Research Article

Smartphone Use and Neurobehavioral Outcomes in Adolescents: A Systematic Review of Cognitive Performance and Sleep Disturbances

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Abstract

Aim: To evaluate associations between adolescent smartphone-related behaviors and attention, inhibitory control, affective and behavioral symptoms, sleep onset, and sleep continuity, while separating smartphone-specific measurements from broader digital-media exposure.

Methods: Primary observational, longitudinal and intensive-monitoring reports published through March 2026 were synthesized narratively. The study-selection diagram records 1,678 identified records, 1,462 screened records, 75 full-text assessments and eight included primary reports. Heterogeneous effect estimates were not pooled.

Results: A five-wave cohort of 11,286 youths associated within-person increases in problematic social-media use with subsequent parent-reported attention-deficit/hyperactivity symptoms, primarily among males. Another prospective analysis of 8,119 early adolescents linked problematic phone/social-media involvement with later sleep disturbance and attention-related scores. In 425 adolescents contributing 7,591 person-nights, each additional minute of post-10-pm smartphone use above the individual average corresponded to 0.87 minutes later sleep onset (95% confidence interval 0.84–0.90) and 0.43 minutes less sleep (95% confidence interval −0.47 to −0.39). An objective 79-youth school-hours study observed mean checking frequency of 64.46 ± 32.83 times and an association with lower go/no-go inhibitory control ($F[1,28] = 4.8$; $P = 0.04$). Associations varied by exposure timing and measurement method.

Conclusion: The evidence more consistently identifies bedtime engagement, compulsive involvement and repeated checking than total phone ownership as correlates of selected sleep and attention outcomes. Most evidence remains non-experimental; developmental vulnerability and reverse causation are plausible.

Keywords: adolescents; smartphone; problematic use; cognitive control; inattention; sleep onset; sleep disturbance; longitudinal cohort.

Introduction

Smartphones integrate communication, entertainment, social interaction and educational functions within a single portable device. Adolescence is also a period of circadian phase delay, increased peer salience and continuing maturation of executive control. The coincidence of these developmental changes complicates attempts to attribute sleep or cognitive outcomes to device exposure alone [1–4].

Neurobehavioral outcomes include response inhibition, sustained attention, emotional dysregulation, externalising symptoms and everyday self-regulation. They must be distinguished from academic marks, questionnaire-defined problematic use and a diagnosed neurodevelopmental disorder. Sleep outcomes similarly differ between delayed onset, curtailed duration, awakenings, efficiency and subjective restfulness. A single composite concept of "smartphone harm" therefore obscures several biologically and clinically separable pathways [3,5,6].

This review focuses on three questions: whether problematic phone or social-media involvement precedes attention or behavioral symptoms; whether objectively recorded smartphone engagement is associated with cognitive control; and whether late-evening use relates to objectively assessed sleep onset and continuity. Comparisons with screen-media studies are included as indirect evidence and identified accordingly.

Methods

Design and eligibility

Original studies were eligible when they included predominantly adolescent or early-adolescent participants; measured mobile-phone ownership, active use, pickups, bedtime use or problematic phone/social-media

involvement; and reported performance-based cognition, behavioral symptoms or sleep outcomes. Longitudinal, intensive repeated-measure, objective-monitoring and cross-sectional designs were considered. Adult-only series, commentaries and studies lacking an outcome of interest were excluded from the primary evidence table.

Information sources and evidence extraction

PubMed/MEDLINE, publisher sources and reference lists were used to identify primary articles available through March 2026. Records identified were 1,438 through PubMed/MEDLINE, 176 from publisher sources and 64 through reference tracking (total 1,678). Following removal of 216 duplicates, 1,462 records were screened by title and abstract. Of these, 1,387 were excluded: 1,152 were unrelated to the review question, 121 were reviews, editorials or commentaries, 74 concerned adult or mixed-age populations and 40 lacked a relevant smartphone-use exposure. Seventy-five articles underwent full-text assessment; 67 were excluded for no relevant sleep or cognitive outcome (22), ineligible design or insufficient primary data (16), duplicate or overlapping reporting (13), non-adolescent focus (10), or insufficient extractable outcome data (6). Eight reports were included in the qualitative synthesis (Fig. 1). Extracted variables included study population, design, smartphone exposure, outcome measure, adjusted effect estimate and relevant sources of bias. Cohort overlap was considered when interpreting findings.

Synthesis and appraisal

A narrative comparison was adopted because exposure instruments, ages, timing contrasts and outcome scales differed materially. Objective passive-sensing results were distinguished from caregiver reports, questionnaires and standardized cognitive tests. Major appraisal domains were exposure recall bias, selection and attrition, residual baseline confounding, temporal ordering, within-person versus between-person inference and measurement overlap. No pooled meta-analysis was attempted.

Results

Overview of the evidence

Eight primary reports were included in the qualitative synthesis (Fig. 1). They comprised prospective cohorts, intensive repeated-measures studies and objective smartphone-monitoring investigations. Large cohorts included 11,286 adolescents in a five-wave analysis, 8,119 participants in a prospective assessment, and 10,588 preadolescents in an ownership analysis; objective and within-person studies included 425 adolescents contributing 7,591 person-nights, as well as studies of 79 and 71 participants. Several reports used partially overlapping Adolescent Brain Cognitive Development (ABCD) cohorts, so their participant counts were not summed [1,2,5,7–11].

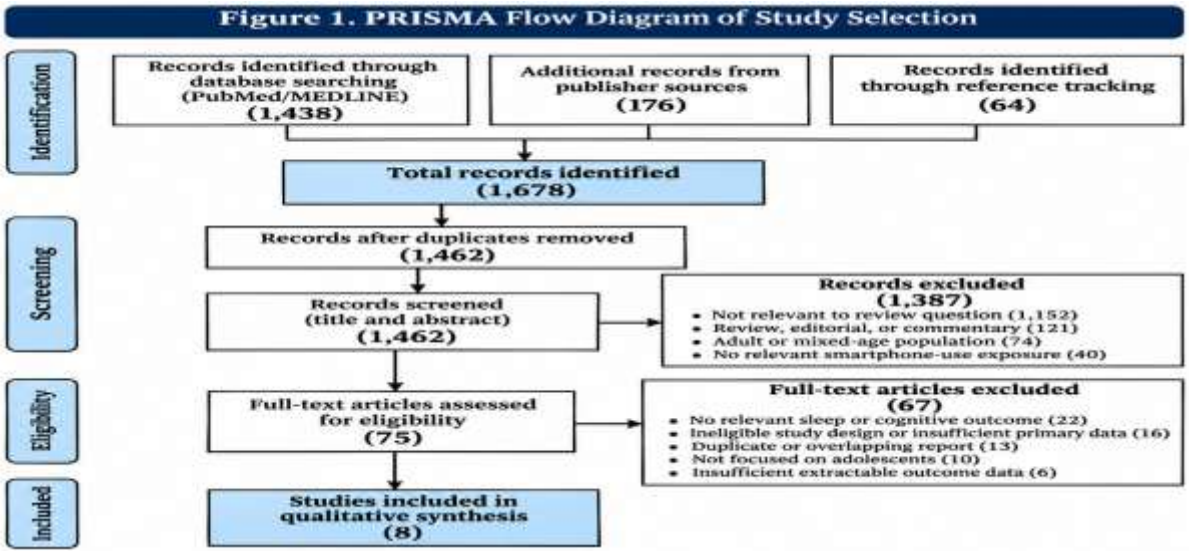


Figure 1. PRISMA flow diagram of study selection. Eight primary reports were included in the qualitative synthesis.

Table 1. Principal primary studies addressing neurobehavioral or sleep outcomes

Study	Population / design	Exposure	Principal outcome
Problematic social-media and ADHD symptoms, 2026 [1]	11,286; five annual waves	Within-person problematic social-media use	Next-year parent-reported ADHD symptom scores; sex moderation
Nagata et al., 2026 [2]	8,119; prospective ABCD	Problematic phone, social media and gaming	Later attention/behavioral symptoms and sleep disturbance
Evening phone use, 2026 [5]	425; 7,591 person-nights	Passively sensed late-evening use	Fitbit sleep onset, duration and WASO
Telzer and Burnell, 2026 [7]	79; 14-day school-hour logs	Phone minutes and checking frequency	Go/no-go inhibitory control
Burnell et al., 2024 [8]	71; 14-day daily diary/Fitbit	Nighttime versus daytime use	Sleep onset and perceived sleep quality
Smartphone ownership cohort, 2026 [9]	10,588; ABCD at age 12	Ownership and acquisition age	Insufficient sleep and mental-health outcomes
Bren et al., 2026 [10]	1,959; prospective follow-up	Acquisition, daily time, bedroom placement	Insufficient sleep at age 14
Digital media and ADHD symptoms, 2026 [11]	Longitudinal youth study	Social media versus games/television	Change in inattention symptom burden

Late-evening smartphone activity and objectively measured sleep

An intensive 2026 cohort study linked passively sensed use to sleep measurements across 425 adolescents and 7,591 person-nights [5]. Above-average smartphone engagement after 10 pm was associated with later sleep onset (0.87 minutes per additional minute of use; 95% CI 0.84–0.90), later sleep offset (0.37 minutes; 95% CI 0.33–0.41) and shorter total sleep time (−0.43 minutes; 95% CI −0.47 to −0.39). Use during the final five minutes before falling asleep was associated with 0.74 additional minutes of sustained wakefulness (95% CI 0.50–0.98), largely early in the sleep period. These within-person effects offer more direct timing information than retrospective duration surveys, although residual time-varying confounding remains possible.

Burnell and colleagues monitored 71 adolescents aged approximately 16.5 years for 14 days using smartphone screenshots and Fitbit sleep measures [8]. Greater-than-usual nighttime engagement was related to later self-reported and Fitbit-detected sleep onset; daytime smartphone exposure was not associated with equivalent sleep outcomes. The findings suggest that exposure timing is an effect modifier, not simply a proxy for accumulated minutes.

A 2026 meta-analysis of daily within-person screen use, including 25 studies and 4,562 participants aged 3–25 years, estimated a small association between more screen use and later sleep onset (r = 0.079, 95% CI 0.010–0.149), without significant pooled associations for sleep duration, efficiency or quality [12]. It is broader than adolescent-specific smartphone research and is used as contextual triangulation rather than counted as a primary study.

Phone ownership, problematic involvement and sleep insufficiency

In a cohort of 10,588 youths, ownership at age 12 versus non-ownership was associated with insufficient sleep (odds ratio [OR] 1.62, 95% CI 1.46–1.79) after adjustment for demographic and family covariates [9]. A related analysis of 1,959 youth initially without a smartphone by age 13 reported that acquisition by age 14 was associated with insufficient sleep (OR 1.29, 95% CI 1.03–1.62) [10]. Among phone owners, keeping the device outside the bedroom correlated with lower odds of insufficient sleep (OR 0.64, 95% CI 0.47–0.87). Cohort overlap and different enrollment windows preclude treating these as independent causal confirmations.

Problematic use, unlike ownership, incorporates intrusive thoughts, impaired control and functional disruption. The prospective cohort of 8,119 early adolescents found associations between problematic mobile-phone/social-

media use and next-year sleep disturbance, depressive symptoms, attention-deficit-related symptoms and externalising behavioral ratings [2]. These broad symptom associations warrant caution: common underlying vulnerabilities may generate both dysregulated digital engagement and sleep/behavioral difficulties.

Attention symptoms and inhibitory performance

A five-wave prospective analysis of 11,286 young people reported that periods of higher-than-usual problematic social-media involvement preceded elevated parent-reported ADHD-related symptom scores in the following year, with statistical evidence concentrated among male participants [1]. These are symptom-scale differences; they do not imply new ADHD diagnoses. Another longitudinal digital-media study identified a small cumulative association between social-media exposure and inattention across four years (standardized $\beta = 0.15$, SE = 0.03; $P < 0.001$), whereas television and video gaming did not show corresponding clinically meaningful cumulative associations [11].

Objective school-day monitoring among 79 adolescents aged 11–18 found 64.46 ± 32.83 phone checks during school hours and a mean of 2.22 smartphone-use hours per school day [7]. More frequent checking related to poorer performance on a go/no-go inhibitory-control task ($F[1,28] = 4.8$; $P = 0.04$; $\eta^2 = 0.15$). The performance-tested subsample was small, and the cross-sectional design cannot establish that checking caused impaired inhibition rather than reflecting pre-existing difficulty sustaining control.

Table 2. Selected estimates from different outcome domains

Exposure comparison	Result	Interpretation
Post-10-pm phone use [5]	Sleep onset +0.87 min; total sleep −0.43 min per additional above-average minute	Within-person associations; objective monitoring
Phone use in final 5 min before sleep [5]	Sustained wakefulness +0.74 min (95% CI 0.50–0.98)	Early sleep-period effect
Smartphone ownership at 12 years [9]	Insufficient sleep OR 1.62 (1.46–1.79)	Adjusted population association
Acquisition at 13–14 years [10]	Insufficient sleep OR 1.29 (1.03–1.62)	Prospective association
Bedroom phone outside [10]	Insufficient sleep OR 0.64 (0.47–0.87)	Behavior-specific protective association
School-hour checking [7]	64.46 ± 32.83 checks; $F(1,28) = 4.8$, $P = 0.04$	Objective activity and smaller cognitive-tested subset
Social-media use and inattention [11]	Four-year $\beta = 0.15$ (SE 0.03), $P < 0.001$	Small longitudinal symptom-scale effect
Daily screen use–sleep onset meta-analysis [12]	$r = 0.079$ (0.010–0.149)	Broader age/media context; not a pooled estimate for this review

Behavioral dysregulation and domain specificity

A critical distinction is whether measures capture symptoms, functional difficulties or standardized performance. Caregiver attention scales describe everyday functioning and may be influenced by sleep disruption, parenting and emotional distress. Go/no-go tasks assess specific inhibitory responses in a constrained testing environment. Neither score alone establishes irreversible neural injury, generalized lower intelligence or clinical psychopathology. Prospective associations between problematic engagement and broader conduct-related scores further indicate potentially common liabilities rather than a single technology-specific mechanism [1,2,7,13].

Cross-sectional estimates frequently exceed longitudinal or within-person changes because stable family routines, sleep vulnerability and psychosocial circumstances influence both device behavior and developmental outcomes. Differentiating device content, timing, active engagement and context provides a clinically more interpretable exposure profile [3,4,12–15].

Figure 2. Conceptual pathways linking smartphone engagement to adolescent outcomes

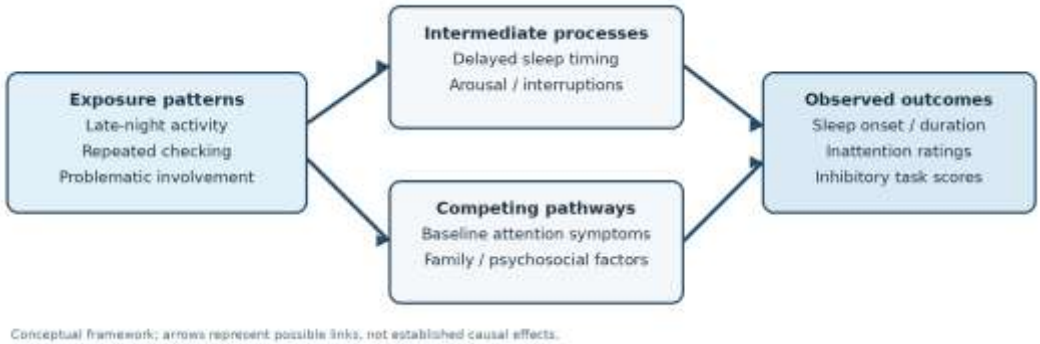


Figure 2. Distinct behavioral exposure patterns may be associated with sleep and neurobehavioral outcomes through partially overlapping mechanisms. Confounding and reverse-direction pathways remain plausible.

Discussion

Principal interpretation

Across distinct designs, the strongest convergent findings involve nighttime timing and patterns of dysregulated engagement rather than ownership alone. Objective late-night monitoring identifies within-person delays in sleep onset and some reduction in sleep time [5,8]. Larger prospective cohorts place problematic use temporally before later attention and sleep symptom ratings [1,2]. However, temporal ordering and measured adjustment do not eliminate confounding. Reciprocal effects are particularly credible: adolescents who already struggle with inhibition, mood or sleep may engage more often with reinforcing digital activities [3,13].

Magnitude, clinical relevance and heterogeneity

Statistically significant associations must be interpreted at their original scale. A 0.87-minute shift in sleep onset per additional above-average minute of late use is not a universal minute-for-minute physiological effect, but a model-based within-person association [5]. A four-year standardized β of 0.15 for inattention is small [11]. At the same time, population-wide shifts may still matter where sleep insufficiency is prevalent. Strong cross-sectional associations should not be combined numerically with prospective odds ratios or performance-task F statistics.

Potential biological and behavioral explanations

Plausible pathways include bedtime displacement, alerting content, reward-driven repeated checking, interruptions of sustained work and fragmented sleep opportunity. A separate mechanism involves shared predisposition to impulsive or compulsive behavior, explaining both problematic use and attention-related symptoms. Direct measures of melatonin phase, cortical executive networks and objective long-term cognition were rarely assessed jointly, limiting mechanistic inference [6,14–18].

Clinical implications

Pediatric and adolescent consultations can document six dimensions: device presence in the sleep environment; timing of last use; active late-night engagement; school-hour checking; perceived loss of control; and underlying insomnia, anxiety, depressive or attention symptoms. A problem-focused approach avoids equating academic phone use with compulsive nighttime engagement. Families may trial sleep-protective routines and observe changes in daytime functioning; such recommendations remain pragmatic rather than proof of therapeutic benefit [9,10,19].

Strengths and limitations

The synthesis places objective passive sensing alongside prospective caregiver and self-report data, preserving distinctions between cognitive tests, behavioral ratings and sleep metrics. Its limitations are substantial: a complete search/export audit and formal calibrated risk-of-bias assessment were not available; some studies relied on broad social-media measures rather than smartphone-only exposure; several cohort reports share ABCD participants; and effects were heterogeneous across age, timing and outcome. Evidence selection therefore cannot establish exhaustive coverage or support quantitative meta-analysis.

Conclusion

Adolescent neurobehavioral and sleep outcomes are associated with particular smartphone-related behaviors, especially late-evening engagement, repeated checking and problematic involvement. Objective monitoring identifies later sleep onset and shorter sleep on nights of greater late use, while longitudinal studies report comparatively small associations with attention-related symptom trajectories. Stronger causal inference will require preregistered longitudinal designs, passive smartphone logs, actigraphy, repeated standardized cognitive testing and careful control of pre-existing sleep and behavioral vulnerabilities.

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