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# ADHD Symptoms, Bedtime, and Parent-Rated Time-Specific Functioning in Relation to Internet Addiction Severity: A Child Psychiatry Registry Study

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# Abstract

### Background

Problematic internet use among children and adolescents frequently accompanies neurodevelopmental traits, internalizing symptoms, and circadian disruption. We aimed to identify and compare independent correlates of internet addiction (IA) severity with parent-rated time-specific functioning in a child psychiatry registry.

### Methods

We analyzed a cross-sectional clinical registry of 1,322 outpatients (mean age 11.3 years, SD = 2.8; 48.3% male) at a national child and adolescent psychiatry center. The Internet Addiction Test (IAT; mean 43.0, SD = 18.1) quantified IA severity. Univariable correlations were calculated using the maximum available data for each variable pair. Independent correlates of IAT scores were examined using a complete-case multivariable ordinary least-squares regression model restricted to participants with complete data across all model variables (n = 612).

### Results

In the multivariable model ($R^2$ = 0.322; adjusted $R^2$ = 0.301), ADHD-RS (β = 0.276, 95% CI 0.178 to 0.374, p < .001) and later bedtime (β = 0.264, 95% CI 0.174 to 0.354, p < .001) were the strongest independent correlates. DSRS-C, OCD symptoms, physical injury fears, and separation anxiety also showed independent associations. In univariable analyses, higher IAT scores were associated with lower QCD functioning scores across all five time bands. The strongest inverse association was observed for QCD Nighttime (r = -0.191, 95% CI -0.244 to -0.137, p < .001).

### Conclusions

These findings suggest that IA severity is linked to neurodevelopmental symptoms, sleep timing, and time-specific functional difficulties, although longitudinal and multi-informant studies are needed to clarify directionality and informant effects.


# Introduction

With the rapid transition toward a hyper-digitalized society, which was further accelerated by the global coronavirus disease 2019 (COVID-19) pandemic, problematic internet use among children and adolescents has increased substantially. The estimated prevalence of internet addiction (IA) among the youth in East Asia ranges between 10% and 20%, correlating with psychosocial issues, including academic failure, social withdrawal, and family conflict. Although “gaming disorder” was formally recognized as a clinical entity by the 11th Revision of the International Classification of Diseases (ICD-11), IA in child and adolescent psychiatry represents a broader and more heterogeneous phenomenon

that frequently co-occurs with neurodevelopmental traits, internalizing symptoms, and sleep–wake disruption.[1–6]

IA is rarely an isolated symptom in clinical psychiatry settings and is often intertwined with attention-deficit/hyperactivity disorder (ADHD), autism spectrum traits, and internalizing symptoms. Core deficits in executive function and reward processing may make children with ADHD susceptible to the instant feedback loops provided by digital platforms. Conversely, the internet may function as a “socially safe harbor” for some children with autism spectrum traits, allowing them to avoid the complexities of face-to-face interpersonal interactions. However, whether these neurodevelopmental traits are independently associated with IA, or whether their apparent associations are better explained by comorbid anxiety, depressive symptoms, and sleep–wake patterns, remains unclear.[7–18]

Furthermore, the quality of anxiety may play divergent roles in digital addictive behaviors. Generalized anxiety, panic/agoraphobia, obsessive-compulsive symptoms, and social phobia have been linked to problematic internet use, whereas separation anxiety may operate differently in childhood and early adolescence. Separation anxiety may show a different pattern of association with IA, particularly in childhood and early adolescence, because caregiver proximity, family monitoring, and dependence on parental support may influence opportunities for solitary or prolonged internet use. This possibility requires testing using granular sub-dimensional assessments rather than broad anxiety associated factors.

Another critical challenge in the diagnosis of IA is informant discrepancy. Clinical evaluation in child and adolescent psychiatry often relies on parent-proxy reports of daily functioning, whereas IA severity and internalizing symptoms may be reported directly by the child. Parent-rated functioning and child-reported distress may therefore capture different aspects of the clinical presentation, particularly during nighttime and sleep-related contexts. A granular tool such as the Questionnaire-Children with Difficulties (QCD) is useful for examining whether parent-rated functioning differs across time bands.[19]

To the best of our knowledge, this is the first study to employ a time-stratified functional impairment measure to examine the temporal specificity of IA-related parent-rated functioning. The QCD disaggregates daily functioning into five successive time bands—morning, school hours, after-school, evening, and nighttime—enabling us to ask not merely whether IA is associated with impairment, but at which point in the day that relationship is most evident. Using a large clinical registry of 1,322 patients at a national tertiary center, we (i) identified independent correlates of IA severity across ADHD, autistic traits, and six distinct anxiety subtypes; and (ii) mapped the relationship between IA and parent-rated functional difficulty across all five time bands.

## Methods

# Study Design and Setting

We employed a retrospective, cross-sectional design using a large-scale clinical registry from the Department of Child and Adolescent Psychiatry at the National Kohnodai Medical Center, Japan Institute for Health Security. The registry is part of a standardized multidisciplinary evaluation framework implemented for all new outpatients seeking psychiatric consultations. The study period spanned January 2021 to December 2025 and captured long-term clinical shifts in the post-pandemic digital era.

## Participants and Data Cleaning

The initial dataset comprised 1,322 pediatric patients with valid Internet Addiction Test (IAT) scores drawn from a total registry of 4,748. To maximize statistical reliability while retaining the clinical breadth of the registry, we applied a two-step analytic strategy. First, participants with valid IAT data were included in descriptive and univariable analyses, using the maximum available data for each measure. Second, for the multivariable regression model, we used a stringent complete-case sample with valid data across the clinical subscales and covariates included in the model. This yielded a final sample of 612 participants. This approach allowed broad estimation of univariable associations while ensuring that the multivariable model was based on a consistent analytic dataset.

## Clinical Measures

Severity of Internet Addiction

The IAT developed by Young [20] was used to quantify the severity of compulsive internet use. We used the validated Japanese version, comprising 20 items rated on a 5-point Likert scale (total score range: 20–100). Although the IAT was originally developed for adults, it has been widely used in adolescent samples, including Japanese clinical and school-based studies. In younger children or those with limited reading comprehension, responses were supported by caregivers when needed. Therefore, findings involving younger participants should be interpreted with this developmental consideration in mind. Scores were categorized into ‘Normal” (20–39), “Mild” (40–59), “Moderate” (60–79), and “Severe” (80–100) based on established clinical cut-offs.[21]

Neurodevelopmental Traits

- ADHD Rating Scale-IV (ADHD-RS) [22]: This parent-rated scale evaluates 18 symptoms of ADHD, as defined in the DSM-IV/5. The total score represents the overall severity of inattention and hyperactivity/impulsivity.
- Autism Spectrum Quotient (AQ) [23, 24]: Autistic traits were quantified using the Japanese version of the AQ for children and adolescents. This parent-rated scale provides a quantitative measure of ASD-related characteristics across social and communicative domains.

Emotional and Internalizing Symptoms

- Spence Children's Anxiety Scale (SCAS) [25, 26]: To achieve a granular understanding of anxiety, we analyzed all six subscales of the SCAS: (1) social phobia, (2) separation anxiety, (3) panic/agoraphobia, (4) physical injury fears, (5) obsessive-compulsive symptoms, and (6) generalized anxiety. This allowed us to assess the unique associations of different anxiety subtypes.
- Birleson Depression Self-Rating Scale for Children (DSRS-C) [27]: Depressive symptoms were assessed using this 18-item self-report scale, which has been specifically validated for capturing the affective and somatic components of pediatric depression.

Time-Specific Functional Impairment

- Questionnaire-Children with Difficulties (QCD) [19]: Functional impairments in daily life were assessed using the parent-rated QCD. In the present analysis, we focused on five time-band subscales available in the analytic tables: morning, school, after-school, evening, and nighttime. Each item is rated on a 4-point scale, with lower scores indicating greater functional difficulty. Previous studies using the QCD have validated its clinical utility in differentiating time-specific functional difficulties across various psychiatric disorders, such as evening-peak difficulty in ADHD and nighttime struggles in depressive disorders.[28, 29]

## Sleep Habits

Sleep habits were assessed using a self- or parent-reported questionnaire regarding typical school days, including bedtime, wake-up time, and total sleep duration. To ensure biological and clinical plausibility, we excluded implausible outliers, such as sleep duration < 3 or > 15 h and bedtimes during daylight hours (8:00 AM to 6:00 PM). Bedtimes and wake-up times were converted to a linear scale (e.g., 1:00 AM as 25.0 h) for statistical correlation analysis.1,322 cases were included in the final analysis of sleep-related variables.

To ensure the reliability of data across the wide age range (6–18 years), a standardized administration protocol was used for all clinical measures. While the IAT, SCAS, and DSRS-C are primarily self-report instruments, parents provided verbal explanations and supported younger children or those with limited reading comprehension in the scoring process. This collaborative approach allowed for the capture of the child's subjective internal state while ensuring clinical validity through parental mediation.

# Statistical Analysis

All statistical analyses were conducted using Python (v3.10) with the statsmodels and scipy packages and R software (version 4.5.3). Statistical analyses were performed using a two-step approach to maximize the utility of the clinical registry while ensuring the robustness of multivariable findings. First, descriptive statistics and Pearson's correlation coefficients (r) were calculated using the maximum available data for each variable pair. Second, a multivariable ordinary least squares (OLS) regression model was constructed using a complete-case sample (n = 612). The IAT total score was the dependent

variable. Independent variables included age, sex, ADHD-RS, AQ, DSRS-C, the six SCAS subscales, the five QCD time-band subscales, bedtime, and sleep duration. All continuous variables were standardized before modeling; therefore, regression coefficients are presented as standardized β coefficients. Multicollinearity was assessed using the variance inflation factor (VIF), and heteroscedasticity-robust standard errors were used for significance testing. The alpha level was set at $p < 0.05$ for all statistical tests. The multivariable model was restricted to the 612 participants with complete responses across all variables included in the model to ensure a consistent analytic dataset for evaluating independent correlates of IA severity.

Multicollinearity was rigorously assessed using the variance inflation factor (VIF). Despite the high univariable correlation between QCD-Morning and QCD-School ($r = 0.97$), the VIF values for all indicators in the final multivariable model remained well below the conservative threshold of 5.0 (all VIFs < 3.2), confirming the statistical stability of the regression coefficients.

## Results

# Descriptive Statistics and Univariable Analysis

The mean IAT score was 43.0 (SD = 18.1; n = 1,322) (Table 1). Univariable analyses revealed significant positive associations between IAT scores and depressive symptoms (DSRS-C: $r = 0.395$, 95% CI 0.346 to 0.442, $p < .001$), panic/agoraphobia ($r = 0.349$, 95% CI 0.297 to 0.398, $p < .001$), social phobia ($r = 0.332$, 95% CI 0.280 to 0.382, $p < .001$), and ADHD symptoms (ADHD-RS: $r = 0.143$, 95% CI 0.087 to 0.198, $p < .001$). AQ showed a small but statistically significant positive correlation with IAT scores ($r = 0.070$, 95% CI 0.006 to 0.133, $p = .031$).

Table 1
Descriptive Statistics and Univariable Correlations With IAT

| Variable | Mean (SD) or % | r (vs IAT) | 95% CI | p-value | sig. | n |
|---|---|---|---|---|---|---|
| IAT (Internet Addiction Test) | 43.0 (18.1) | — | — | — | — | 1322 |
| Age (years) | 11.3 (2.8) | — | — | — | — | 1245 |
| Sex (% male) | 48.3% | — | — | — | — | 1322 |
| UNIVARIABLE CORRELATIONS WITH IAT | | | | | | |
| ADHD-RS | 16.3 (12.6) | 0.143 | [0.087, 0.198] | < .001 | *** | 1198 |
| DSRS-C (depression) | 15.3 (7.5) | 0.395 | [0.346, 0.442] | < .001 | *** | 1190 |
| SCAS Social phobia | 7.6 (5.0) | 0.332 | [0.280, 0.382] | < .001 | *** | 1170 |
| SCAS Panic/agoraphobia | 6.2 (6.3) | 0.349 | [0.297, 0.398] | < .001 | *** | 1170 |
| SCAS OCD | 6.1 (4.2) | 0.300 | [0.247, 0.351] | < .001 | *** | 1170 |
| SCAS Separation anxiety | 6.1 (4.4) | 0.091 | [0.034, 0.147] | = .002 | ** | 1170 |
| SCAS Physical injury fears | 5.4 (3.4) | 0.165 | [0.109, 0.221] | < .001 | *** | 1170 |
| SCAS Generalized anxiety | 6.9 (4.7) | 0.327 | [0.275, 0.377] | < .001 | *** | 1170 |
| AQ (autistic traits) | 21.3 (8.0) | 0.070 | [0.006, 0.133] | = .031 | * | 945 |
| Age | 11.3 (2.8) | 0.250 | [0.197, 0.301] | < .001 | *** | 1245 |
| Sex (male = 1) | 0.5 (0.5) | -0.059 | [-0.113, -0.005] | = .031 | * | 1322 |
| QCD Morning | 5.6 (3.4) | -0.132 | [-0.187, -0.077] | < .001 | *** | 1237 |
| QCD School | 4.5 (2.5) | -0.126 | [-0.181, -0.071] | < .001 | *** | 1237 |
| QCD After-school | 4.7 (2.5) | -0.077 | [-0.132, -0.021] | = .007 | ** | 1237 |

Note: n (IAT valid) = 1322; Pearson r; 95% CI via Fisher z-transformation

| Variable | Mean (SD) or % | r (vs IAT) | 95% CI | p-value | sig. | n |
|---|---|---|---|---|---|---|
| QCD Evening | 6.3 (3.3) | -0.112 | [-0.167, -0.056] | < .001 | *** | 1237 |
| QCD Nighttime | 4.8 (2.7) | -0.191 | [-0.244, -0.137] | < .001 | *** | 1237 |
| Bedtime (h, decimal) | 22.8 (1.9) | 0.363 | [0.314, 0.410] | < .001 | *** | 1242 |
| Sleep duration (h) | 7.9 (1.6) | -0.230 | [-0.282, -0.176] | < .001 | *** | 1233 |
| Note: n (IAT valid) = 1322; Pearson r; 95% CI via Fisher z-transformation | | | | | | |

To assess potential selection bias associated with complete-case analysis, we compared participants included in the multivariable model (n = 612) with those excluded because of missing data in at least one model variable (n = 710). The included and excluded subsamples did not differ significantly in age, IAT scores, ADHD-RS scores, AQ scores, DSRS-C scores, bedtime, or sleep duration. However, several QCD time-band scores were significantly lower among excluded participants, indicating that the excluded subsample had greater parent-rated functional difficulty at baseline than the analyzed cohort.

## Inverse Correlations with Parent-Rated Time-Specific Functioning

In univariable analyses, IAT scores showed inverse correlations with all five QCD time-band functioning scores: Morning (r = -0.132, 95% CI -0.187 to -0.077, p < .001), School (r = -0.126, 95% CI -0.181 to -0.071, p < .001), After-school (r = -0.077, 95% CI -0.132 to -0.021, p = .007), Evening (r = -0.112, 95% CI -0.167 to -0.056, p < .001), and Nighttime (r = -0.191, 95% CI -0.244 to -0.137, p < .001). Because lower QCD scores indicate greater functional difficulty, these findings suggest that higher IA severity was associated with greater parent-rated difficulty across the day, with the strongest univariable association observed at nighttime.

A key methodological contribution of this study is the use of a time-stratified outcome measure. Examining all five QCD time bands revealed a consistent inverse gradient: as IA severity increased, parent-rated functioning scores decreased across all times of the day (Table 1; Fig. 2), indicating greater parent-perceived functional difficulty. The magnitude of this inverse association was small but consistent, with correlation coefficients ranging from after-school (r = -0.077, p = .007) to nighttime (r = -0.191, p < .001). These findings suggest that parent-rated functioning may capture time-specific aspects of IA-related impairment, with the strongest univariable association observed for nighttime functioning.

Sleep-related analyses showed that higher IAT scores were associated with later bedtime (r = 0.363, 95% CI 0.314 to 0.410, p < .001) and shorter sleep duration (r = -0.230, 95% CI -0.282 to -0.176, p < .001) (Fig. 1).

Across all QCD time bands, higher IAT scores were inversely correlated with parent-rated functioning scores, indicating greater parent-perceived functional difficulty as IA severity increased. The inverse association was strongest for QCD Nighttime ($r = -0.191$, 95% CI -0.244 to -0.137, $p < .001$), followed by QCD Morning ($r = -0.132$), QCD School ($r = -0.126$), QCD Evening ($r = -0.112$), and QCD After-school ($r = -0.077$). These findings support a time-stratified pattern in which nighttime and circadian functioning are particularly relevant to IA severity. Severe IA was defined as IAT ≥ 80.

# Multivariable Analysis: Significant and Non-significant Associations

The multivariable model ($n = 612$; $R^2 = 0.322$; adjusted $R^2 = 0.301$; Table 2) clarified the independent contributions of clinical traits, functional ratings, and sleep variables.

Table 2
Independent Correlates of IAT Scores in the Multivariable OLS Model

| Variable | Std. beta | 95% CI lower | 95% CI upper | p-value | sig. |
|---|---|---|---|---|---|
| ADHD-RS | 0.276 | 0.178 | 0.374 | < .001 | *** |
| DSRS-C | 0.142 | 0.038 | 0.247 | = .007 | ** |
| Social phobia | 0.073 | -0.045 | 0.19 | = .226 | |
| Panic/agoraphobia | 0.052 | -0.061 | 0.165 | = .366 | |
| OCD | 0.143 | 0.045 | 0.241 | = .004 | ** |
| Separation anxiety | -0.183 | -0.283 | -0.082 | < .001 | *** |
| Physical injury fears | 0.101 | 0.019 | 0.183 | = .016 | * |
| Generalized anxiety | 0.041 | -0.092 | 0.174 | = .542 | |
| AQ | -0.029 | -0.111 | 0.052 | = .483 | |
| Age | 0.062 | -0.029 | 0.152 | = .180 | |
| Sex | 0.017 | -0.058 | 0.093 | = .654 | |
| QCD Morning | 0.029 | -0.063 | 0.122 | = .536 | |
| QCD School | -0.033 | -0.129 | 0.063 | = .505 | |
| QCD After-school | 0.037 | -0.057 | 0.131 | = .443 | |
| QCD Evening | -0.094 | -0.197 | 0.009 | = .073 | |
| QCD Nighttime | 0.01 | -0.077 | 0.097 | = .826 | |
| Bedtime | 0.264 | 0.174 | 0.354 | < .001 | *** |
| Sleep duration | -0.023 | -0.105 | 0.059 | = .589 | |
| $R^2$ = 0.322 / Adjusted $R^2$ = 0.301 / n = 612 | | | | | |

Note: Standardized beta (X and y both standardized). 95% CI = beta ± 1.96*SE.

ADHD symptoms and later bedtime were the largest independent correlates in the model. Separation anxiety showed a negative independent association after adjustment, whereas its univariable correlation with IAT was positive but small. This pattern is compatible with a statistical suppression effect and should be interpreted cautiously. OCD symptoms, depressive symptoms, and physical injury fears also showed smaller independent positive associations with IAT scores. Social phobia, AQ, generalized anxiety, age, sex, and the QCD time-band subscales were not independently associated with IAT scores after adjustment.

- After adjustment, ADHD-RS (standardized β = 0.276, 95% CI 0.178 to 0.374, p < .001), bedtime (β = 0.264, 95% CI 0.174 to 0.354, p < .001), DSRS-C (β = 0.142, 95% CI 0.038 to 0.247, p = .007), OCD symptoms (β = 0.143, 95% CI 0.045 to 0.241, p = .004), physical injury fears (β = 0.101, 95% CI 0.019 to 0.183, p = .016), and separation anxiety (β = -0.183, 95% CI -0.283 to -0.082, p < .001) were independently associated with IAT scores. AQ was not independently associated with IAT scores after adjustment (β = -0.029, 95% CI -0.111 to 0.052, p = .483), and QCD Nighttime was also not independently associated in the multivariable model (β = 0.010, 95% CI -0.077 to 0.097, p = .826) (Fig. 2). No QCD time-band subscale retained a significant independent association with IA severity after adjustment for clinical and sleep variables.

## Discussion

# Parent-Rated Time-Specific Functioning and Informant Discrepancy

We observed a statistically significant inverse univariable correlation between IA severity and parent-rated nighttime functioning (QCD Nighttime: r = -0.191, p < .001). This was a small effect, and QCD Nighttime was not independently associated with IA severity in the multivariable model, suggesting that its univariable association was largely accounted for by shared variance with psychiatric symptoms and sleep timing. Therefore, this finding should be interpreted as a descriptive time-specific association rather than as evidence of a distinct syndrome or causal mechanism. The result nevertheless highlights the clinical value of assessing functioning across specific parts of the day, particularly in relation to sleep timing.

The association between IA and delayed bedtime was one of the strongest findings in the present study. Nocturnal internet use, delayed sleep phase, and internalizing symptoms may reinforce one another, but the direction of these associations cannot be determined from cross-sectional data. Clinicians should therefore assess sleep timing and nighttime routines directly, rather than relying only on global functional ratings.

This interpretation should be regarded as a hypothesis generated from cross-sectional data. Reverse causality is also plausible: children with insomnia, delayed sleep phase, anxiety, or depressive symptoms may increase digital use at night as a coping strategy. Therefore, the observed associations should not be interpreted as evidence that IA causes sleep disturbance or functional impairment.[28, 29]

# Neurodevelopmental Divergence

Our results refine, rather than confirm, a neurodevelopmental model of IA. Although AQ showed a small positive univariable correlation with IAT scores, it was not independently associated with IAT scores in the multivariable model. This suggests that autism spectrum traits alone may not explain IA severity once ADHD symptoms, internalizing symptoms, anxiety subtypes, and sleep variables are considered.

Future studies should test whether social phobia, depressive symptoms, or sleep disturbance moderate or mediate these associations using longitudinal and formal mediation designs.

In contrast, ADHD symptoms remained an independent correlate of IA severity. Separation anxiety showed a negative independent association with IA severity after adjustment ($\beta = -0.183$, $p < .001$), despite a small positive univariable correlation with IAT. This likely reflects a suppression pattern among correlated internalizing symptoms. One possible interpretation is that caregiver-proximity needs may reduce solitary nocturnal digital immersion, but this explanation is hypothesis-generating and requires longitudinal replication.

# Clinical Implications and Informant Discrepancy

A strength of this study is the use of real-world clinical registry data from routine multidisciplinary assessments at a tertiary child and adolescent psychiatry center. This design allowed us to examine IA severity in a clinically heterogeneous population in which ADHD symptoms, internalizing symptoms, sleep timing, and parent-rated functioning naturally co-occur. At the same time, the real-world nature of the data also introduced challenges, including missingness, informant heterogeneity, and potential measurement bias, which were addressed through complete-case tracking and cautious interpretation.

This study emphasizes the need to interpret parent-proxy functional reports alongside direct patient clinical assessment when evaluating IA. Discrepancies between child-reported internalizing distress and parent-rated behavioral functioning are common in child and adolescent psychiatry; such divergence often captures distinct contextual phenotypes rather than simple measurement error. Clinicians should therefore simultaneously assess both subjective distress and observable functioning, especially when nighttime digital use appears behaviorally quiet to parents. Furthermore, the shared method variance resulting from different informants (i.e., child-reported internalizing distress vs. parent-reported functional impairment) may have contributed to the attenuated independent associations of the QCD subscales after adjusting for subjective emotional symptoms.

Core independent correlates: ADHD, delayed bedtime, and internalizing symptoms

# Limitations

Several limitations should be noted. First, the cross-sectional design precludes causal inference, and reverse causality remains possible. Second, the complete-case multivariable analysis reduced the analytic sample to 612 participants, introducing the potential for selection bias due to missing data in one or more clinical subscales. Third, clinical variables such as digital content type, duration of use, parental digital habits, socioeconomic status, medication, and family environment were not fully captured. Fourth, informant discrepancy may reflect both true contextual differences and measurement differences between child- and parent-rated scales. Furthermore, because younger children or those with limited reading comprehension sometimes required parental assistance when completing self-report instruments such as the IAT, SCAS, and DSRS-C, potential measurement bias arising from parent–child dyadic interpretation could not be fully excluded. Finally, although we reported multiple univariable

correlations, these findings should be interpreted descriptively and require replication in longitudinal datasets. Because our findings are based on a tertiary hospital registry, they may reflect higher clinical severity than community samples. Approximately 47% of IAT-valid cases (710/1,322) were excluded from the multivariable model due to missing values in at least one clinical subscale. In the present complete-case tracking analysis, the included and excluded subsamples did not differ significantly in age, IAT severity, ADHD symptoms, autistic traits, depressive symptoms, bedtime, or sleep duration. However, excluded participants had lower scores on several QCD time-band subscales. Because lower QCD scores indicate greater functional difficulty, this systematic attrition may have led to an underestimation of the independent association between daily functional impairment and IA severity in the multivariable model. Residual selection bias related to parent-rated functioning cannot be excluded, implying that the non-significant independent associations of QCD subscales in the multivariable model should be interpreted as conservative estimates. These limitations are partly inherent to real-world registry data, which improve clinical generalizability but also introduce missingness, heterogeneity in assessment conditions, and potential informant-related measurement bias.

In summary, IA severity in child and adolescent psychiatry was independently associated with ADHD symptoms, depressive symptoms, specific anxiety subtypes, and later bedtime. The strongest multivariable correlates were ADHD-RS and bedtime. The observed inverse univariable correlations between IAT and QCD time-band functioning scores, particularly nighttime functioning, highlight the importance of time-stratified assessment and careful interpretation of parent-proxy reports.

# Conclusions

In a real-world child psychiatry registry, ADHD symptoms and later bedtime were the strongest independent correlates of IA severity. Although parent-rated QCD time-band functioning scores, especially nighttime functioning, were inversely associated with IA severity in univariable analyses, these associations were not independent after adjustment for psychiatric symptoms and sleep variables. These cross-sectional findings support integrated assessment of ADHD symptoms, sleep–wake timing, internalizing symptoms, and parent–child informant discrepancies when evaluating problematic internet use in child and adolescent psychiatry.

# Declarations

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**Competing interests**

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**Author contributions**

UM designed the study and drafted the manuscript. YS, MI, MM, YM SK, NK, RM, MO, YH, YK, HM, YN, MM, YS, MO, KI, KY, MT, MI, KI, YH, and YM collected clinical data. MI, KM, and NT managed the registry and discussed the results. All authors contributed to the study meaningfully, providing feedback on the interpretation of the results and on the writing of the paper.

**Ethics approval**

The study protocol was reviewed and approved by the Institutional Review Board of the Japan Institute for Health Security (Approval No. 4743).

**Consent to participate**

Informed consent was obtained using an opt-out approach, in accordance with the Ethical Guidelines for Medical and Health Research Involving Human Subjects in Japan. All data were pseudonymized prior to analysis to ensure patient confidentiality.

**Consent for publication**

Not applicable.

**Data availability**

The datasets generated and analyzed during the current study are not publicly available due to ethical restrictions but are available from the corresponding author on reasonable request.

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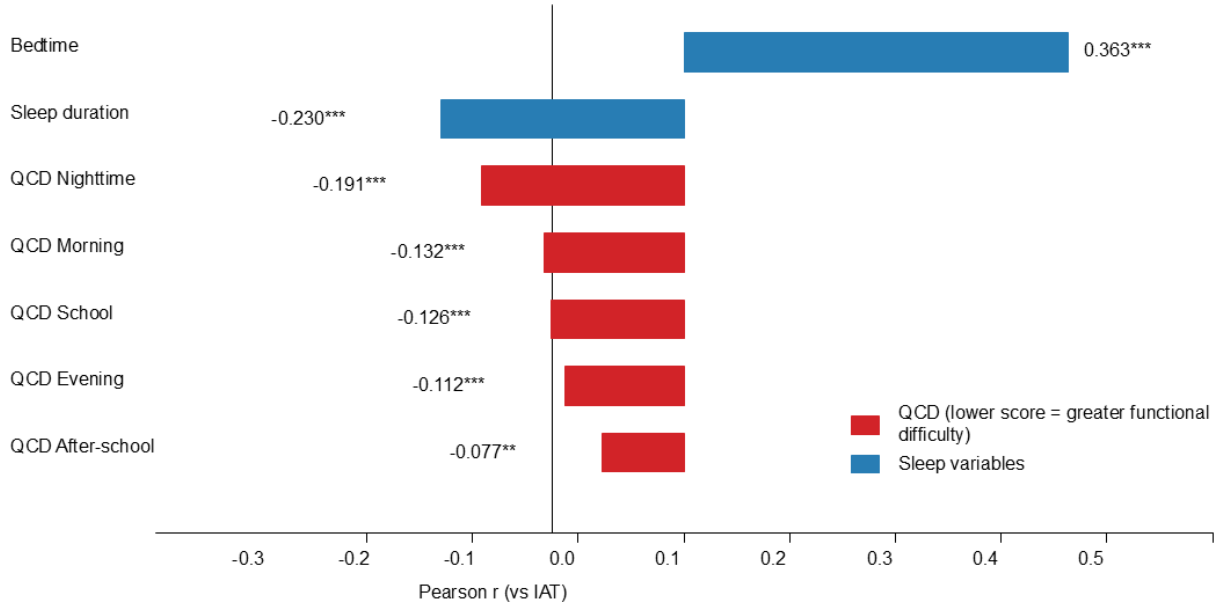
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# Figures

Figure 1. Parent-Rated Time-Specific Functioning: Temporal Gradient Across All Five QCD Time Bands

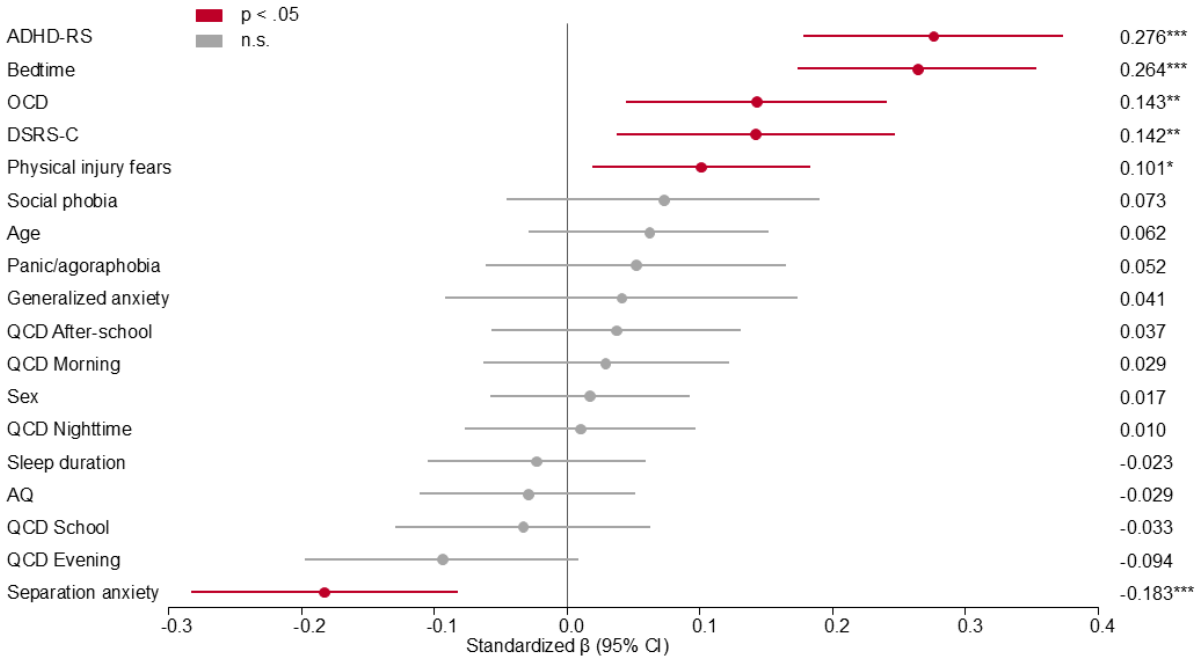



Pearson r between IAT and parent-rated QCD functioning scores across five successive time bands, plus sleep variables. All five QCD bands show inverse correlations: higher IA severity was associated with lower QCD functioning scores, indicating greater parent-rated functional difficulty. *** p < .001; ** p < .01; * p < .05.

## Figure 1

Parent-Rated Time-Specific Functioning Across QCD Time Bands. Pearson correlations between IAT scores and parent-rated QCD functioning scores across five successive time bands, with bedtime and sleep duration shown for comparison. All five QCD time bands showed inverse correlations with IAT scores, indicating that higher IA severity was associated with lower QCD functioning scores, i.e., greater parent-rated functional difficulty. The strongest inverse association was observed for nighttime functioning (r = -0.191). *** p < .001; ** p < .01; * p < .05.

Figure 2. Forest Plot: Independent Correlates of IA Severity (Multivariable OLS)




Standardized β coefficients with 95% confidence intervals from the complete-case multivariable ordinary least-squares model (n = 612; $R^2$ = 0.322; adjusted $R^2$ = 0.301). Red indicates p < .05; gray indicates non-significant associations. *** p < .001; ** p < .01; * p < .05.

**Figure 2**

Independent Correlates of IA Severity in the Complete-Case Multivariable OLS Model. Standardized β coefficients and 95% confidence intervals from the multivariable ordinary least-squares regression model (n = 612; $R^2$ = 0.322; adjusted $R^2$ = 0.301). ADHD-RS and bedtime were the two strongest independent correlates of IA severity. Depressive symptoms, obsessive-compulsive symptoms, physical injury fears, and separation anxiety also showed independent associations. QCD time-band functioning scores were not independently associated with IAT scores after adjustment. Red indicates p < .05; gray indicates non-significant associations. *** p < .001; ** p < .01; * p < .05.

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