources (Owens et al., 2012; Vytal et al., 2013). Accordingly, the lower verbal performance observed in the ADHD with NB group may be partly attributable to their greater anxiety burden rather than to a primary cognitive deficit, an interpretation that warrants caution and further investigation."

ADHD with NB group demonstrated higher levels of anxiety and depressive symptoms, as measured by the RCADS-P. Statistically significant differences were found across multiple anxiety subscales, including SAD, SPD, GAD, PD, OCD, and MDD, with the ADHD with NB group exhibiting greater symptom severity. These findings align with previous research suggesting that BFRBs may serve as maladaptive coping mechanisms for underlying emotional distress (Gratz & Roemer, 2004). Emotion regulation difficulties have been widely reported in BFRBs (Roberts et al., 2013). Boredom, tension, anxiety, and frustration appear to be the most relevant emotions, and these emotions are more likely than others to trigger a BFRB episode. They may also be the most susceptible to modulation by BFRBs (Teng et al., 2004). In a study examining the contexts in which NB behavior occurs, it was found that NB primarily takes place during states of boredom or while working on difficult tasks, often reflecting emotional states such as frustration (Williams et al., 2006). Another study demonstrated that patients with severe NB reported a sense of tension relief when engaging in the behavior (Wells et al., 1999). Consistent with these observations, an analog functional assessment in children indicated that nail biting is often maintained by automatic reinforcement, occurring more frequently under conditions of low stimulation or task-related demand (Woods et al., 2001). Taken together, these findings support the interpretation that the elevated anxiety burden observed in the ADHD with NB group may both trigger and reinforce the behavior. Considering all these study findings, the higher anxiety scores in the ADHD with NB group have been interpreted as an expected outcome. However, relying solely on parent reports to assess internalizing symptoms can be a study limitation.

CPRS-R:S subscale scores for oppositional behavior, hyperactivity, and the ADHD index showed no significant differences between groups. This finding suggests that NB is not directly correlated with ADHD severity but may instead represent a distinct clinical profile. However, the WISC-R profile indicated that the NB group had lower cognitive performance; an opposite pattern was observed in the CPRS-R:S cognitive problems/inattention subscale, where higher scores were reported in the ADHD without NB group. This discrepancy may reflect differences in objective cognitive assessments versus parental perceptions of

inattention and cognitive difficulties. For a more accurate assessment of cognitive problems and attention, it is suggested that, instead of relying solely on parental reports, input from teachers in the school setting, where the child's difficulties in these areas may be more apparent, would provide a more comprehensive evaluation.

Regression analysis revealed that all variables showing significant group differences—particularly internalizing symptoms and cognitive performance—also significantly predicted NB. This supports the interpretation that internalizing symptoms and cognitive vulnerabilities are key contributors to NB behavior in children with ADHD.

The radar charts highlight the significant differences in psychiatric comorbidities, particularly anxiety and speech-related disorders, between ADHD children with and without NB behavior. Children with ADHD with NB are notably more likely to exhibit anxiety disorders such as SAD, SPD, and performance anxiety. They also have higher rates of obsessive-compulsive disorder and speech sound disorder. These findings suggest that NB may serve as a behavioral marker of heightened anxiety and stress-related conditions in children with ADHD (see Supplementary Figs. 2 and 3).

Clinically, this emphasizes the importance of screening for anxiety and related comorbidities when assessing children with ADHD who exhibit BFRBs like NB. Early identification and intervention targeting both anxiety and self-regulatory behaviors may prevent further emotional distress and functional impairment (Topal Hangül et al., 2022). The absence of significant differences in externalizing disorders, such as oppositional defiant disorder and conduct disorder, highlights that internalizing symptoms may play a more prominent role in this subgroup. These results support the need for tailored, integrative treatment strategies addressing both core ADHD symptoms and co-occurring emotional disorders.

This study adds to the limited literature on BFRBs in ADHD and provides a more detailed understanding of their cognitive and psychiatric correlates. Key strengths include the relatively large sample size and the use of standardized and validated assessment tools (WISC-R, RCADS-P, and CPRS-R:S), which enhance the reliability of cognitive and emotional evaluations. By examining multiple BFRBs alongside ADHD-related clinical profiles, the study offers a comprehensive view of this complex behavioral domain.

Several limitations should be noted. Information on the frequency, severity, and functional impact of NB and other BFRBs was not available, and the absence of both a validated BFRB-specific scale and a universally accepted threshold for defining pathological nail biting may have affected measurement precision. The assessment was limited to NB, thumb sucking, lip/cheek biting, and bruxism, excluding other BFRBs such as trichotillomania and skin-picking disorder. Internalizing symptoms were assessed only through parent reports, and structured diagnostic interviews were not used due to the retrospective, naturalistic design. The lack of a healthy control group further limits specificity to ADHD. Finally, although internalizing symptoms were included as covariates based on theoretical considerations, some analyses were exploratory and do not imply causality.

5. CONCLUSION

This study provides insight into the associations between BFRBs, cognitive performance, psychiatric comorbidities, and emotional symptoms in children with ADHD. NB and other BFRBs appear to define a clinical subgroup characterized by greater anxiety burden, higher rates of speech disorders, and lower cognitive performance, particularly in verbal domains.

The co-occurrence of BFRBs and their links to anxiety and emotional regulation difficulties support a multidimensional approach to ADHD assessment; however, these associations should not be interpreted causally. Clinically, the findings highlight the importance of screening for BFRBs and related cognitive and emotional symptoms in children with ADHD, and of implementing early, targeted interventions addressing both core ADHD symptoms and emotional regulation difficulties. Longitudinal studies with healthy control groups are needed to clarify developmental trajectories and clinical implications.

Declarations

Ethics approval and consent to participate:

The study protocol was approved by the Clinical Research Ethics Committee of Ankara Etlik City Hospital (Date: 07/05/2025, No: AEŞH-BADEK1-2025-092) and was conducted in accordance with the Declaration of Helsinki. Owing to the retrospective design based on the review of existing medical records, the Ethics Committee waived the requirement for informed consent.

Consent for publication:

Not applicable.

Competing interests:

The authors declare that they have no competing interests.

Funding:

No funding was received for this research.

Author Contribution

H.B.D. and M.E.Ö. contributed to the conceptualization and methodology of the study. H.B.D. and M.E.Ö. were responsible for the investigation, data curation, and project administration. M.E.Ö. performed the formal statistical analysis and contributed to validation, visualization, and resources. H.B.D. drafted the initial manuscript, and M.E.Ö. critically reviewed and revised it for important intellectual content. Both authors reviewed the manuscript, approved the final version, and agree to be accountable for all aspects of the work.

Acknowledgements:

The authors extend their gratitude to the young participants and their families for their involvement.

Data Availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Figures

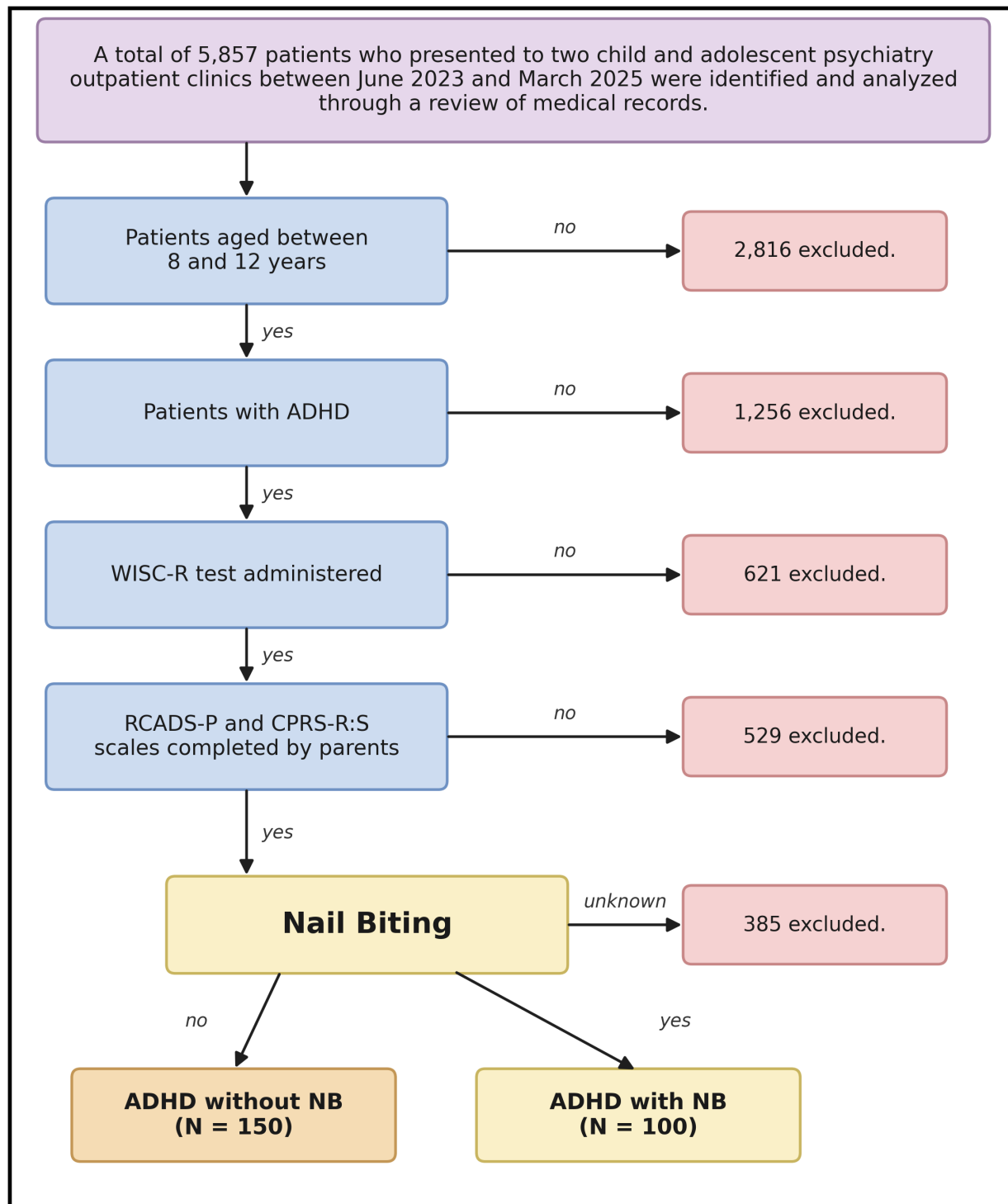


Figure 1

Flow diagram of participant screening, eligibility assessment, and inclusion in the final analysis.

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