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Addictive Screen Use Trajectories and Suicidal Behaviors, Suicidal Ideation, and Mental Health in US Youths

Yunyu Xiao, PhD; Yuan Meng, PhD; Timothy T. Brown, PhD; Katherine M. Keyes, PhD; J. John Mann, MD

IMPORTANCE Increasing child and adolescent use of social media, video games, and mobile phones has raised concerns about potential links to youth mental health problems. Prior research has largely focused on total screen time rather than longitudinal addictive use trajectories.

OBJECTIVES To identify trajectories of addictive use of social media, mobile phones, and video games and to examine their associations with suicidal behaviors and ideation and mental health outcomes among youths.

DESIGN, SETTING, AND PARTICIPANTS Cohort study analyzing data from baseline through year 4 follow-up in the Adolescent Brain Cognitive Development Study (2016-2022), with population-based samples from 21 US sites.

EXPOSURES Addictive use of social media, mobile phones, and video games using validated child-reported measures from year 2, year 3, and year 4 follow-up surveys.

MAIN OUTCOMES AND MEASURES Suicidal behaviors and ideation assessed using child- and parent-reported information via the Kiddie Schedule for Affective Disorders and Schizophrenia. Internalizing and externalizing symptoms were assessed using the parent-reported Child Behavior Checklist.

RESULTS The analytic sample (n = 4285) had a mean age of 10.0 (SD, 0.6) years; 47.9% were female; and 9.9% were Black, 19.4% Hispanic, and 58.7% White. Latent class linear mixed models identified 3 addictive use trajectories for social media and mobile phones and 2 for video games. Nearly one-third of participants had an increasing addictive use trajectory for social media or mobile phones beginning at age 11 years. In adjusted models, increasing addictive use trajectories were associated with higher risks of suicide-related outcomes than low addictive use trajectories (eg, increasing addictive use of social media had a risk ratio of 2.14 [95% CI, 1.61-2.85] for suicidal behaviors). High addictive use trajectories for all screen types were associated with suicide-related outcomes (eg, high-peaking addictive use of social media had a risk ratio of 2.39 [95% CI, 1.66-3.43] for suicidal behaviors). The high video game addictive use trajectory showed the largest relative difference in internalizing symptoms (T score difference, 2.03 [95% CI, 1.45-2.61]), and the increasing social media addictive use trajectory for externalizing symptoms (T score difference, 1.05 [95% CI, 0.54-1.56]), compared with low addictive use trajectories. Total screen time at baseline was not associated with outcomes.

CONCLUSIONS AND RELEVANCE High or increasing trajectories of addictive use of social media, mobile phones, or video games were common in early adolescents. Both high and increasing addictive screen use trajectories were associated with suicidal behaviors and ideation and worse mental health.

Editorial

Supplemental content

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The increasing use of social media, video games, mobile phones, and other screen-based activities among adolescents, combined with rising rates of suicidal behaviors and mental health problems in children and younger adolescents, has raised concerns,[1-4] including a US surgeon general warning label.[5] While most existing research has focused on total screen time,[6-11] emerging evidence suggests that addictive screen use may be a more salient risk factor for suicidality and mental health in youths.[12-15] Addictive use may vary by platform[16,17] and follow distinct developmental trajectories. However, addictive use trajectories among youths have not been well characterized, and how they may relate to suicide-related and mental health outcomes remains largely unknown.[18,19]

To address these gaps, this study used nationwide data from the Adolescent Brain Cognitive Development (ABCD) Study, a population-based, longitudinal cohort of children and adolescents, to (1) characterize longitudinal trajectories of addictive use of social media, mobile phones, and video games; (2) assess whether addictive use trajectories were associated with suicidal behaviors, suicidal ideation, and internalizing and externalizing symptoms over 4 years, controlling for baseline demographics and clinical characteristics; and (3) examine whether addictive use trajectories were associated with outcomes after adjusting for total screen time.

Key Points

Question Are addictive screen use trajectories associated with suicidal behaviors, suicidal ideation, and mental health outcomes in US youth?

Findings In this cohort study of 4285 US adolescents, 31.3% had increasing addictive use trajectories for social media and 24.6% for mobile phones over 4 years. High or increasing addictive use trajectories were associated with elevated risks of suicidal behaviors or ideation compared with low addictive use. Youths with high-peaking or increasing social media use or high video game use had more internalizing or externalizing symptoms.

Meaning Both high and increasing addictive screen use trajectories were associated with suicidal behaviors, suicidal ideation, and worse mental health in youths.

Methods

This study used the most recent available data from the ABCD Study (release 5.1),[20] a longitudinal cohort study of participants aged 9 to 10 years recruited from 21 US sites at baseline (n = 11 868) and followed up annually. Data collection spanned 2016 through January 2022, covering both the COVID-19 prepandemic and postpandemic years. Because the 4-year follow-up data release is ongoing, we used the available random subset (n = 4754). χ^2 Automatic interaction detection (CHAID) analysis comparing baseline characteristics of participants with and without year 4 follow-up data showed no selection bias (eAppendix 1 in Supplement 1).[21]

Our analytic sample included 4285 participants with complete data on addictive screen use from the year 2 to year 4 follow-up surveys and baseline demographics (**Figure 1**).[22-24] This study was approved by institutional review boards at each site, with central institutional review board approval from the University of California, San Diego. Parents or guardians provided written informed consent. This study follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.

Addictive Screen Use (Years 2-4 Follow-Up)

Validated self-report questionnaires[25,26] were used to assess addictive uses for 3 platforms—social media, mobile phones, and video games—including a 6-item Social Media Addiction Questionnaire (SMAQ), 8-item Mobile Phone Involvement Questionnaire (MPIQ), and 6-item Video Game Addiction Questionnaire (VGAQ),[27,28] measuring compulsive use, difficulty disengaging, and distress when not using (see details in the **Box** and in eTable 1 in Supplement 1). Responses used Likert-type scales (1 [“never”] to 6 [“very often”] for SMAQ and VGAQ; 1 [“strongly disagree”] to 7 [“strongly agree”] for MPIQ). We calculated weighted addictive use scores using confirmatory factor analysis,[22] which were appropriate for this study because of their greater measurement precision and construct validity than mean scores (eTable 1 and eAppendix 2 in Supplement 1).[29] Higher scores indicate greater addictive use. All scales have high reliability (Cronbach α = 0.88 for each scale) (eTable 2 in Supplement 1).

Total Screen Time (Baseline)

Because different screen activities can overlap, this analysis used self-reported questions assessing the average daily nonschoolwork-related screen time (separately for weekdays and weekends) (eTable 1 in Supplement 1). Prior ABCD studies showed positive correlations between self-reported and objectively measured screen use (r = 0.49; P < .001).[6]

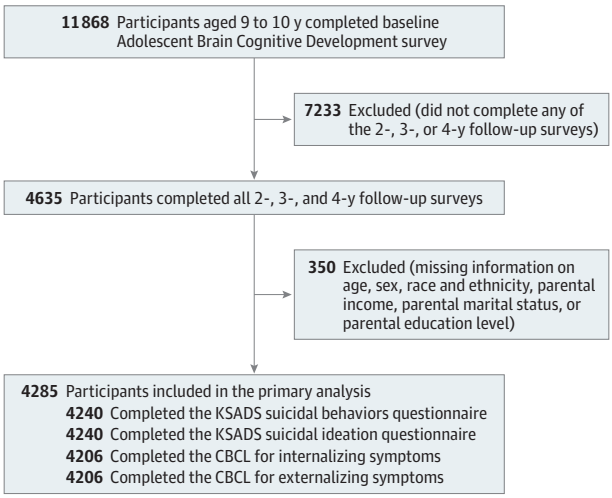
Suicidal Behaviors and Suicidal Ideation (Year 4 Follow-Up)

Child and parent reports of suicidal behaviors and suicidal ideation over the prior year were assessed at year 4 follow-up using the Kiddie Schedule for Affective Disorders and Schizophrenia (KSADS),[30,31] covering a spectrum of suicide-related outcomes: (1) passive ideation; (2) nonspecific active suicidal ideation; (3) specific active suicidal ideation; (4) active ideation with intent; (5) active ideation with plan and intent; (6) preparatory actions for imminent suicidal behavior; (7) interrupted suicidal attempt; (8) aborted suicidal attempt; and (9) suicide attempt (eTable 3 in Supplement 1). Consistent with prior literature,[32,33] suicidal ideation was classified as present if any of items 1 to 5 were endorsed, and suicidal behaviors were classified as present if any of items 6 to 9 were endorsed, by either the youth or caregiver. The KSADS exhibits strong validity and reliability for this population.[30]

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Figure 1. Participant Flow in a Study of Addictive Screen Use Trajectories and Suicidal Behaviors and Ideation and Mental Health in Youths



CBCL indicates Child Behavior Checklist; KSADS, Kiddie Schedule for Affective Disorders and Schizophrenia.

Box. Sample Items From Addictive Use Scales and Baseline Screen Time Measures[a]

Addictive Use (Social Media/Mobile Phone/Video Games)

- I feel the need to use social media apps more and more (1 [never] to 6 [very often]).
- The thought of being without my phone makes me feel distressed (1 [strongly disagree] to 7 [strongly agree]).
- I play video games so I can forget about my problems (1 [never] to 6 [very often]).

Total Screen Time (Weekday/Weekend)

Total typical weekend and weekday screen times on streaming movies or television shows, single-player games, multiplayer games, texting, social media, and video chatting (0-24 hours).

[a] eTable 1 in Supplement 1 is a full table of addictive use and screen time measures.

Mental Health Outcomes (Year 4 Follow-Up)

Analyses included current parent-reported internalizing (eg, anxiety, depression) and externalizing (eg, aggression, rule-breaking) symptoms using T scores derived from the Child Behavior Checklist (CBCL).[29] T scores of 65 or greater are considered to indicate clinically elevated symptoms.[34]

Covariates (Baseline)

Models were adjusted for child age, sex, race and ethnicity, parental income, education, and marital status as reported in the baseline ABCD parent demographics survey. Race and ethnicity were based on caregiver-reported predefined categories, including non-Hispanic Asian, non-Hispanic Black, Hispanic (any race), non-Hispanic White, and multiracial and/or other racial and ethnic groups, collected as social constructs to investigate the differential impact of structural disadvantages (eTable 3 in Supplement 1).[35,36] Models were also adjusted for baseline clinical characteristics (ie, suicidal behaviors, suicidal ideation, and internalizing and externalizing symptoms).

Statistical Analysis

Latent class linear mixed models[37] were used to identify addictive use trajectories based on age and quadratic age terms (eAppendix 3 in Supplement 1). In the addictive use questionnaires, missing data resulting from skip patterns based on previous use or nonuse questions were replaced with "1 = never/strongly disagree" for participants who reported having no social media accounts or mobile phones or who did not play video games. The optimal group-based trajectory model was selected based on (1) the lowest bayesian information criterion; (2) greater than 70% average probability of participants being correctly classified into their respective trajectories; (3) greater than 5.0 odds of correct classification; and (4) greater than 5% minimum trajectory sample sizes out of the total sample. Each addictive use trajectory represents children who shared similar addictive use levels over time.

Subsequently, these addictive use trajectories were treated as categorical variables in outcome models. For categorical outcomes (suicidal behaviors and suicidal ideation), Poisson regression models were used to estimate risk ratios (RRs), with 95% CIs calculated using robust standard errors. Poisson models are appropriate in this context.[38-40] For continuous outcomes (internalizing and externalizing symptoms), generalized linear models were used to estimate mean differences, with 95% CIs calculated using ordinary standard errors. E-values were computed to evaluate sensitivity to unmeasured confounding.[41] Total screen time was added as a covariate to examine whether it explained the magnitude or direction of the associations between addictive use trajectories and outcomes. In the sensitivity analysis, total screen time was also tested for independent associations with the outcomes.

Significance was set at a 2-sided $P < .05$, corrected for false discovery rate (FDR) using the Benjamini-Hochberg method to adjust for multiple testing within each group.[42] All analyses were conducted in R version 4.3.1 (R Foundation).

Results

Among 4285 participants (baseline mean age, 10.0 [SD, 0.6] years; 47.9% female), the sample included 96 (2.2%) Asian, 426 (9.9%) Black, 830 (19.4%) Hispanic, and 2515 (58.7%) White individuals, as well as 418 (9.8%) individuals identifying as multiracial and/or other races (**Table**).

Addictive Use Trajectories

The optimal trajectory models were selected based on multiple fit criteria (eTable 4 and eAppendix 4 in Supplement 1).

For social media, 3 addictive use trajectories emerged (**Figure 2**): high-peaking (n = 410 [9.6%]), increasing (n = 1342 [31.3%]), and low (n = 2533 [59.1%]). At baseline, high-peaking and increasing trajectories had similar levels of

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Table. Baseline Characteristics and Year 4 Follow-Up Suicidal Behaviors, Suicidal Ideation, and Mental Health Outcomes

Characteristics	No. (%) [n = 4285]
Age, mean (SD), y	10.0 (0.6)
Sex	
Female	2051 (47.9)
Male	2234 (52.1)
Race and ethnicity	
Asian	96 (2.2)
Black	426 (9.9)
Hispanic	830 (19.4)
White	2515 (58.7)
Multiracial and/or other[a]	418 (9.8)
Annual household income, $	
<75 000	1722 (40.2)
≥75 000	2563 (59.8)
Parental marital status	
Married	3138 (73.2)
Living with partner	197 (4.6)
Single	950 (22.2)
Parental education	
Less than bachelor's degree	1474 (34.4)
Bachelor's or higher	2811 (65.6)
Suicidal behaviors (year 4 follow-up)[b]	
No	4036 (94.9)
Yes	218 (5.1)
Suicidal ideation (year 4 follow-up)[c]	
No	3494 (82.1)
Yes	760 (17.9)
Child Behavior Checklist T score, mean (SD)[d]	
Internalizing symptoms	47.5 (10.8)
Externalizing symptoms	43.4 (9.3)

[a] Primary caregivers were allowed to choose multiple race subgroups for children; the "other" category indicates that no specific race or ethnicity group was identified.

[b] Suicidal behaviors were determined if any of the questions for the following Kiddie Schedule for Affective Disorders and Schizophrenia (KSADS) items had a "yes" response by the child or the caregiver: (1) preparatory actions for imminent suicidal behavior; (2) interrupted suicidal attempt; (3) aborted suicidal attempt; and (4) suicide attempt.

[c] Suicidal ideation was determined if any of the questions for the following KSADS items had a "yes" response by the child or the caregiver: (1) passive ideation; (2) nonspecific active suicidal ideation; (3) specific active suicidal ideation; (4) active ideation with intent; and (5) active ideation with plan and intent.

[d] Child Behavior Checklist T scores for internalizing range from 33 to 87 and for externalizing range from 33 to 82. T scores are standard scores derived from raw scores. Higher T scores reflect more severe internalizing and externalizing symptoms; T scores of 65 or greater indicate clinically meaningful internalizing and externalizing concerns.

social media addictive use, providing no clear indication of their subsequent divergence. By age 14 years, the increasing social media addictive use trajectory reached levels comparable with the high-peaking addictive use trajectory and continued to rise further.

Mobile phone addictive use also followed 3 trajectories: high (n = 2109 [49.2%]), increasing (n = 1052 [24.6%]), and low (n = 1124 [26.2%]). The low and increasing addictive use trajectories began with almost the same baseline levels but diverged in their subsequent trajectories. The increasing mobile phone addictive use trajectory showed a steady increase in its addictive use level in the following 4 years, reaching levels comparable with the high addictive use trajectory by age 15 years.

For video games, 2 trajectories were identified: high addictive use (n = 1761 [41.1%]) and low addictive use (n = 2524 [58.9%]).

Trajectory Differences in Baseline Demographics and Clinical Characteristics

The high addictive social media use trajectory included a higher proportion of females than the low addictive use trajectory (51.0% vs 42.8%; absolute difference, 8.18%; 95% CI, 3.07%-13.36%) (eTable 5 in Supplement 1). In contrast, youths in high addictive video game use trajectories were more likely to be male than those in low addictive use trajectories (70.1% vs 39.6%; absolute difference, 30.55%; 95% CI, 27.64%-33.40%).

Youths in high addictive use trajectories were more likely to be Black (absolute differences, 3.08%-7.91%) or Hispanic (absolute differences, 7.12%-10.03%) compared with those in low addictive use trajectories.

High addictive use trajectories also had higher proportions of youths from households with annual incomes below $75 000, unmarried parents, and parents with less than a bachelor's degree education (absolute differences across these indicators ranged from 1.55% to 18.95%) compared with low addictive use trajectories.

Youths in high addictive social media use trajectories had the largest differences in baseline suicidal behaviors (absolute difference, 1.67%; 95% CI, 0.06%-3.50%) and baseline externalizing symptom scores (absolute T score mean difference, 1.79; 95% CI, 0.75-2.82) compared with those in low addictive use trajectories. The largest differences in baseline suicidal ideation (absolute difference, 6.79%; 95% CI, 4.58%-8.91%) and baseline internalizing symptom scores (absolute T score mean difference, 1.80; 95% CI, 1.19-2.44) were observed between the groups in high and low addictive use trajectories for video games.

Associations of Trajectories of Addiction Severity With Suicidal Behaviors, Suicidal Ideation, and Mental Health

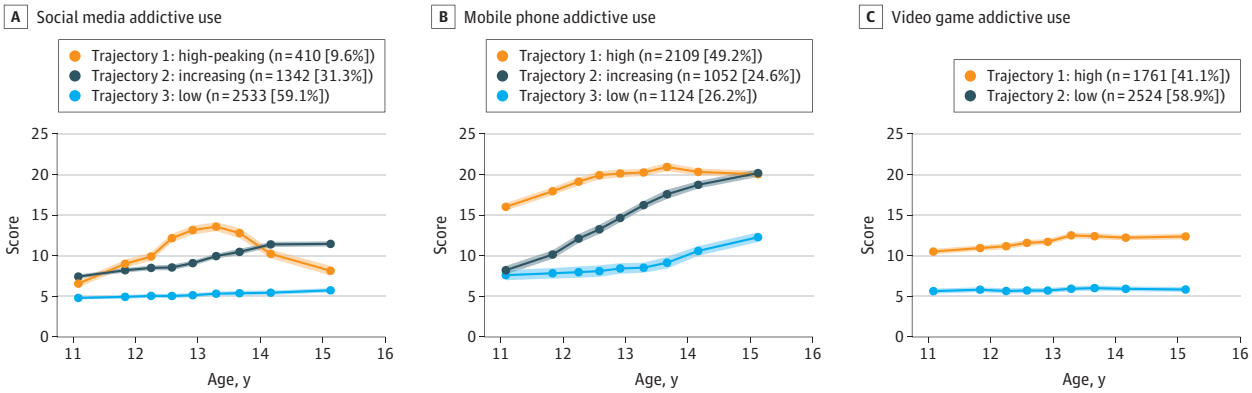
Among 4285 participants, 218 (5.1%) reported suicidal behaviors and 760 (17.9%) reported suicidal ideation at year 4 follow-up. Mean year 4 CBCL internalizing and externalizing T scores were 47.5 (SD, 10.8) and 43.4 (SD, 9.3), respectively (Table).

For social media addictive use, adjusted models (**Figure 3**) showed that both high-peaking and increasing addictive use trajectories were associated with higher risk of suicidal behaviors (high-peaking: RR, 2.39; 95% CI, 1.66-3.43; FDR-adjusted $P < .001$; increasing: RR, 2.14; 95% CI, 1.61-2.85; FDR-adjusted $P < .001$) and elevated risk of suicidal ideation (high-peaking: RR, 1.51; 95% CI, 1.25-1.83; FDR-adjusted $P < .001$; increasing: RR, 1.46; 95% CI, 1.28-1.67;

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Figure 2. Addictive Use Trajectories of Social Media, Mobile Phones, and Video Games



Latent class linear mixed models were used to identify distinct trajectories for each type of addictive use based on repeated measures of self-reported use of social media, mobile phones, and video games from ages 11 to 15 years. Each trajectory represents a group of children with similar temporal patterns of addictive use. Models were fit separately for each screen type and regressed on age and quadratic age terms. Model selection was based on the lowest bayesian information criterion, an average posterior probability of assignment greater than 70%, an odds of correct classification greater than 5.0, and a minimum group size of 5% (eTable 4 in Supplement 1). Addictive use scores were derived from confirmatory factor analysis (eTable 2 and eAppendix 2 in Supplement 1) and ranged as follows: social media, 4.5-26.8; mobile phone, 5.6-39.5; and video games, 4.5-26.9. Shaded areas represent 95% CIs. Data points along each trajectory line represent model-estimated mean scores at specific ages based on the latent class linear mixed models. Age values reflect quantiles of the observed age distribution.

FDR-adjusted $P < .001$) compared with the low addictive use trajectory. Internalizing symptom T scores were higher in the increasing addictive use trajectory (mean difference, 1.27; 95% CI, 0.66-1.88; FDR-adjusted $P < .001$), while externalizing symptom T scores were higher in both high-peaking (mean difference, 1.25; 95% CI, 0.45-2.04; FDR-adjusted $P = .004$) and increasing (mean difference, 1.05; 95% CI, 0.54-1.56; FDR-adjusted $P < .001$) addictive use trajectories compared with the low addictive use trajectory, all having small effect sizes (Cohen $d < 2$).

For mobile phone use, the high addictive use trajectory was associated with higher risks of suicidal behaviors (RR, 2.17; 95% CI, 1.48-3.19; FDR-adjusted $P < .001$) and suicidal ideation (RR, 1.50; 95% CI, 1.27-1.78; FDR-adjusted $P < .001$) compared with the low addictive use trajectory. The increasing addictive use trajectory was modestly associated with a greater relative risk of suicidal ideation (RR, 1.22; 95% CI, 1.01-1.48; FDR-adjusted $P < .001$) but not with other mental health outcomes.

For video game addictive use, the high addictive use trajectory was associated with higher risk of suicidal behaviors (RR, 1.54; 95% CI, 1.18-2.03; FDR-adjusted $P = .004$) and suicidal ideation (RR, 1.53; 95% CI, 1.35-1.75; FDR-adjusted $P < .001$), as well as higher internalizing symptom T scores (mean difference, 2.03; 95% CI, 1.45-2.61; FDR-adjusted $P < .001$) and externalizing symptom T scores (mean difference, 0.94; 95% CI, 0.45-1.43; FDR-adjusted $P < .001$) compared with the low addictive use trajectory.

Baseline total screen time alone was not associated with suicidal behaviors, suicidal ideation, or internalizing or externalizing symptom associations (**Figure 4**). Additionally, when models were adjusted for addictive use trajectories, baseline screen time remained not independently associated with these outcomes (eFigures 1-3 in Supplement 1). E-values indicated moderate to strong robustness to potential unmeasured confounding (range, 1.10-4.21).

Discussion

This study identified distinct trajectories of addictive use of social media, mobile phones, and video games from childhood to early adolescence and found links to suicidal behaviors, suicidal ideation, and worse mental health outcomes. High or increasing addictive use trajectories were common. Almost 1 in 2 youths had a high addictive use trajectory for mobile phones, and more than 40% had a high addictive use trajectory for video games. Many others had increasing addictive use over the 4-year observation period that ended with high addictive use; almost 1 in 3 had this trajectory for social media and 1 in 4 for mobile phones.

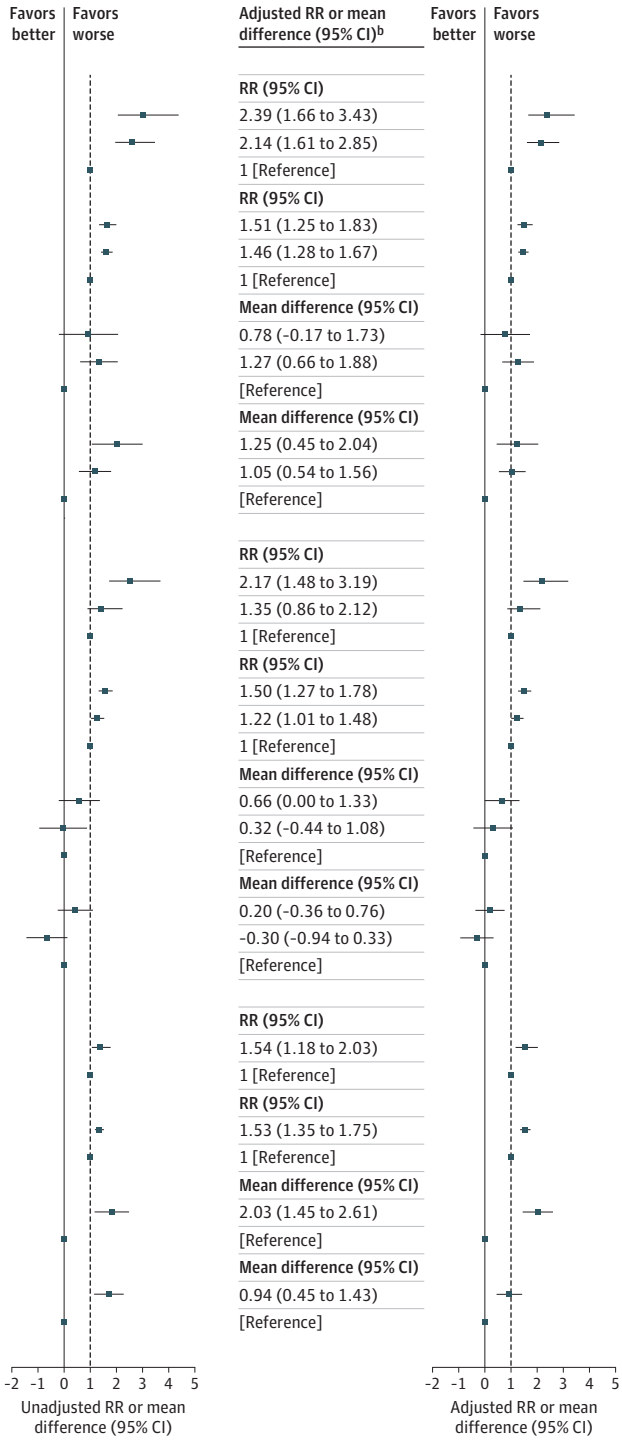
For social media and mobile phones, both the high and increasing addictive use trajectories were associated with 2 to 3 times greater risks of suicidal behaviors and suicidal ideation compared with the low addictive use trajectory. High-peaking and increasing addictive use trajectories of social media were also associated with higher internalizing and externalizing symptom scores compared with the low addictive use trajectory. For video games, the high addictive use trajectory was associated with greater risks of suicidal behaviors, suicidal ideation, and higher internalizing symptoms scores compared with the low addictive use trajectory.

To our knowledge, this is the first study to characterize longitudinal addictive use trajectories for social media, mobile phones, and video games among children and early adolescents and to assess their prospective associations with suicide-related and mental health outcomes. Specific strengths include

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Figure 3. Associations of Addictive Use Trajectories With Year 4 Follow-Up Suicidal Behaviors, Suicidal Ideation, and Mental Health Outcomes

Outcomes, by trajectory[a]	No./total No. (%)		Unadjusted RR or mean difference (95% CI)[b]	Adjusted RR or mean difference (95% CI)[b]
	With outcome	Without outcome		
Social media addictive use				
Suicidal behaviors			**RR (95% CI)**	**RR (95% CI)**
High-peaking	36/407 (8.8)	371/407 (91.2)	3.00 (2.05 to 4.38)	2.39 (1.66 to 3.43)
Increasing	105/1326 (7.9)	1221/1326 (92.1)	2.61 (1.96 to 3.48)	2.14 (1.61 to 2.85)
Low	76/2507 (3.0)	2431/2507 (97.0)	1 [Reference]	1 [Reference]
Suicidal ideation			**RR (95% CI)**	**RR (95% CI)**
High-peaking	94/407 (23.1)	313/407 (76.9)	1.64 (1.34 to 2.00)	1.51 (1.25 to 1.83)
Increasing	305/1326 (23.0)	1021/1326 (77.0)	1.62 (1.41 to 1.86)	1.46 (1.28 to 1.67)
Low	357/2507 (14.2)	2150/2507 (85.8)	1 [Reference]	1 [Reference]
CBCL internalizing			**Mean difference (95% CI)**	**Mean difference (95% CI)**
High-peaking	36/403 (8.9)	367/403 (91.1)	0.93 (-0.20 to 2.07)	0.78 (-0.17 to 1.73)
Increasing	138/1315 (10.5)	1177/1315 (89.5)	1.33 (0.61 to 2.05)	1.27 (0.66 to 1.88)
Low	165/2488 (6.6)	2323/2488 (93.4)	[Reference]	[Reference]
CBCL externalizing			**Mean difference (95% CI)**	**Mean difference (95% CI)**
High-peaking	25/403 (6.2)	378/403 (93.8)	2.03 (1.06 to 3.00)	1.25 (0.45 to 2.04)
Increasing	38/1315 (2.9)	1277/1315 (97.1)	1.18 (0.57 to 1.80)	1.05 (0.54 to 1.56)
Low	45/2488 (1.8)	2443/2488 (98.2)	[Reference]	[Reference]
Mobile phone addictive use				
Suicidal behaviors			**RR (95% CI)**	**RR (95% CI)**
High	146/2085 (7.0)	1939/2085 (93.0)	2.52 (1.72 to 3.69)	2.17 (1.48 to 3.19)
Increasing	41/1040 (3.9)	999/1040 (96.1)	1.41 (0.89 to 2.24)	1.35 (0.86 to 2.12)
Low	30/1115 (2.7)	1085/1115 (97.3)	1 [Reference]	1 [Reference]
Suicidal ideation			**RR (95% CI)**	**RR (95% CI)**
High	435/2085 (20.9)	1650/2085 (79.1)	1.57 (1.32 to 1.86)	1.50 (1.27 to 1.78)
Increasing	173/1040 (16.6)	867/1040 (83.4)	1.26 (1.03 to 1.54)	1.22 (1.01 to 1.48)
Low	148/1115 (13.3)	967/1115 (86.7)	1 [Reference]	1 [Reference]
CBCL internalizing			**Mean difference (95% CI)**	**Mean difference (95% CI)**
High	180/2067 (8.7)	1887/2067 (91.3)	0.58 (-0.20 to 1.37)	0.66 (0.00 to 1.33)
Increasing	79/1030 (7.7)	951/1030 (92.3)	-0.04 (-0.95 to 0.88)	0.32 (-0.44 to 1.08)
Low	80/1109 (7.2)	1029/1109 (92.8)	[Reference]	[Reference]
CBCL externalizing			**Mean difference (95% CI)**	**Mean difference (95% CI)**
High	57/2067 (2.8)	2010/2067 (97.2)	0.43 (-0.25 to 1.10)	0.20 (-0.36 to 0.76)
Increasing	20/1030 (1.9)	1010/1030 (98.1)	-0.66 (-1.44 to 0.13)	-0.30 (-0.94 to 0.33)
Low	31/1109 (2.8)	1078/1109 (97.2)	[Reference]	[Reference]
Video game addictive use				
Suicidal behaviors			**RR (95% CI)**	**RR (95% CI)**
High	106/1749 (6.1)	1643/1749 (93.9)	1.38 (1.06 to 1.78)	1.54 (1.18 to 2.03)
Low	111/2491 (4.5)	2380/2491 (95.5)	1 [Reference]	1 [Reference]
Suicidal ideation			**RR (95% CI)**	**RR (95% CI)**
High	366/1749 (20.9)	1383/1749 (79.1)	1.34 (1.18 to 1.52)	1.53 (1.35 to 1.75)
Low	390/2491 (15.7)	2101/2491 (84.3)	1 [Reference]	1 [Reference]
CBCL internalizing			**Mean difference (95% CI)**	**Mean difference (95% CI)**
High	178/1728 (10.3)	1550/1728 (89.7)	1.83 (1.17 to 2.49)	2.03 (1.45 to 2.61)
Low	161/2478 (6.5)	2317/2478 (93.5)	[Reference]	[Reference]
CBCL externalizing			**Mean difference (95% CI)**	**Mean difference (95% CI)**
High	58/1728 (3.4)	1670/1728 (96.6)	1.71 (1.15 to 2.28)	0.94 (0.45 to 1.43)
Low	50/2478 (2.0)	2428/2478 (98.0)	[Reference]	[Reference]



Dashed vertical line at x = 1 represents the reference for risk ratios (RRs). Solid vertical line at x = 0 represents the reference for mean differences.

[a]See descriptions of suicidal behaviors, suicidal ideation, and Child Behavior Checklist (CBCL) internalizing and externalizing scores in footnotes b-d of the Table. Participants with CBCL internalizing and externalizing T scores ≥65 are shown in the "With outcome" column as these scores are considered to indicate clinically elevated symptoms. Exposure categories were dummy coded (low, increasing, high), with the low-use trajectory as the reference group.

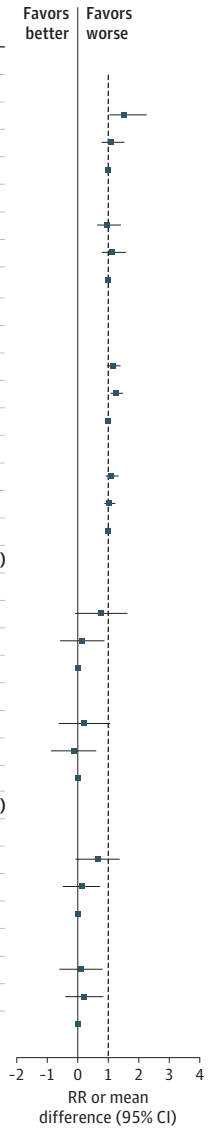
[b]For categorical outcomes (suicidal behaviors and suicidal ideation), Poisson regression was used to estimate RRs and 95% CIs using robust standard errors. For continuous outcomes (internalizing and externalizing symptoms), generalized linear models were used to estimate mean differences with 95% CIs using ordinary standard errors. Unadjusted models included only the addictive use trajectories. Adjusted models also controlled for baseline age; sex; race and ethnicity; parental education, income, and marital status; baseline suicidal ideation and behaviors; and baseline internalizing and externalizing symptoms.

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Figure 4. Associations of Baseline Screen Time With Year 4 Follow-Up Suicidal Behaviors, Suicidal Ideation, and Mental Health Outcomes

Outcomes, by baseline screen time[a]	No./total No. (%)		RR or mean difference (95% CI)[b]
	With outcome	Without outcome	
Suicidal behaviors			RR (95% CI)
Weekday screen time			
High	78/1138 (6.9)	1060/1138 (93.1)	1.53 (1.04 to 2.26)
Moderate	54/1133 (4.8)	1079/1133 (95.2)	1.09 (0.78 to 1.53)
Low	85/1964 (4.3)	1879/1964 (95.7)	1 [Reference]
Weekend screen time			
High	99/1732 (5.7)	1633/1732 (94.3)	0.95 (0.64 to 1.41)
Moderate	65/1265 (5.1)	1200/1265 (94.9)	1.11 (0.79 to 1.58)
Low	53/1238 (4.3)	1185/1238 (95.7)	1 [Reference]
Suicidal ideation			RR (95% CI)
Weekday screen time			
High	212/1138 (18.6)	926/1138 (81.4)	1.16 (0.95 to 1.40)
Moderate	227/1133 (20.0)	906/1133 (80.0)	1.26 (1.08 to 1.48)
Low	315/1964 (16.0)	1649/1964 (84.0)	1 [Reference]
Weekend screen time			
High	332/1732 (19.2)	1400/1732 (80.8)	1.10 (0.91 to 1.33)
Moderate	225/1265 (17.8)	1040/1265 (82.2)	1.04 (0.87 to 1.23)
Low	197/1238 (15.9)	1041/1238 (84.1)	1 [Reference]
CBCL internalizing			Mean difference (95% CI)
Weekday screen time			
High	106/1130 (9.4)	1024/1130 (90.6)	0.77 (-0.09 to 1.63)
Moderate	84/1123 (7.5)	1039/1123 (92.5)	0.15 (-0.58 to 0.88)
Low	149/1948 (7.6)	1799/1948 (92.4)	[Reference]
Weekend screen time			
High	157/1718 (9.1)	1561/1718 (90.9)	0.22 (-0.62 to 1.06)
Moderate	84/1261 (6.7)	1177/1261 (93.3)	-0.14 (-0.88 to 0.61)
Low	98/1222 (8.0)	1124/1222 (92.0)	[Reference]
CBCL externalizing			Mean difference (95% CI)
Weekday screen time			
High	45/1130 (4.0)	1085/1130 (96.0)	0.65 (-0.08 to 1.37)
Moderate	24/1123 (2.1)	1099/1123 (97.9)	0.12 (-0.49 to 0.74)
Low	39/1948 (2.0)	1909/1948 (98.0)	[Reference]
Weekend screen time			
High	54/1718 (3.1)	1664/1718 (96.9)	0.11 (-0.60 to 0.81)
Moderate	28/1261 (2.2)	1233/1261 (97.8)	0.22 (-0.41 to 0.84)
Low	26/1222 (2.1)	1196/1222 (97.9)	[Reference]



Risk estimates from models examining associations between baseline screen time (weekday and weekend) and year 4 outcomes: suicidal behaviors, suicidal ideation, and Child Behavior Checklist (CBCL) internalizing and externalizing symptoms, controlling for demographics, suicidal behaviors, suicidal ideation, and CBCL internalizing and externalizing symptom T scores at baseline. Dashed vertical line at x = 1 represents the reference for risk ratios (RRs). Solid vertical line at x = 0 represents the reference for mean differences.

[a]See descriptions of suicidal behaviors, suicidal ideation, and CBCL internalizing and externalizing T scores in footnotes b-d of the Table. Participants with CBCL internalizing and externalizing T scores ≥65 are shown in the "With outcome" column as these scores are considered to indicate clinically elevated symptoms. Baseline screen time was classified as low (≤2 h/d),[43] moderate (>2 to ≤4 h/d), or high (≥4 h/d).[44] Cutoffs were selected based on existing literature that has linked moderate and high levels of screen time to elevated risks of depressive symptoms, anxiety, and behavioral problems in children and adolescents. Exposure categories were dummy coded (low, high, medium), with low screen time as the reference group.

[b]For categorical outcomes (suicidal behaviors, suicidal ideation), Poisson regression was used to estimate RRs and 95% CIs using robust standard errors. For continuous outcomes (internalizing and externalizing symptoms), generalized linear models were used to estimate mean differences with 95% CIs using ordinary standard errors.

the use of a large, population-based longitudinal sample and comprehensive, platform-specific assessment of addictive use trajectories. Previous studies, mostly cross-sectional and measuring only total screen time, have reported associations between more screen time and poorer mental health.[4,10,45,46] The current study's findings align with prior studies observing associations between addictive screen use and psychiatric symptoms at single time points.[47,48] This study adds substantially to existing knowledge by examining longitudinal trajectories and their associations with long-term outcomes.

For both social media and mobile phones, addictive use trajectories followed 3 different patterns, and a substantial proportion of youths had addictive use trajectories that increased over the 4 years of observation, starting at age 10

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years. These increasing addictive use patterns, which would not have been predicted based on baseline assessments alone, were associated with elevated risks of suicidal behaviors and ideation. This underscores the potential importance of repeated assessment of addictive use of social media and mobile phones among children entering adolescence. In contrast, video game addictive use followed 2 trajectories, high and low, which were stable over time, potentially allowing earlier identification of risk without repeated assessment.

One key finding was that total screen time was not associated with suicide-related or mental health outcomes, nor did it alter the strength or direction of associations between addictive use trajectories and these outcomes. This underscores the importance of treating time spent and addictive use as separate constructs when examining associations with suicide-related and mental health outcomes.[15]

These findings suggest that focusing future research or interventions on addictive screen use might hold more promise than focusing on total screen time, which may unnecessarily involve low-risk youths. Future studies could evaluate whether monitoring addictive screen use is useful to identify higher-risk youths in clinical practice. Future research could also evaluate interventions that address the addictive aspect of screen use and prevention approaches targeting higher-risk subgroups of children and adolescents.[49,50]

Limitations

There are limitations. First, the observational nature of this study precludes establishing that addictive use trajectories cause the outcomes studied, although the longitudinal design mitigates concerns about reverse causality. Second, reliance on self-reported data may introduce recall and social desirability biases.[20,51] This analysis used weighted confirmatory factor analysis scores for quantifying addictive use, confirming their construct validity, and personal estimates of screen use. Still, future studies should consider incorporating objective measures, such as passive digital monitoring. Third, parent-reported CBCL measures may underestimate mental health conditions. Fourth, the COVID-19 pandemic may have influenced screen time,[10] but sensitivity analyses demonstrated consistent findings (eAppendix 5 in Supplement 1). Fifth, the ABCD Study did not assess multitasking across screen platforms, so it is not possible to tell how measurement of multitasking would have affected these findings. Sixth, not all of the participants in the ABCD Study had year 4 follow-up data available at the time of this study; future analyses should seek to replicate results when these data are available. Finally, these analyses did not include psychosocial and behavioral factors such as bullying,[52] adverse childhood experiences,[53,54] parental monitoring,[55,56] sleep disturbances,[57] stress,[58] social isolation,[49] and social determinants of health (eg, neighborhood and school contexts).[59,60] Future studies should examine potential interactions and mediating relationships among these factors, addictive use trajectories, and mental health outcomes.

Conclusions

High or increasing trajectories of addictive use of social media, mobile phones, or video games were common in early adolescence and were associated with suicide-related and mental health outcomes. Addictive screen use trajectories warrant further study regarding potential use for clinical evaluation of risk and for the design and testing of interventions to improve youth mental health.

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