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Association of Screen Time With Internalizing and Externalizing Behavior Problems in Children 12 Years or Younger
A Systematic Review and Meta-analysis

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IMPORTANCE Currently, there is a lack of consensus in the literature on the association between screen time (eg, television, video games) and children's behavior problems.

OBJECTIVE To assess the association between the duration of screen time and externalizing and internalizing behavior problems among children 12 years or younger.

DATA SOURCES For this systematic review and meta-analysis, MEDLINE, Embase, and PsycINFO databases were searched for articles published from January 1960 to May 2021. Reference lists were manually searched for additional studies.

STUDY SELECTION Included studies measured screen time (ie, duration) and externalizing or internalizing behavior problems in children 12 years or younger, were observational or experimental (with baseline data), were available in English, and had data that could be transformed into an effect size. Studies conducted during the COVID-19 pandemic were excluded. Of 25 196 nonduplicate articles identified and screened for inclusion, 595 met the selection criteria.

DATA EXTRACTION AND SYNTHESIS The study followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) reporting guideline. Extracted variables were child age, sex, and socioeconomic status; informants and measurement type for screen time and behavior problems; study publication year; and study design and quality. Data were extracted by 2 independent coders and were pooled using a random-effects model.

MAIN OUTCOMES AND MEASURES The primary outcome was the association of screen time duration with externalizing (eg, aggression, attention deficit/hyperactivity disorder symptoms) and internalizing (eg, depression, anxiety) behaviors or diagnoses.

RESULTS Of the 595 full-text articles assessed for eligibility, 87 studies met all inclusion criteria, comprising 98 independent samples and 159 425 participants (mean [SD] age, 6.07 [2.89] years; 83 246 [51.30%] male). Increased duration of screen time had a small but significant correlation with more externalizing problems (90 samples; r, 0.11; 95% CI, 0.10-0.12) and internalizing problems (43 samples; r, 0.07; 95% CI, 0.05-0.08) in children. Several methodological moderators explained between-study heterogeneity. There was evidence of significant between study heterogeneity (I^2 = 87.80).

CONCLUSIONS AND RELEVANCE This systematic review and meta-analysis found small but significant correlations between screen time and children's behavior problems. Methodological differences across studies likely contributed to the mixed findings in the literature.

Multimedia

Supplemental content

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The effects of screen time on children's mental health has been rigorously debated.[1,2] Some literature suggests that screen time may be associated with risk of poor mental health outcomes by displacing sleep and physical activities as well as social exchanges and learning opportunities known to foster well-being.[3,4] Screen media may also impede self-regulation strategies and increase arousal levels owing to fast-paced and intense audiovisual effects, which may be associated with inattention and aggressive behavior.[5,6] However, it has been argued that concern with regard to screen time and its effect on child mental health is not empirically justified owing to conflicting research results and methodological shortcomings.[7-10]

Meta-analyses can address discrepancies in the literature by providing greater statistical precision through pooled results from multiple individual studies[11] and can detect whether variations in study findings are explained by moderators. In the screen time literature, methodological differences have likely contributed to the conflicting findings: effect sizes may differ based on the statistical analyses conducted,[12] how variables are measured,[13] and whether data are cross-sectional or longtudinal.[7] Effect sizes may also vary as a function of child sex (eg, sex differences in the associations of screen time[14,15] with behavior problems),[16-18] child age (eg, association of increased screen use with increasing age among children),[15,19] and socioeconomic risk (eg, association of increased screen use with behavior problems in the context of low socioeconomic status).[20,21] Identifying when and for whom correlations are stronger or weaker may inform the ongoing screen time debate and help develop targeted interventions for children most at risk for potential behavior problems associated with screen time.

Owing to substantial research to date on duration of screen time and behavior problems, it appeared timely to meta-analytically summarize this body of research. Given that the context and nature of screen use changes from childhood to adolescence from mostly parent-mediated and television-centric to less parent-mediated and weighted toward social media,[19,22,23] this systematic review and meta-analysis focused on children 12 years or younger. Because of their different mechanisms,[24,25] we conducted 2 separate meta-analyses for externalizing (eg, aggression, attention deficit/hyperactivity disorder symptoms) and internalizing (eg, anxiety, depression) behavior problems.[25] In addition, we sought to identify sources of between-study heterogeneity.

Key Points

Question Is there an association between screen time and children's internalizing and externalizing behavior problems in the extant screen time literature?

Findings In this systematic review and meta-analysis of 87 studies (98 independent samples) including 159 425 children 12 years or younger, greater duration of screen time was weakly but significantly correlated with externalizing (eg, aggression, inattention) and internalizing (eg, anxiety, depression) behavior problems. Results varied as a function of demographic (eg, sex) and methodological factors (eg, informant and measurement method).

Meaning The findings showed weak but significant correlations between screen time and children's behavior problems and suggest that methodological variability may have contributed to mixed findings in the literature.

Methods

Search Strategy

In this systematic review and meta-analysis, searches were conducted in the MEDLINE, Embase, and PsycINFO databases by a science librarian for articles published from January 1960 to May 2021. The concepts of screen time, internalizing and externalizing behavior, and children were captured by searching database-specific subject headings and text word fields (eTable 1 in the Supplement). Synonymous terms were combined with the Boolean "OR" and then combined with the Boolean "AND." The concept of children (12 years or younger) was searched using the "age limits" database functions and via text word search. In all databases, truncation symbols were used in text word searches to capture variations in phrasing and spelling. No language limits were applied. Reference lists in included studies and review articles were manually searched for additional studies. This study followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) reporting guideline.

Study Inclusion and Exclusion Criteria

Studies were included if (1) the age range of included children was 12 years or less, (2) screen time duration was measured (hours and/or minutes), (3) behavior problems (ie, internalizing, externalizing) were measured, (4) the studies were observational or experimental (with baseline data), (5) statistical data were available, and (6) the article was available in English. Because child screen time and mental distress have increased during the COVID-19 pandemic,[26,27] we excluded studies conducted during the pandemic. Inclusion and exclusion criteria are detailed in eTable 2 in the Supplement. Studies were assessed for inclusion by 2 coders (R.E. and C.A.). Any study deemed to meet inclusion criteria by either coder was considered for full-text review.

Data Extraction

Study Quality Assessment

Each study was evaluated by 2 independent coders (C.A. and C.M.) for quality based on an adapted 16-item quality assessment tool[28] (eTable 3 in the Supplement), with each item coded as 0 (no) or 1 (yes) (eTable 4 in the Supplement). Intercoder agreement for the overall quality score was good (intraclass correlation coefficient, 0.75). Discrepancies were resolved via consensus.

Moderating Variables

Moderators extracted were (1) child sex (percentage of males in the study); (2) child age at outcome measurement (in months); (3) screen time informant (child or parent); (4) screen time measurement method (ie, activity log, questionnaire, or

interview); (5) type of internalizing (anxiety, depression, or somatization) or externalizing (aggression or attention deficit/hyperactivity disorder symptoms) behavior problems; (6) informant (child, parent, clinician or coder, peers, teacher, or combination); (7) measurement method (diagnostic and structural interview, observer report, or questionnaire); (8) whether informants differed for screen time and behavior problems; (9) clinical sample (diagnosis of a preexisting behavior problem [yes or no]); (10) publication year; (11) study design (cross-sectional, longitudinal with baseline outcome adjustment, or longitudinal with no baseline adjustment); (12) sociodemographic risk (less than 80% vs 80% or more of the sample had at least 1 of the following: low income, low caregiver educational level, or an adolescent parent); and (13) geographic location. eTable 5 in the Supplement shows the data extraction document used. All included studies were independently coded by 2 trained coders (C.A. and C.M.), with excellent reliability[29] for continuous moderators (intraclass correlation coefficient, 0.80-1.00). The mean percentage of agreement for categorical moderators was 92.5% (range, 85%-100%). Discrepancies were resolved via consensus.

Data Synthesis

When multiple studies conducted analyses on the same sample, the study with the largest sample size and most comprehensive information was selected. Adjusted statistics were selected over unadjusted statistics whenever available. Global measures of internalizing or externalizing symptoms and of screen time were selected over discrete symptoms (eg, depression, anxiety) or screen types (eg, tablet, video games). Similar to the methods of other meta-analyses,[30-32] when a single study measured screen time and/or behavior problems at multiple time points, effect sizes with the largest temporal distance between measures were selected. When studies reported nonsignificant findings without any corresponding statistic or *P* value, a *P* value of .50 was entered.[33] Studies reporting β coefficients between -0.50 and 0.50 were imputed to correlations (*r*).[34] Effect sizes were pooled when a single effect size among many in a study could not be selected based on the aforementioned criteria. In addition, if a study provided effect sizes from multiple discrete samples with different population parameters (eg, different cohorts), these samples were entered into the meta-analysis separately.

Statistical Analysis

Pooled effect size estimates and moderator analyses were conducted using Comprehensive Meta-Analysis, version 3.0 (Biostat).[35] Effect sizes were transformed into correlations (*r*) with 95% CIs using random-effects modeling.[36] Correlations were interpreted as small (0.1), moderate (0.2), or large (0.3) based on conventional standards.[37]

Q and I^2 statistics were used to assess between-study heterogeneity. Random-effect meta-regressions and subgroup comparisons were conducted to assess continuous and categorical moderators, respectively. Subgroup comparisons were only conducted when there were at least 3 samples (ie, ≥3 cells) available for each categorical comparison.[35] Inspection of funnel plots and the Egger test were used to estimate publication bias.[38] A 2-tailed *P* value of .05 was used for the primary analyses, and owing to the number of moderator analyses conducted, a conservative 2-sided α value of .01 was used to assess the significance of moderators.[39]

Results

The search strategy revealed 25 196 nonduplicate abstracts to be reviewed for determination of meeting inclusion criteria. A total of 595 full-text articles were assessed for eligibility, and 87 studies (with 98 unique samples) were included in the meta-analysis (**Figure 1**).

Study Characteristics

The 98 samples consisted of 159 425 participants. Sample sizes in the included studies ranged from 15 to 15 291 participants (median, 532.5 participants). The mean (SD) age of participants when screen time was assessed was 6.07 (2.89) years (range, 0.5-11.0 years), and the mean (SD) age when behavior problems were assessed was 7.16 (2.70) years (range, 1.3-12.0 years). A total of 83 246 participants (51.25%) were male (median percentage of males per study, 51.31% [range, 36.60% to 78.70%]). Of the 98 total samples, 44 (44.9%) were in North America, 24 (24.5%) in Europe, 1 (1.0%) in Africa, 14 (14.3%) in Asia, 7 (7.1%) in Australia or New Zealand, 5 (5.1%) in the Middle East, and 2 (2.0%) in South America; 1 sample (1.0%) was multisite (detailed study characteristics are shown in eTable 6 in the Supplement).

Screen Time and Externalizing Behavior Problems

Pooled Effect Sizes

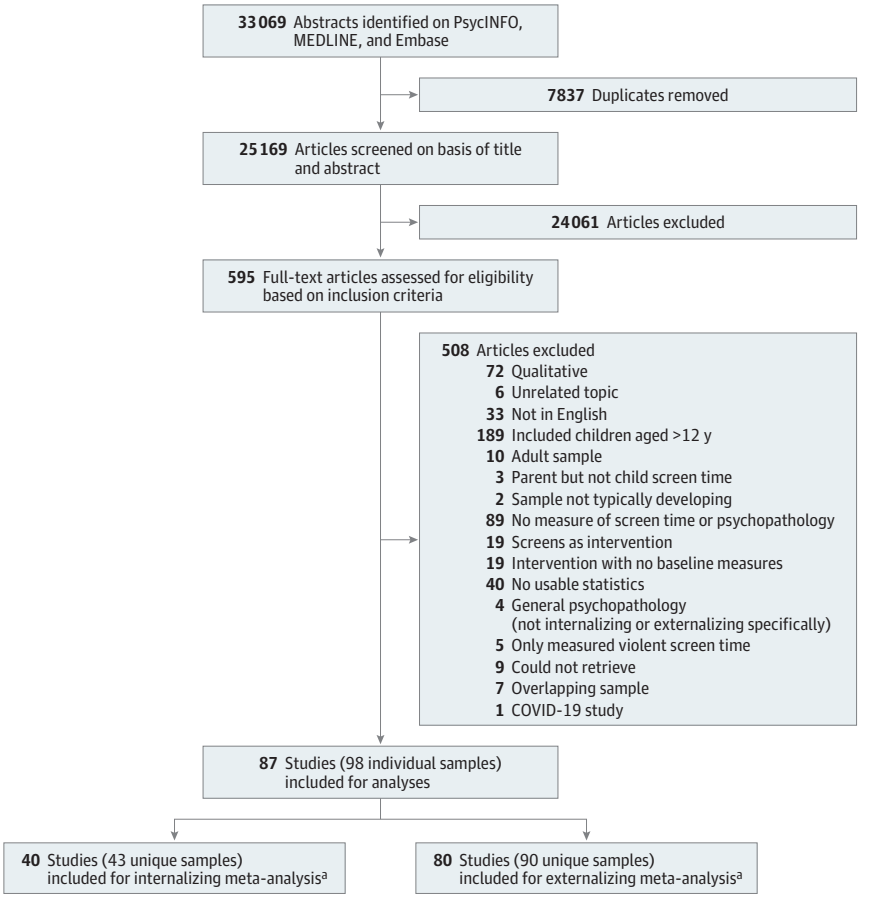
In the 90 samples from 80 studies (124 027 children), the correlation was small but significant (*r*, 0.11; 95% CI, 0.10-0.12) (**Figure 2**).[16,40-118] The Egger test result provided evidence that studies with smaller sample sizes had more extreme effect sizes, and the funnel plot showed asymmetry (eFigure 1 in the Supplement), indicating possible publication bias and/or small-study effects. There was evidence of significant between-study heterogeneity (*Q*, 729.78; *P* < .001; I^2 = 87.80); therefore, moderators were explored (**Table 1**).

Moderator Analyses

Meta-regression analyses of the 90 samples showed that the effect size for the association between screen time and externalizing problems increased as the percentage of males in studies increased (*b*, 0.007 [SE, 0.002]; *z*, 3.23; *P* = .001). Effect sizes also decreased as the study publication year increased (*b*, −0.003 [SE, 0.001]; *z*, -3.98; *P* < .001). The effect size for the association between screen time and externalizing problems decreased as study quality increased (*b*, −0.017 [SE, 0.004]; *z*, -4.30; *P* < .001) (**Table 2**).

Correlations between screen time and externalizing problems were stronger in studies examining aggression (21 samples; *r*, 0.17; 95% CI, 0.13-0.20) compared with those examining attention deficit/hyperactivity disorder symptoms (25 samples; *r*, 0.09; 95% CI, 0.06-0.11). Correlations were weaker in longitudinal studies that controlled for baseline

Figure 1. PRISMA Flow Diagram



[a] Internalizing and externalizing categories were not mutually exclusive.

externalizing problems (19 samples; *r*, 0.06; 95% CI, 0.04-0.08) compared with cross-sectional studies (50 samples; *r*, 0.13; 95% CI, 0.11-0.15) and longitudinal studies without baseline control (21 samples; *r*, 0.11; 95% CI, 0.08-0.14). Studies conducted in the Middle East had stronger associations between screen time and externalizing problems (5 samples; *r*, 0.23; 95% CI, 0.17-0.29) compared with those conducted in all other geographic locations. Stronger correlations were also found in studies using observer reports (8 samples; *r*, 0.20; 95% CI, 0.14-0.26) compared with those using questionnaires (74 samples; *r*, 0.10; 95% CI, 0.08-0.12). In addition, studies using peers to assess externalizing problems had stronger correlations (8 samples; *r*, 0.20; 95% CI, 0.15-0.26) compared with those that used child report (4 samples; *r*, 0.08; 95% CI, 0.00-0.15), parent report (57 samples; *r*, 0.10; 95% CI, 0.08-0.12), teacher report (7 samples; *r*, 0.07; 95% CI, 0.02-0.13), and a combination of informants (8 samples; *r*, 0.09; 95% CI, 0.04-0.14).

Screen Time and Internalizing Behavior Problems

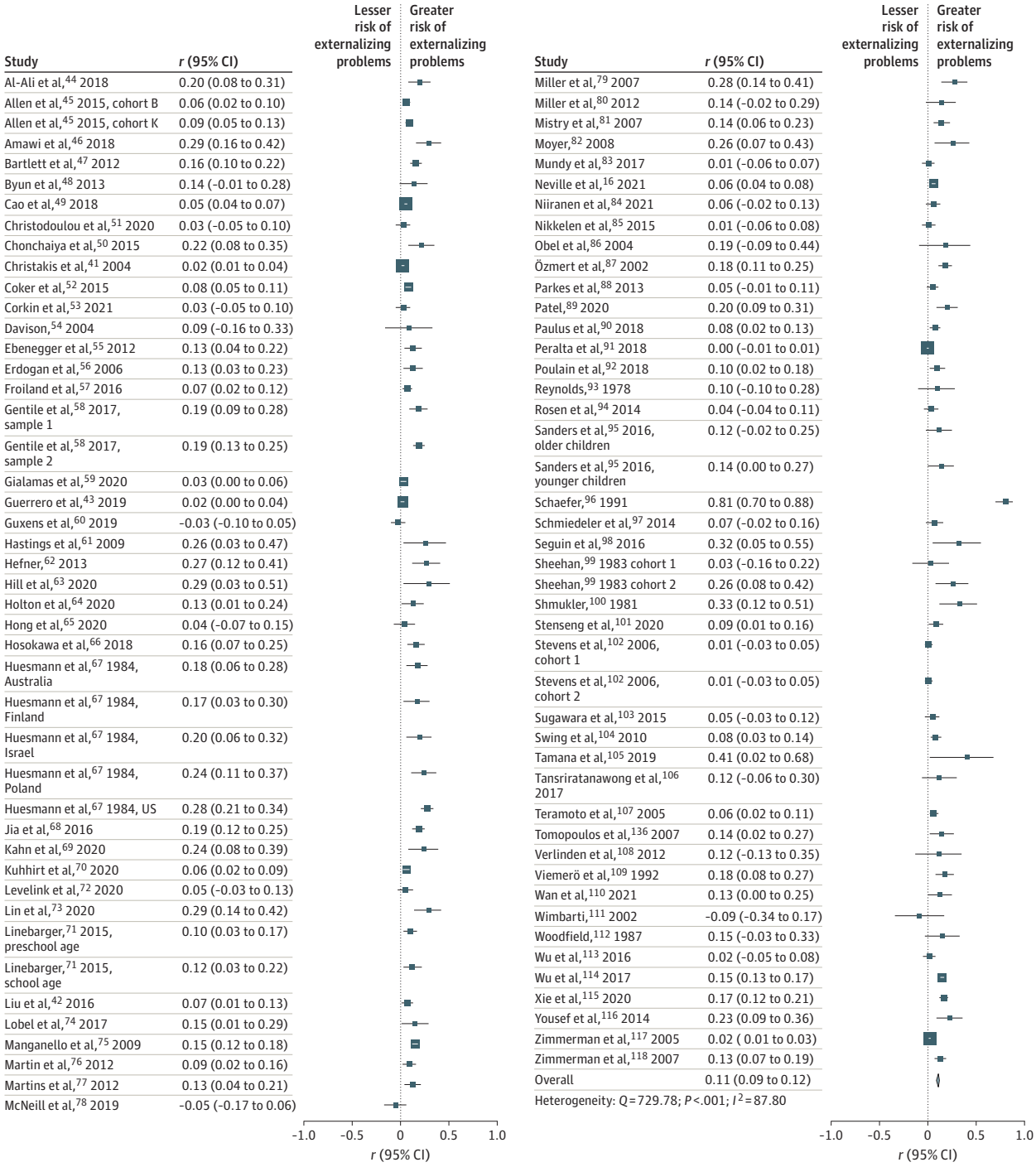
Pooled Effect Sizes

In 43 samples from 40 studies (99 603 children), the effect size between child screen time and internalizing problems was weak but significant (*r*, 0.07; 95% CI, 0.05-0.08) (**Figure 3**).[16,42,43,45,50-52,56,60,66,69,73,74,76,78,81,83,84,87,88,92,94,95,98,101,105-107,110,113-116,119-125] The funnel plot showed some asymmetry (eFigure 2 in the Supplement), indicating possible publication bias; however, the Egger test result did not suggest that smaller sample sizes had more extreme effect sizes. The *Q* statistic was significant (*Q*, 285.10; $P < .001$; I^2, 85.27), and moderator analyses were conducted to explain between-study heterogeneity (Table 1). Only 1 moderator analysis had significant results: studies that used different informants to measure internalizing problems and screen time had a stronger correlation (9 samples; *r*, 0.08; 95% CI, 0.05-0.10) compared with those with the same informant across measures (34 samples; *r*, 0.01; 95% CI, -0.02 to 0.03).

Discussion

The increasing rate of screen time in early childhood has engendered concern among clinicians, policy makers, and parents regarding its possible effects on children's mental health. This study found small but significant correlations between screen time and children's internalizing and externalizing behavior problems. The magnitude of these correlations is comparable with that found in other meta-analyses on the association between screen time and child language skills[126] and academic performance.[127] Moreover, effect sizes derived in this study are similar to those in other meta-analyses examining

Figure 2. Meta-analysis of the Correlation of Screen Time With Externalizing Problems



Markers indicate estimates, with the size of the marker indicating weight; horizontal lines represent 95% CIs; diamonds represent pooled estimates, with the outer points indicating 95% CIs.

associations between various family and child factors (eg, language skills[128] and socioeconomic status[129]) and internalizing and externalizing problems. Although the effect sizes found in this study were small, the consequences of screen time at a population level are likely meaningful,[37,130] particularly because a recent meta-analysis[131] suggested that 75% of children younger than 2 years and 64% of children aged 2 to 5 years exceed screen time guidelines.

Effect sizes were larger for the association between screen time and externalizing problems compared with internalizing problems given nonoverlapping 95% CIs. Future studies testing which discrete mechanisms underlie the association

Table 1. Moderator Analyses for the Correlation Between Screen Time and Behavior Problems

Variable	Samples, No.	*r* (95% CI)	*Q*	Contrast *P* value[a]
Externalizing behavior				
Screen type				
Video games or computer	9	0.13 (0.08 to 0.18)[b]	0.32	.57
Television	42	0.11 (0.09 to 0.14)[b]		
Externalizing behavior type				
Aggression	21	0.17 (0.13 to 0.20)[b]	11.11	.001
Attention-deficit/hyperactivity disorder symptoms	25	0.09 (0.06 to 0.12)[b]		
Sociodemographic risk				
No	87	0.11 (0.09 to 0.12)[b]	0.04	.84
Yes	3	0.12 (0.03 to 0.21)[c]		
Study design				
Cross-sectional	50	0.13 (0.11 to 0.15)[b]	23.55	<.001
Longitudinal without control for baseline outcome	21	0.11 (0.08 to 0.14)[b]		
Longitudinal with control for baseline outcome	19	0.06 (0.04 to 0.08)[b]		
Screen time measurement method				
Activity log	9	0.12 (0.08 to 0.17)[b]	2.81	.25
Interview	7	0.15 (0.09 to 0.21)[b]		
Questionnaire	74	0.10 (0.09 to 0.12)[b]		
Screen time informant				
Child	19	0.15 (0.11 to 0.18)[b]	5.71	.02
Parent	69	0.10 (0.08 to 0.12)[b]		
Behavior measurement method				
Diagnosis and/or structured interview	8	0.12 (0.07 to 0.17)[b]	10.04	.007
Observer report	8	0.20 (0.14 to 0.26)[b]		
Questionnaire	74	0.10 (0.08 to 0.12)[b]		
Behavior informant				
Child	4	0.08 (0.00 to 0.15)[c]	15.39	.009
Clinician or coder	6	0.16 (0.08 0.23)[b]		
Peers	8	0.20 (0.15 to 0.26)[b]		
Teacher	7	0.07 (0.02 to 0.13)[d]		
Parent	57	0.10 (0.08 to 0.12)[b]		
Combination	8	0.09 (0.04 to 0.14)[d]		
Different informants for screen time and behavior				
Yes	35	0.13 (0.09 to 0.16)[b]	1.56	.21
No	55	0.10 (0.08 to 0.12)[b]		
Geographic location				
Asia	13	0.12 (0.08 to 0.16)[b]	25.17	<.001
Australia and New Zealand	7	0.05 (−0.01 to 0.10)		
Europe and UK	22	0.08 (0.06 to 0.11)[b]		
Middle East	5	0.23 (0.17 to 0.29)[b]		
North America	39	0.12 (0.10 to 0.15)[b]		
Clinical sample				
Yes	4	0.13 (0.03 to 0.23)[c]	0.16	.69
No	86	0.11 (0.09 to 0.12)[b]		
Internalizing behavior				
Screen type				
Video games or computer	4	0.02 (−0.07 to 0.12)	1.58	.21
Television	8	0.09 (0.04 to 0.15)[d]		

(continued)

Table 1. Moderator Analyses for the Correlation Between Screen Time and Behavior Problems (continued)

Variable	Samples, No.	*r* (95% CI)	*Q*	Contrast *P* value[a]
Study design				
Cross-sectional	29	0.08 (0.05 to 0.10)[b]	2.76	.25
Longitudinal without control for baseline outcome	5	0.07 (0.01 to 0.08)[b]		
Longitudinal with control for baseline outcome	9	0.03 (−0.02 to 0.08)		
Screen time informant				
Child	10	0.09 (0.04 to 0.13)[b]	1.43	.23
Parent	32	0.06 (0.03 to 0.08)[b]		
Behavior measurement method				
Questionnaire	40	0.06 (0.04 to 0.08)[b]	0.94	.33
Diagnosis and/or structured interview	3	0.10 (0.03 to 0.17)[d]		
Different informants for screen time and behavior				
Yes	9	0.08 (0.05 to 0.10)[b]	14.86	<.001
No	34	0.01 (−0.02 to 0.03)		
Geographic location				
Asia	9	0.08 (0.06 to 0.10)[b]	1.75	.42
Europe	12	0.07 (0.03 to 0.11)[d]		
North America	16	0.05 (0.02 to 0.09)[d]		
Behavior informant				
Child	7	0.10 (0.05 to 0.14)[b]	1.20	.27
Parent	33	0.07 (0.04 to 0.09)[b]		

[a] Contrast *P* values represent the *P* values for the comparison of effect sizes between categorical moderators.

[b] $P < .001$ for the effect size of this categorical moderating factor alone.

[c] $P < .05$ for the effect size of this categorical moderating factor alone.

[d] $P < .01$ for the effect size of this categorical moderating factor alone.

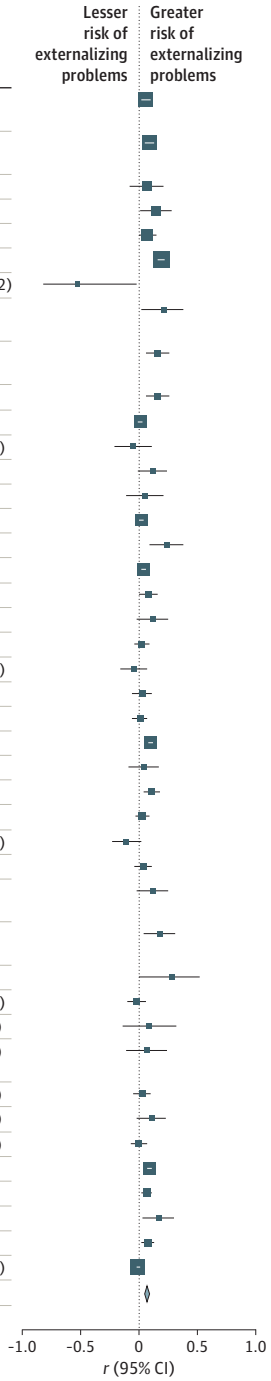
Table 2. Meta-regression Analyses of the Association Between Screen Time and Externalizing and Internalizing Problems

Continuous moderator	Samples, No.	β (SE)	*z* Score	*P* value
Externalizing behavior				
Male	90	0.007 (0.002)	3.23	.001
Age at externalizing assessment	90	0.000 (0.000)	0.10	.92
Publication year	90	−0.003 (0.001)	−3.98	<.001
Study quality	90	−0.017 (0.004)	−4.30	<.001
Internalizing behavior				
Male	43	0.002 (0.003)	0.52	.60
Age at internalizing assessment	43	0.000 (0.000)	−0.37	.71
Publication year	43	−0.001 (0.002)	−0.44	.66
Study quality	43	−0.003 (0.006)	−0.49	.62

between screen time and externalizing vs internalizing problems are warranted. For example, it is possible that the content viewed (eg, inappropriate or violent) underlies the association between screen time and externalizing problems, whereas indirect effects such as social withdrawal or sleep disruption may underlie the association between screen time and internalizing problems. From a methodological perspective, externalizing problems may be easier for reporters to observe than internalizing problems owing to their outward display, leading to poorer sensitivity for identifying internalizing problems.[132]

We found stronger correlations between screen time and externalizing problems in boys compared with girls. This finding is consistent with that of previous research in which boys had higher screen use[14,133] and more externalizing problems[17] than did girls. Externalizing behaviors, such as aggression, may be more readily modeled by boys through sex-stereotypic socialization.[134] In addition, we found that studies measuring aggression had larger effect sizes than those measuring attention deficit/hyperactivity disorder symptoms. While viewing screen media, children may be exposed to inappropriate content, aggression, and violence.[40,135,136] Consistent with social learning theory,[137] children may become desensitized after repeated exposures and model aggressive or violent content toward others.[6,40,136] Moreover, as screen time becomes more normalized, it is possible that aggressive behavior within some screen programming does as well. Screen use guidelines[138] suggest that parents should monitor screen time, ensure the content their children are viewing is age-appropriate, limit exposure to violent content, communicate with their children about inappropriate on-screen content, and model healthy device habits.[139]

Figure 3. Meta-analysis of the Correlation of Screen Time With Internalizing Problems



Study	r (95% CI)
Allen et al,[45] 2015, cohort K	0.06 (0.02 to 0.10)
Allen et al,[45] 2015, cohort B	0.09 (0.05 to 0.13)
Brubaker,[119] 2020	0.07 (−0.08 to 0.21)
Chonchaiya et al,[50] 2015	0.15 (0.01 to 0.28)
Christodoulou et al,[87] 2020	0.07 (0.00 to 0.15)
Coker et al,[52] 2015	0.19 (0.16 to 0.22)
Cooper,[120] 2004	-0.53 (-0.82 to -0.02)
Dunkeld et al,[121] 2020, sample 1	0.21 (0.02 to 0.38)
Dunkeld et al,[121] 2020, sample 2	0.16 (0.06 to 0.26)
Erdogan et al,[56] 2006	0.16 (0.06 to 0.26)
Guerrero et al,[43] 2019	0.01 (-0.01 to 0.03)
Guxens et al,[60] 2019	-0.05 (-0.21 to 0.11)
Hosokawa et al,[66] 2018	0.12 (-0.01 to 0.24)
Kahn et al,[69] 2020	0.05 (-0.11 to 0.21)
Lam et al,[122] 2019	0.02 (0.00 to 0.04)
Lin et al,[73] 2020	0.24 (0.09 to 0.38)
Lin et al,[123] 2020	0.04 (0.02 to 0.06)
Liu et al,[42] 2016	0.08 (0.00 to 0.16)
Lobel et al,[74] 2017	0.12 (-0.02 to 0.25)
Martin et al,[76] 2012	0.02 (-0.04 to 0.09)
McNeill et al,[78] 2019	-0.04 (-0.16 to 0.07)
Mistry et al,[81] 2007	0.03 (-0.06 to 0.11)
Mundy et al,[83] 2017	0.01 (-0.06 to 0.07)
Neville et al,[16] 2021	0.10 (0.08 to 0.12)
Niiranen et al,[84] 2021	0.04 (-0.09 to 0.17)
Özmert et al,[87] 2002	0.11 (0.04 to 0.18)
Parkes et al,[88] 2013	0.03 (-0.03 to 0.09)
Poulain et al,[92] 2018	-0.11 (-0.23 to 0.02)
Rosen et al,[94] 2014	0.04 (-0.04 to 0.11)
Sanders et al,[95]2016, older children	0.12 (-0.02 to 0.25)
Sanders et al,[95] 2016, younger children	0.18 (0.04 to 0.31)
Séguin et al,[98] 2016	0.28 (0.00 to 0.52)
Stenseng et al,[101] 2020	-0.02 (-0.10 to 0.06)
Tamana et al,[105] 2019	0.09 (-0.14 to 0.32)
Tansriratanawong et al,[106] 2017	0.07 (-0.11 to 0.24)
Teramoto et al,[107] 2005	0.03 (-0.05 to 0.10)
Wan et al,[110] 2021	0.11 (-0.02 to 0.23)
Wu et al,[113] 2016	0.00 (-0.07 to 0.07)
Wu et al,[114] 2017	0.09 (0.07 to 0.11)
Xie et al,[115] 2020	0.07 (0.02 to 0.11)
Yousef et al,[116] 2014	0.17 (0.03 to 0.30)
Zhang et al,[124] 2020	0.08 (0.02 to 0.13)
Zhu et al,[125] 2019	-0.01 (-0.02 to 0.01)
Overall	0.07 (0.05 to 0.09)
Heterogeneity: $Q = 285.10$; $P < .001$; $I^2 = 85.27$	

Markers indicate estimates, with the size of the marker indicating weight; horizontal lines represent 95% CIs; diamonds represent pooled estimates, with the outer points indicating 95% CIs.

Correlations of screen time with externalizing behavior problems were stronger in the Middle East compared with any other geographic location; however, sample sizes in studies from the Middle East were small, and 95% CIs were wide, limiting the conclusions that can be made. A dose-response relationship between screen time and externalizing problems[41,42,140] may explain the stronger correlations found in countries in the Middle East because early-onset screen use has been increasing at a faster rate in these countries compared with other countries.[141,142] More research is needed to understand how cultural differences (eg, different guidelines and beliefs about screen time)[143] contribute to associations between screen time and behavior problems.

The mixed findings in the literature on screen time and behavior problems may largely be the result of methodological variability.[7] Studies that used more objective methods (eg, observer report) and reporters (eg, peers) of children's externalizing problems had stronger correlations than those using child, parent, or teacher reports. In addition, studies that used different informants for screen time and internalizing problems had stronger correlations than those using the same informant across measures. Inconsistency between informants for children's behavior problems is common,[144] but informant discrepancies may indicate the contexts and ways in which behavior problems are perceived by the child and others.[145] For example, aggression may be noticed more readily by peers owing to children having more opportunities to engage with peers aggressively (eg, bullying).

Variability exists both across (ie, aggression, oppositional behavior, and hyperactivity) and within (eg, demanding, hits others) the broad construct of externalizing behavior problems. However, historically, externalizing problems have been examined as a composite.[25,146] This study's finding that screen time was more strongly correlated with aggression suggests that the use of an externalizing composite may not capture inherent nuances in the association between screen time and behavior problems. Furthermore, as children move into adolescence, attention problems and aggression are often measured as separate constructs.[147] Future research should consider disaggregating externalizing behaviors, presenting associations in their subcomponents (eg, aggression, attention deficit/hyperactivity disorder symptoms), and examining which items within the subcomponents are correlated most strongly with screen time.

Given that methodological variability is critical for understanding patterns of associations in this body of research, several methodological implications are suggested for future research. To the extent possible, future research should use multiinformant (eg, peers, child), multimethod (eg, passive sensing apps and questionnaires), and longitudinal approaches to measure the association of screen time with child outcomes. Of importance, self-report screen time measurement may be biased.[148] None of the studies identified in our meta-analysis used objective measures (eg, sensing apps) to evaluate screen time, presenting an opportunity for future research to use novel screen-time measurement methods.

Two characteristics of publications were identified as significant moderators of associations between screen time and externalizing problems: study quality and publication year. Associations found between screen time and externalizing problems decreased as study quality increased. Poorer quality studies often have more random error and inflated effects owing to less methodological rigor (eg, a single informant, lack

of statistical controls). Study quality is also closely connected to study year, with larger effect sizes found in older, discovery studies typically owing to more reliance on significance testing (*P* value thresholds), inadequate power, and measurement error.[149] Thus, effect sizes also decreased in newer studies, which is consistent with the notion of a decline effect (ie, diminishing effect sizes over time).[150,151] The accessibility and use of screens have increased over time.[152] As screens become normalized in childhood and contemporary culture, the risks associated with their use may become less consequential for children's behavior problems. Furthermore, parents today may be more informed and better at monitoring screen time and content owing to awareness of screen time guidelines.[131]

Limitations

This study has several limitations. First and of most importance, effect sizes are correlational, not causal. Causal reductionism should be avoided because behavior problems are associated with a complex combination of genetic and environmental factors. Additional research that addresses this complexity is needed (eg, genetically informative designs).[153-155] Directionality cannot be inferred; screens may be used as a tool to placate or negotiate with children.[156,157] Second, although there was significant heterogeneity for internalizing problems, only 1 of the moderator analyses had significant results. Other important but unexamined moderators, such as genetic susceptibility,[155] sleep,[43] or language development,[126] may have a significant role in associations. Third, with rapid shifts in technology, generational cohorts may not use devices comparably.[7] Mobile phones were originally used almost exclusively for calling, and few children had their own; now, smartphones are used to access web pages, play games, stream videos, and socialize, and 69% of US children have their own smartphone by 12 years of age.[22] Although we excluded studies conducted during the COVID-19 pandemic, a cohort of children are growing up during the pandemic. Screen time has increased significantly during the pandemic, and this increase may affect child development.[26,158,159] In addition, not all screen time is equal in terms of content, subject, and formal features; some screen time may be more consequential than other screen time. Our findings only apply to screen time broadly in terms of duration or quantity of use. More nuanced aspects of screen time, such as screen content (eg, social media, violent video games), context (eg, coviewing vs passive viewing), and quality (eg, educational vs entertainment), should be examined. Future studies should also ensure that screen time is not measured as a single construct across multiple devices and should instead focus on the function of screen use (eg, entertainment, socializing, or education) to examine the way screens are being used without being device-specific.

Conclusions

The association between screen time and children's mental health has garnered marked attention from academic, health, and public sectors. This systematic review and meta-analysis found that screen time was weakly but significantly correlated with children's internalizing and externalizing behaviors. Our study identified several important methodological moderators of the association between screen time and behavior problems, such as the type of informants and the measures of screen time used, that highlight the lack of harmony in the screen time literature. It is essential for researchers to use more rigorous methods and approaches to analyzing screen time data[16,160] and to further explore the various facets of screen use (ie, content and context) associated with children's mental health in a rapidly evolving digital world.

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REFERENCES

1. Browne D, Thompson DA, Madigan S. Digital media use in children: clinical vs scientific responsibilities. *JAMA Pediatr*. 2020;174(2):111-112. doi:10.1001/jamapediatrics.2019.4559

2. Odgers CL, Jensen MR. Annual research review: adolescent mental health in the digital age: facts, fears, and future directions. *J Child Psychol Psychiatry*. 2020;61(3):336-348. doi:10.1111/jcpp.13190

3. Christakis DA, Gilkerson J, Richards JA, et al. Audible television and decreased adult words, infant vocalizations, and conversational turns: a population-based study. *Arch Pediatr Adolesc Med*. 2009;163(6):554-558. doi:10.1001/archpediatrics.2009.61

4. Christakis DA. Interactive media use at younger than the age of 2 years: time to rethink the American Academy of Pediatrics guideline? *JAMA Pediatr*. 2014;168(5):399-400. doi:10.1001/jamapediatrics.2013.5081

5. Linebarger DL, Barr R, Lapierre MA, Piotrowski JT. Associations between parenting, media use, cumulative risk, and children's executive functioning. *J Dev Behav Pediatr*. 2014;35(6):367-377. doi:10.1097/DBP.0000000000000069

6. Nikkelen SW, Valkenburg PM, Huizinga M, Bushman BJ. Media use and ADHD-related behaviors in children and adolescents: a meta-analysis. *Dev Psychol*. 2014;50(9):2228-2241. doi:10.1037/a0037318

7. Kaye L, Orben A, Ellis D, Hunter S, Houghton S. The conceptual and methodological mayhem of "screen time." *Int J Env Res Public Health*. 2020;17(10):3661. doi:10.3390/ijerph17103661

8. Blum-Ross A, Livingstone S. The trouble with "screen time" rules. In: Mascheroni G, Jorge A, Ponte C (Eds.). *Digital Parenting: The Challenges for Families in the Digital Age*. International Clearinghouse on Children, Youth, and the Media; 2018:179-187.

9. Ferguson CJ, Beresin E. Social science's curious war with pop culture and how it was lost: the media violence debate and the risks it holds for social science. *Prev Med*. 2017;99:69-76. doi:10.1016/j.ypmed.2017.02.009

10. Elson M, Ferguson CJ, Gregerson M, et al Do policy statements on media effects faithfully represent the science? *Adv Methods Pract Psychol Sci*. 2019;2(1):12-25. doi:10.1177/2515245918811301

11. Cohn LD, Becker BJ. How meta-analysis increases statistical power. *Psychol Methods*. 2003;8(3):243-253. doi:10.1037/1082-989X.8.3.243

12. McBee MT, Brand RJ, Dixon WE Jr. Challenging the link between early childhood television exposure and later attention problems: a multiverse approach. *Psychol Sci*. 2021;32(4):496-518. doi:10.1177/0956797620971650

13. Stiglic N, Viner RM. Effects of screentime on the health and well-being of children and adolescents: a systematic review of reviews. *BMJ Open*. 2019;9(1):e023191. doi:10.1136/bmjopen-2018-023191

14. de Jong E, Visscher TLS, HiraSing RA, Heymans MW, Seidell JC, Renders CM. Association between TV viewing, computer use and overweight, determinants and competing activities of screen time in 4- to 13-year-old children. *Int J Obes (Lond)*. 2013;37(1):47-53. doi:10.1038/ijo.2011.244

15. Rideout V, Hamel E. *The Media Family: Electronic Media in the Lives of Infants, Toddlers, Preschoolers and Their Parents*. Kaiser Family Foundation;2006.

16. Neville RD, McArthur BA, Eirich R, Lakes KD, Madigan S. Bidirectional associations between screen time and children's externalizing and internalizing behaviors. *J Child Psychol Psychiatry*. 2021;62(12):1475-1484. doi:10.1111/jcpp.13425

17. Zahn-Waxler C, Shirtcliff EA, Marceau K. Disorders of childhood and adolescence: gender and psychopathology. *Annu Rev Clin Psychol*. 2008;4:275-303. doi:10.1146/annurev.clinpsy.3.022806.091358

18. Bado P, Schafer J, Simioni AR, et al. Screen time and psychopathology: investigating directionality using cross-lagged panel models. *Eur Child Adolesc Psychiatry*. Published online November 1, 2020. doi:10.1007/s00787-020-01675-5

19. Rideout V, Robb MB. The common sense census: media use by kids age zero to eight. Common Sense Media; 2020. Accessed January 20, 2021. https://www.commonsensemedia.org/sites/default/files/uploads/research/2020_zero_to_eight_census_final_web.pdf

20. Carson V, Spence JC, Cutumisu N, Cargill L. Association between neighborhood socioeconomic status and screen time among pre-school children: a cross-sectional study. *BMC Public Health*. 2010;10:367. doi:10.1186/1471-2458-10-367

21. Tandon PS, Zhou C, Sallis JF, Cain KL, Frank LD, Saelens BE. Home environment relationships with children's physical activity, sedentary time, and screen time by socioeconomic status. *Int J Behav Nutr Phys Act*. 2012;9:88. doi:10.1186/1479-5868-9-88

22. Rideout V, Robb MB. The common sense census: media use by tweens and teens. Common Sense Media; 2019. Accessed January 10, 2021. https://www.commonsensemedia.org/sites/default/files/uploads/research/2019-census-8-to-18-full-report-updated.pdf

23. Ramirez ER, Norman GJ, Rosenberg DE, et al. Adolescent screen time and rules to limit screen time in the home. *J Adolesc Health*. 2011;48(4):379-385. doi:10.1016/j.jadohealth.2010.07.013

24. Marceau K, Laurent HK, Neiderhiser JM, et al. Combined influences of genes, prenatal environment, cortisol, and parenting on the development of children's internalizing versus externalizing problems. *Behav Genet*. 2015;45(3):268-282. doi:10.1007/s10519-014-9689-z

25. Achenbach TM. The classification of children's psychiatric symptoms: a factor-analytic study. *Psychol Monogr*. 1966;80(7):1-37. doi:10.1037/h0093906

26. McArthur BA, Racine N, Browne D, McDonald S, Tough S, Madigan S. Recreational screen time before and during COVID-19 in school-aged children. *Acta Paediatr*. Published online June 15, 2021. doi:10.1111/apa.15966

27. Racine N, McArthur BA, Cooke JE, Eirich R, Zhu J, Madigan S. Global prevalence of depressive and anxiety symptoms in children and adolescents during COVID-19: a meta-analysis. *JAMA Pediatr*. 2021;175(11):1142-1150. doi:10.1001/jamapediatrics.2021.2482

28. National Heart, Lung, and Blood Institute. Study quality assessment tools: quality assessment tool for observational cohort and cross-sectional studies. National Institutes of Health. Accessed February 10, 2021. https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools

29. Cicchetti DV. Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology. *Psychol Assess*. 1994;6(4):284-290.

30. Caldwell DM, Davies SR, Hetrick SE, et al. School-based interventions to prevent anxiety and depression in children and young people: a systematic review and network meta-analysis. *Lancet Psychiatry*. 2019;6(12):1011-1020. doi:10.1016/S2215-0366(19)30403-1

31. Brumariu LE, Madigan S, Giuseppone KR, Movahed Abtahi M, Kerns KA. The Security Scale as a measure of attachment: meta-analytic evidence of validity. *Attach Hum Dev*. 2018;20(6):600-625. doi:10.1080/14616734.2018.1433217

32. Witzel TC, Eshun-Wilson I, Jamil MS, et al. Comparing the effects of HIV self-testing to standard HIV testing for key populations: a systematic review and meta-analysis. *BMC Med*. 2020;18(1):381. doi:10.1186/s12916-020-01835-z

33. Rosenthal R. Writing meta-analytic reviews. *Psychol Bull*. 1995;118(2):183-192. doi:10.1037/0033-2909.118.2.183

34. Peterson RA, Brown SP. On the use of beta coefficients in meta-analysis. *J Appl Psychol*. 2005;90(1):175-181. doi:10.1037/0021-9010.90.1.175

35. Borenstein M, Hedges L, Higgins JPT, Rothstein HR. *Comprehensive Meta-Analysis Version 3.0*. Biostat; 2013.

36. DerSimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials*. 1986;7(3):177-188. doi:10.1016/0197-2456(86)90046-2

37. Funder DC, Ozer DJ. Evaluating effect size in psychological research: sense and nonsense. *Adv Methods Pract Psychol Sci*. 2019;2(2):156-168. doi:10.1177/2515245919847202

38. Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. *BMJ*. 1997;315(7109):629-634. doi:10.1136/bmj.315.7109.629

39. Borenstein M. *Introduction to Meta-Analysis*. John Wiley & Sons; 2009. doi:10.1002/9780470743386

40. Huesmann LR. The impact of electronic media violence: scientific theory and research. *J Adolesc Health*. 2007;41(6)(suppl 1):S6-S13. doi:10.1016/j.jadohealth.2007.09.005

41. Christakis DA, Zimmerman FJ, DiGiuseppe DL, McCarty CA. Early television exposure and subsequent attentional problems in children. *Pediatrics*. 2004;113(4):708-713. doi:10.1542/peds.113.4.708

42. Liu M, Wu L, Yao S. Dose-response association of screen time-based sedentary behaviour in children and adolescents and depression: a meta-analysis of observational studies. *Br J Sports Med*. 2016;50(20):1252-1258. doi:10.1136/bjsports-2015-095084

43. Guerrero MD, Barnes JD, Chaput J-P, Tremblay MS. Screen time and problem behaviors in children: exploring the mediating role of sleep duration. *Int J Behav Nutr Phys Act*. 2019;16(1):105. doi:10.1186/s12966-019-0862-x

44. Al-Ali NM, Yaghy HS, Shattnawi KK, Al-Shdayfat NM. Parents' knowledge and beliefs about the impact of exposure to media violence on children's aggression. *Issues Ment Health Nurs*. 2018;39(7):592-599. doi:10.1080/01612840.2017.1422201

45. Allen MS, Vella SA. Screen-based sedentary behaviour and psychosocial well-being in childhood: cross-sectional and longitudinal associations. *Ment Health Phys Act*. 2015;9:41-47. doi:10.1016/j.mhpa.2015.10.002

46. Amawi SO, Subki AH, Khatib HA, et al. Use of electronic entertainment and communication devices among a Saudi pediatric population: cross-sectional study. *Interact J Med Res*. 2018;7(2):e13. doi:10.2196/ijmr.9103

47. Barlett ND, Gentile DA, Barlett CP, Eisenmann JC, Walsh DA. Sleep as a mediator of screen time effects on US children's health outcomes. *J Child Media*. 2012;6(1):37-50. doi:10.1080/17482798.2011.633404

48. Byun Y-H, Ha M, Kwon H-J, et al. Mobile phone use, blood lead levels, and attention deficit hyperactivity symptoms in children: a longitudinal study. *PLoS One*. 2013;8(3):e59742. doi:10.1371/journal.pone.0059742

49. Cao H, Yan S, Gu C, et al. Prevalence of attention-deficit/hyperactivity disorder symptoms and their associations with sleep schedules and sleep-related problems among preschoolers in mainland China. *BMC Pediatr*. 2018;18(1):70. doi:10.1186/s12887-018-1022-1

50. Chonchaiya W, Sirachairat C, Vijakkhana N, Wilaisakditipakorn T, Pruksananonda C. Elevated background TV exposure over time increases behavioural scores of 18-month-old toddlers. *Acta Paediatr*. 2015;104(10):1039-1046. doi:10.1111/apa.13067

51. Christodoulou G, Majmundar A, Chou C-P, Pentz MA. Anhedonia, screen time, and substance

use in early adolescents: a longitudinal mediation analysis. *J Adolesc*. 2020;78(C):24-32. doi:10.1016/j.adolescence.2019.11.007

52. Coker TR, Elliott MN, Schwebel DC, et al. Media violence exposure and physical aggression in fifth-grade children. *Acad Pediatr*. 2015;15(1):82-88. doi:10.1016/j.acap.2014.09.008

53. Corkin MT, Peterson ER, Henderson AME, Waldie KE, Reese E, Morton SMB. Preschool screen media exposure, executive functions and symptoms of inattention/hyperactivity. *J Appl Dev Psychol*. 2021;73:101237. doi:10.1016/j.appdev.2020.101237

54. Davison LL. *Media Viewing and the Neurological Development of ADHD: Voluntary and Involuntary Processing*. Dissertation. Claremont Graduate University; 2004.

55. Ebenegger V, Marques-Vidal P-M, Munsch S, et al. Relationship of hyperactivity/inattention with adiposity and lifestyle characteristics in preschool children. *J Child Neurol*. 2012;27(7):852-858. doi:10.1177/0883073811428009

56. Erdogan A, Kiran S, Aydogan G, et al Behavioral correlates of television viewing time in a Turkish sample of preschool children. *Neurol Psychiatr Brain Res*. 2006;13(4):225-230.

57. Froiland JM, Davison ML. Home literacy, television viewing, fidgeting and ADHD in young children. *Educational Psychology*. 2016;36(8):1337-1353. doi:10.1080/01443410.2014.963031

58. Gentile DA, Berch ON, Choo H, Khoo A, Walsh DA. Bedroom media: one risk factor for development. *Dev Psychol*. 2017;53(12):2340-2355. doi:10.1037/dev0000399

59. Gialamas A, Haag DG, Mittinty MN, Lynch J. Which time investments in the first 5 years of life matter most for children's language and behavioural outcomes at school entry? *Int J Epidemiol*. 2020;49(2):548-558. doi:10.1093/ije/dyz192

60. Guxens M, Vermeulen R, Steenkamer I, et al. Radiofrequency electromagnetic fields, screen time, and emotional and behavioural problems in 5-year-old children. *Int J Hyg Environ Health*. 2019;222(2):188-194. doi:10.1016/j.ijheh.2018.09.006

61. Hastings EC, Karas TL, Winsler A, Way E, Madigan A, Tyler S. Young children's video/computer game use: relations with school performance and behavior. *Issues Ment Health Nurs*. 2009;30(10):638-649. doi:10.1080/01612840903050414

62. Hefner HL. *Risks of Television Viewing Among Children With and Without the ADHD Diagnosis*. Dissertation. Walden University; 2013.

63. Hill MM, Gangi D, Miller M, Rafi SM, Ozonoff S. Screen time in 36-month-olds at increased likelihood for ASD and ADHD. *Infant Behav Dev*. 2020;61:101484.

64. Holton KF, Nigg JT. The association of lifestyle factors and ADHD in children. *J Atten Disord*. 2020;24(11):1511-1520. doi:10.1177/1087054716646452

65. Hong GCC, Conduit R, Wong J, Di Benedetto M, Lee E. Diet, physical activity, and screen time to sleep better: multiple mediation analysis of lifestyle factors in school-aged children with and without attention deficit hyperactivity disorder. *J Atten Disord*. Published July 14, 2020.

66. Hosokawa R, Katsura T. Association between mobile technology use and child adjustment in early elementary school age. *PLoS One*. 2018;13(7):e0199959. doi:10.1371/journal.pone.0199959

67. Huesmann LR, Eron LD. Cognitive processes and the persistence of aggressive behavior. *Aggress Behav*. 1984;10(3):243-251. doi:10.1002/1098-2337(1984)10:3<243::AID-AB2480100308>3.0.CO;2-6

68. Jia S, Wang L, Shi Y, Li P. Family risk factors associated with aggressive behavior in Chinese preschool children. *J Pediatr Nurs*. 2016;31(6):e367-e374. doi:10.1016/j.pedn.2016.08.001

69. Kahn M, Schnabel O, Gradisar M, et al. Sleep, screen time and behaviour problems in preschool children: an actigraphy study. *Eur Child Adolesc Psychiatry*. Published online October 1, 2020.

70. Kuhhirt M, Klein M. Parental education, television exposure, and children's early cognitive, language and behavioral development. *Soc Sci Res*. 2020;86:102391.

71. Linebarger DL. Contextualizing video game play: the moderating effects of cumulative risk and parenting styles on the relations among video game exposure and problem behaviors. *Psychol Pop Media Cult*. 2015;4(4):375-396. doi:10.1037/ppm0000069

72. Levelink B, van der Vlegel M, Mommers M, et al. The longitudinal relationship between screen time, sleep and a diagnosis of attention-deficit/hyperactivity disorder in childhood. *J Atten Disord*. 2020.

73. Lin H-P, Chen K-L, Chou W, et al. Prolonged touch screen device usage is associated with emotional and behavioral problems, but not language delay, in toddlers. *Infant Behav Dev*. 2020;58:101424.

74. Lobel A, Engels RCME, Stone LL, Burk WJ, Granic I. Video gaming and children's psychosocial wellbeing: a longitudinal study. *J Youth Adolesc*. 2017;46(4):884-897. doi:10.1007/s10964-017-0646-z

75. Manganello JA, Taylor CA. Television exposure as a risk factor for aggressive behavior among 3-year-old children. *Arch Pediatr Adolesc Med*. 2009;163(11):1037-1045. doi:10.1001/archpediatrics.2009.193

76. Martin A, Razza R, Brooks-Gunn J. Specifying the links between household chaos and preschool children's development. *Early Child Dev Care*. 2012;182(10):1247-1263. doi:10.1080/03004430.2011.605522

77. Martins N, Wilson BJ. Social aggression on television and its relationship to children's aggression in the classroom. *Hum Commun Res*. 2012;38(1):48-71. doi:10.1111/j.1468-2958.2011.01417.x

78. McNeill J, Howard SJ, Vella SA, Cliff DP. Longitudinal associations of electronic application use and media program viewing with cognitive and psychosocial development in preschoolers. *Acad Pediatr*. 2019;19(5):520-528. doi:10.1016/j.acap.2019.02.010

79. Miller CJ, Marks DJ, Miller SR, et al. Brief report: television viewing and risk for attention problems in preschool children. *J Pediatr Psychol*. 2007;32(4):448-452. doi:10.1093/jpepsy/jsl035

80. Miller LE, Grabell A, Thomas A, Bermann E, Graham-Bermann SA. The associations between community violence, television violence, intimate partner violence, parent-child aggression, and aggression in sibling relationships of a sample of preschoolers. *Psychol Violence*. 2012;2(2):165-178. doi:10.1037/a0027254

81. Mistry KB, Minkovitz CS, Strobino DM, Borzekowski DLG. Children's television exposure and behavioral and social outcomes at 5.5 years: does timing of exposure matter? *Pediatrics*. 2007;120(4):762-769. doi:10.1542/peds.2006-3573

82. Moyer VS. *The Role of User Motivations in Moderating the Relation Between Video Game Playing and Children's Adjustment*. Dissertation. Bowling Green State University; 2008.

83. Mundy LK, Canterford L, Olds T, Allen NB, Patton GC. The association between electronic media and emotional and behavioral problems in late childhood. *Acad Pediatr*. 2017;17(6):620-624. doi:10.1016/j.acap.2016.12.014

84. Niiranen J, Kiviruusu O, Vornanen R, Saarenpää-Heikkilä O, Paavonen EJ. High-dose electronic media use in five-year-olds and its association with their psychosocial symptoms: a cohort study. *BMJ Open*. 2021;11(3):e040848. doi:10.1136/bmjopen-2020-040848

85. Nikkelen SWC, Vossen HGM, Valkenburg PM. Children's television viewing and ADHD-related behaviors: evidence from The Netherlands. *J Child Media*. 2015;9(4):399-418. doi:10.1080/17482798.2015.1088872

86. Obel C, Henriksen TB, Dalsgaard S, et al. Does children's watching of television cause attention problems? retesting the hypothesis in a Danish cohort. *Pediatrics*. 2004;114(5):1372-1373. doi:10.1542/peds.2004-0954

87. Özmert E, Toyran M, Yurdakök K. Behavioral correlates of television viewing in primary school children evaluated by the child behavior checklist. *Arch Pediatr Adolesc Med*. 2002;156(9):910-914. doi:10.1001/archpedi.156.9.910

88. Parkes A, Sweeting H, Wight D, Henderson M. Do television and electronic games predict children's psychosocial adjustment? Longitudinal research using the UK Millennium Cohort Study. *Arch Dis Child*. 2013;98(5):341-348. doi:10.1136/archdischild-2011-301508

89. Patel C. *Co-occurrence and Non-overlap Among Behavioral and Health-Related Problems in Preschool Children*. Dissertation. University of South Carolina; 2019.

90. Paulus FW, Sinzig J, Mayer H, Weber M, von Gontard A. Computer gaming disorder and ADHD in young children—a population-based study. *Int J Ment Health Addict*. 2018;16(5):1193-1207. doi:10.1007/s11469-017-9841-0

91. Peralta GP, Forns J, García de la Hera M, et al. Sleeping, TV, cognitively stimulating activities, physical activity, and attention-deficit hyperactivity disorder symptom incidence in children: a prospective study. *J Dev Behav Pediatr*. 2018;39(3):192-199. doi:10.1097/DBP.0000000000000539

92. Poulain T, Vogel M, Neef M, et al. Reciprocal associations between electronic media use and behavioral difficulties in preschoolers. *Int J Environ Res Public Health*. 2018;15(4):814. doi:10.3390/ijerph15040814

93. Reynolds JE. *An Assessment of Variables Associated With Television Viewing and Their*

Influence on Aggressive Behavior of Third Grade Children. Dissertation. Southern Illinois University. ProQuest Dissertations; 1978.

94. Rosen LD, Lim AF, Felt J, et al. Media and technology use predicts ill-being among children, preteens and teenagers independent of the negative health impacts of exercise and eating habits. *Comput Human Behav*. 2014;35:364-375. doi:10.1016/j.chb.2014.01.036

95. Sanders W, Parent J, Forehand R, Sullivan ADW, Jones DJ. Parental perceptions of technology and technology-focused parenting: associations with youth screen time. *J Appl Dev Psychol*. 2016; 44:28-38. doi:10.1016/j.appdev.2016.02.005

96. Schaefer WG. *The Effects of Television Viewing on the Academic Performance of Elementary School Children With Attention Deficit Disorder*. Dissertation. Western Michigan University; 1991.

97. Schmiedeler S, Niklas F, Schneider W. Symptoms of attention-deficit hyperactivity disorder (ADHD) and home learning environment (HLE): findings from a longitudinal study. *Eur J Psychol Educ*. 2014;29(3):467-482. doi:10.1007/s10212-013-0208-z

98. Séguin D, Klimek V. Just five more minutes please: electronic media use, sleep and behaviour in young children. *Early Child Dev Care*. 2016;186(6): 981-1000. doi:10.1080/03004430.2015.1071528

99. Sheehan PW. Age trends and the correlates of children's television viewing. *Aust J Psychol*. 1983; 35(3):417-431. doi:10.1080/00049538308258753

100. Shmukler D. A descriptive analysis of television viewing in South African Preschoolers and its relationship to their spontaneous play. *S Afr J Psychol*. 1981;11(3):106-110. doi:10.1177/008124638101100303

101. Stenseng F, Hygen BW, Wichstrøm L. Time spent gaming and psychiatric symptoms in childhood: cross-sectional associations and longitudinal effects. *Eur Child Adolesc Psychiatry*. 2020;29(6):839-847. doi:10.1007/s00787-019-01398-2

102. Stevens T, Mulsow M. There is no meaningful relationship between television exposure and symptoms of attention-deficit/hyperactivity disorder. *Pediatrics*. 2006;117(3):665-672. doi:10.1542/peds.2005-0863

103. Sugawara M, Matsumoto S, Murohashi H, Sakai A, Isshiki N. Trajectories of early television contact in Japan: relationship with preschoolers' externalizing problems. *J Child Media*. 2015;9(4): 453-471. doi:10.1080/17482798.2015.1089298

104. Swing EL, Gentile DA, Anderson CA, Walsh DA. Television and video game exposure and the development of attention problems. *Pediatrics*. 2010;126(2):214-221. doi:10.1542/peds.2009-1508

105. Tamana SK, Ezeugwu V, Chikuma J, et al; CHILD study Investigators. Screen-time is associated with inattention problems in preschoolers: results from the CHILD birth cohort study. *PLoS One*. 2019;14(4):e0213995. doi:10.1371/journal.pone.0213995

106. Tansriratanawong S, Louthrenoo O, Chonchaiya W, Charnsil C. Screen viewing time and externalising problems in pre-school children in Northern Thailand. *J Child Adolesc Ment Health*. 2017;29(3):245-252. doi:10.2989/17280583.2017.1409226

107. Teramoto S, Soeda A, Hayashi Y, Saito K, Urashima M. Problematic behaviours of 3-year-old children in Japan: relationship with socioeconomic and family backgrounds. *Early Hum Dev*. 2005;81 (6):563-569. doi:10.1016/j.earlhumdev.2004.12.011

108. Verlinden M, Tiemeier H, Hudziak JJ, et al. Television viewing and externalizing problems in preschool children: the Generation R Study. *Arch Pediatr Adolesc Med*. 2012;166(10):919-925. doi:10.1001/archpediatrics.2012.653

109. Viemerö V, Paajanen S. The role of fantasies and dreams in the TV viewing—aggression relationship. *Aggress Behav*. 1992;18(2):109-116. doi:10.1002/1098-2337(1992)18:2<109::AID-AB2480180204>3.0.CO;2-1

110. Wan MW, Fitch-Bunce C, Heron K, Lester E. Infant screen media usage and social-emotional functioning. *Infant Behav Dev*. 2021;62:101509. doi:10.1016/j.infbeh.2020.101509

111. Wimbarti S. *Children's Aggression in Indonesia: The Effects of Culture, Familial Factors, Peers, TV Violence Viewing, and Temperament*. Dissertation. University of Southern California; 2002.

112. Woodfield DL. *Mass Media Viewing Habits and Toleration of Real-life Aggression*. Dissertation. In: *ProQuest Dissertations*; 1987.

113. Wu X, Kirk SFL, Ohinmaa A, Veugelers P. Health behaviours, body weight and self-esteem among grade five students in Canada. *Springerplus*. 2016;5(1):1099. doi:10.1186/s40064-016-2744-x

114. Wu X, Tao S, Rutayisire E, Chen Y, Huang K, Tao F. The relationship between screen time, nighttime sleep duration, and behavioural problems in preschool children in China. *Eur Child Adolesc Psychiatry*. 2017;26(5):541-548. doi:10.1007/s00787-016-0912-8

115. Xie G, Deng Q, Cao J, Chang Q. Digital screen time and its effect on preschoolers' behavior in China: results from a cross-sectional study. *Ital J Pediatr*. 2020;46(1):9. doi:10.1186/s13052-020-0776-x

116. Yousef S, Eapen V, Zoubeidi T, Mabrouk A. Behavioral correlation with television watching and videogame playing among children in the United Arab Emirates. *Int J Psychiatry Clin Pract*. 2014;18 (3):203-207. doi:10.3109/13651501.2013.874442

117. Zimmerman FJ, Christakis DA. Associations between content types of early media exposure and subsequent attentional problems. *Pediatrics*. 2007;120(5):986-992. doi:10.1542/peds.2006-3322

118. Zimmerman FJ, Glew GM, Christakis DA, Katon W. Early cognitive stimulation, emotional support, and television watching as predictors of subsequent bullying among grade-school children. *Arch Pediatr Adolesc Med*. 2005;159(4):384-388. doi:10.1001/archpedi.159.4.384

119. Brubaker MM. *Exploring the Relationship Between Social Support and Social Behavior: Moderating Effects of Video Game Use*. Dissertation. Fielding Graduate University. ProQuest Dissertations Publishing; 2020.

120. Cooper NS. *The Identification of Psychological and Social Correlates of internet Use in Children and Teenagers*. Dissertation. Alliant International University; 2004.

121. Dunkeld C, Wright ML, Banerjee RA, Easterbrook MJ, Slade L. Television exposure, consumer culture values, and lower well-being among preadolescent children: the mediating role of consumer-focused coping strategies. *Br J Soc Psychol*. 2020;59(1):26-48. doi:10.1111/bjso.12325

122. Lam MW, Burgoon E, Jin C. 5.37 Associations of screen time and depression in children in a US nationally representative sample. *J Am Acad Child Adolesc Psychiatry*. 2019;58 (10)(suppl):S257. doi:10.1016/j.jaac.2019.08.351

123. Lin S-Y, Eaton NR, Schleider JL. Unpacking associations between mood symptoms and screen time in preadolescents: a network analysis. *J Abnorm Child Psychol*. 2020;48(12):1635-1647. doi:10.1007/s10802-020-00703-x

124. Zhang J, Liu M-W, Yu H-J, et al. Associations of health-risk behaviors with mental health among Chinese children. *Psychol Health Med*. Published December 9, 2020.

125. Zhu X, Haegele JA, Healy S. Movement and mental health: behavioral correlates of anxiety and depression among children of 6-17 years old in the US. *Ment Health Phys Act*. 2019;16:60-65. doi:10.1016/j.mhpa.2019.04.002

126. Madigan S, McArthur BA, Anhorn C, Eirich R, Christakis DA. Associations between screen use and child language skills: a systematic review and meta-analysis. *JAMA Pediatr*. 2020;174(7):665-675. doi:10.1001/jamapediatrics.2020.0327

127. Adelantado-Renau M, Moliner-Urdiales D, Cavero-Redondo I, Beltran-Valls MR, Martínez-Vizcaíno V, Álvarez-Bueno C. Association between screen media use and academic performance among children and adolescents: a systematic review and meta-analysis. *JAMA Pediatr*. 2019;173(11):1058-1067. doi:10.1001/jamapediatrics.2019.3176

128. Hentges RF, Devereux C, Graham SA, Madigan S. Child language difficulties and internalizing and externalizing symptoms: a meta-analysis. *Child Dev*. 2021;92(4):e691-e715. doi:10.1111/cdev.13540

129. Peverill M, Dirks MA, Narvaja T, Herts KL, Comer JS, McLaughlin KA. Socioeconomic status and child psychopathology in the United States: a meta-analysis of population-based studies. *Clin Psychol Rev*. 2021;83:101933. doi:10.1016/j.cpr.2020.101933

130. Rutledge T, Loh C. Effect sizes and statistical testing in the determination of clinical significance in behavioral medicine research. *Ann Behav Med*. 2004;27(2):138-145. doi:10.1207/s15324796abm2702_9

131. McArthur BA, Volkova V, Tomopoulos S, Madigan S. Global prevalence of meeting screen time guidelines among children 5 years and younger: a systematic review and meta-analysis. *JAMA Pediatr*. Published online February 14, 2022. doi:10.1001/jamapediatrics.2021.6386

132. Groh AM, Roisman GI, van Ijzendoorn MH, Bakermans-Kranenburg MJ, Fearon RP. The significance of insecure and disorganized attachment for children's internalizing symptoms: a meta-analytic study. *Child Dev*. 2012;83(2):591-610. doi:10.1111/j.1467-8624.2011.01711.x

133. Hoyos Cillero I, Jago R. Sociodemographic and home environment predictors of screen viewing among Spanish school children. *J Public Health (Oxf)*. 2011;33(3):392-402. doi:10.1093/pubmed/fdq087

134. Mesman J, Bongers IL, Koot HM. Preschool developmental pathways to preadolescent internalizing and externalizing problems. *J Child*

Psychol Psychiatry. 2001;42(5):679-689. doi:10.1111/1469-7610.00763

135. Tomopoulos S, Dreyer BP, Valdez P, et al. Media content and externalizing behaviors in Latino toddlers. *Ambul Pediatr*. 2007;7(3):232-238. doi:10.1016/j.ambp.2007.02.004

136. Funk JB, Baldacci HB, Pasold T, Baumgardner J. Violence exposure in real-life, video games, television, movies, and the internet: is there desensitization? *J Adolesc*. 2004;27(1):23-39. doi:10.1016/j.adolescence.2003.10.005

137. Bandura A. *Social Learning Theory*. Prentice-Hall; 1977.

138. World Health Organization. *Guidelines on Physical Activity, Sedentary Behaviour and Sleep for Children Under 5 Years of Age*. World Health Organization; 2019. Accessed February 9, 2022. https://apps.who.int/iris/handle/10665/311664

139. Madigan S, Racine N, Tough S. Prevalence of preschoolers meeting vs exceeding screen time guidelines. *JAMA Pediatr*. 2020;174(1):93-95. doi:10.1001/jamapediatrics.2019.4495

140. Sigman A. Time for a view on screen time. *Arch Dis Child*. 2012;97(11):935-942. doi:10.1136/archdischild-2012-302196

141. Harvey DL, Milton K, Jones AP, Atkin AJ. International trends in screen-based behaviours from 2012 to 2019. *Prev Med*. 2022;154:106909. doi:10.1016/j.ypmed.2021.106909

142. Paulo MS, Nauman J, Abdulle A, et al. Results from the United Arab Emirates' 2018 report card on physical activity for children and youth. *J Phys Act Health*. 2018;15(S2):S419-S421. doi:10.1123/jpah.2018-0543

143. Ernest JM, Causey C, Newton AB, Sharkins K, Summerlin J, Albaiz N. Extending the global dialogue about media, technology, screen time, and young children. *Childhood Education*. 2014;90(3):182-191. doi:10.1080/00094056.2014.910046

144. De Los Reyes A, Kazdin AE. Informant discrepancies in the assessment of childhood psychopathology: a critical review, theoretical framework, and recommendations for further study. *Psychol Bull*. 2005;131(4):483-509. doi:10.1037/0033-2909.131.4.483

145. De Los Reyes A. Introduction to the special section: more than measurement error: discovering meaning behind informant discrepancies in clinical assessments of children and adolescents. *J Clin Child Adolesc Psychol*. 2011;40(1):1-9. doi:10.1080/15374416.2011.533405

146. Achenbach TM, Edelbrock CS. The classification of child psychopathology: a review and analysis of empirical efforts. *Psychol Bull*. 1978;85(6):1275-1301. doi:10.1037/0033-2909.85.6.1275

147. Greenbaum PE, Dedrick RF. Hierarchical confirmatory factor analysis of the Child Behavior Checklist/4-18. *Psychol Assess*. 1998;10(2):149-155. doi:10.1037/1040-3590.10.2.149

148. Radesky JS, Weeks HM, Ball R, et al. Young children's use of smartphones and tablets. *Pediatrics*. 2020;146(1):e20193518. doi:10.1542/peds.2019-3518

149. Ioannidis JP. Why most discovered true associations are inflated. *Epidemiology*. 2008;19(5):640-648. doi:10.1097/EDE.0b013e31818131e7

150. Schooler J. Unpublished results hide the decline effect. *Nature*. 2011;470(7335):437.

151. de Bruin A, Della Sala S. The decline effect: how initially strong results tend to decrease over time. *Cortex*. 2015;73:375-377. doi:10.1016/j.cortex.2015.05.025

152. Chen W, Adler JL. Assessment of screen exposure in young children, 1997 to 2014. *JAMA Pediatr*. 2019;173(4):391-393. doi:10.1001/jamapediatrics.2018.5546

153. van IJzendoorn MH, Bakermans-Kranenburg MJ. Differential susceptibility experiments: going beyond correlational evidence: comment on beyond mental health, differential susceptibility articles. *Dev Psychol*. 2012;48(3):769-774. doi:10.1037/a0027536

154. Sudan M, Olsen J, Arah OA, Obel C, Kheifets L. Prospective cohort analysis of cellphone use and emotional and behavioural difficulties in children. *J Epidemiol Community Health*. 2016;70(12):1207-1213. doi:10.1136/jech-2016-207419

155. Christakis DA. The challenges of defining and studying "digital addiction" in children. *JAMA*. 2019;321(23):2277-2278. doi:10.1001/jama.2019.4690

156. Shah RR, Fahey NM, Soni AV, Phatak AG, Nimbalkar SM. Screen time usage among preschoolers aged 2-6 in rural Western India: a cross-sectional study. *J Family Med Prim Care*. 2019;8(6):1999-2002. doi:10.4103/jfmpc.jfmpc_206_19

157. Tang L, Darlington G, Ma DWL, Haines J; Guelph Family Health Study. Mothers' and fathers' media parenting practices associated with young children's screen-time: a cross-sectional study. *BMC Obes*. 2018;5(1):37. doi:10.1186/s40608-018-0214-4

158. Korhonen L. The good, the bad and the ugly of childreńs screen time during the COVID-19 pandemic. *Acta Paediatr*. 2021;110(10):2671-2672. doi:10.1111/apa.16012

159. Xiang M, Zhang Z, Kuwahara K. Impact of COVID-19 pandemic on children and adolescents' lifestyle behavior larger than expected. *Prog Cardiovasc Dis*. 2020;63(4):531-532. doi:10.1016/j.pcad.2020.04.013

160. Hamaker EL, Kuiper RM, Grasman RPPP. A critique of the cross-lagged panel model. *Psychol Methods*. 2015;20(1):102-116. doi:10.1037/a0038889