Effect of Screen Time Exposure on Neurodevelopmental Outcome Among Toddlers: A Systematic Review of Longitudinal Evidence

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DOI: https://doi.org/10.51244/IJRSI.2026.1310000002

Received: 08 October 2026; Accepted: 13 October 2026; Published: 28 October 2026

ABSTRACT

Background: Screen-based media is increasingly present in early childhood, but the longitudinal association between toddler screen exposure and later neurodevelopment remains uncertain. This systematic review synthesized longitudinal evidence on screen-time exposure in toddlers and subsequent developmental outcomes.

Methods: The review was registered in PROSPERO (CRD420261511593) and reported with reference to PRISMA 2020. PubMed, MEDLINE, PsycINFO and the Cochrane Library were searched for studies published from January 2020 to July 2026. Sixteen reports were included; one methods paper without exposure–outcome data did not contribute to the empirical synthesis. Of 15 empirical studies, five with usable effect-size information were pooled in an exploratory random-effects meta-analysis (DerSimonian–Laird estimator with a Hartung–Knapp-adjusted confidence interval) and ten were synthesized narratively. Sample size, participant age, screen-time measurement, follow-up, outcomes, effect estimates and confounder adjustment are tabulated for every study.

Results: Higher early screen exposure was associated with higher odds of adverse neurodevelopmental outcomes (pooled OR = 2.04, 95% CI 1.25–3.34; Hartung–Knapp CI 1.05–3.96). Heterogeneity was substantial (I^2 = 89%, τ^2 = 0.26) and the 95% prediction interval was wide (0.33–12.54). Pooled estimates were OR = 2.18 (95% CI 0.78–6.10; k = 2) for ADHD/behavioural outcomes and OR = 1.93 (95% CI 1.16–3.21; k = 3) for autism-related outcomes, with no evidence of a subgroup difference (p = .83). Leave-one-out estimates ranged from 1.68 to 2.34. Narrative findings were mixed. A formal risk-of-bias assessment was not performed, and meta-regression was not feasible with five pooled studies.

Conclusion: Greater early screen exposure was associated with adverse neurodevelopmental outcomes, but high heterogeneity, imprecision and an observational evidence base prevent causal conclusions. Balanced, developmentally appropriate media use and protection of caregiver–child interaction, sleep, play and physical activity are reasonable priorities while stronger longitudinal evidence is developed.

Keywords: screen time; toddlerhood; neurodevelopment; systematic review; meta-analysis

INTRODUCTION

The first three years of life involve rapid development in communication, cognition, social-emotional functioning and motor abilities. During this period, children learn through active exploration, play and responsive interaction with caregivers. Screen-based media has become a common feature of family life, raising questions about whether the duration and context of exposure are associated with later developmental outcomes.

Screen exposure is not a single, uniform experience. Television viewing, background media, interactive applications and educational content differ in pace, social contingency and caregiver involvement. The developmental implications may therefore depend not only on duration but also on content, co-viewing, family

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue X October 2026

context and the activities that screen use may replace. WHO guidance for children under five emphasizes limiting sedentary screen time and supporting physical activity and sleep [1].

Longitudinal studies have examined associations between early screen exposure and later language, behaviour, attention and autism-related outcomes, but findings vary across populations and measures. A previous meta-analysis of children aged 12 years or younger reported small but significant correlations between screen time and externalizing and internalizing behaviour problems [2]; it spanned the whole childhood age range and addressed behaviour problems only. A further challenge is that associations may reflect confounding or bidirectionality: early developmental differences can influence how much screen media children use, while parental mental health, education, socioeconomic conditions and interaction patterns may influence both exposure and outcomes.

This systematic review therefore examined the association between screen-time exposure in early childhood—primarily ages 12–36 months—and later neurodevelopmental outcomes. Where sufficiently comparable effect estimates were available, an exploratory meta-analysis was conducted; remaining studies were synthesized narratively. The review aimed to estimate the pooled association, examine broad outcome domains and describe the limitations of the evidence.

METHODS

Design and registration

This systematic review of longitudinal evidence was registered in PROSPERO (CRD420261511593) and was reported with reference to the PRISMA 2020 statement [3]. The review focused primarily on screen exposure measured between 12 and 36 months and developmental outcomes assessed at follow-up.

Search strategy and rationale for the search window

PubMed, MEDLINE, PsycINFO and the Cochrane Library were searched for publications dated 1 January 2020 to 31 July 2026. The search was restricted to this window for three reasons. First, the screen environment in which toddlers are now raised (touchscreen tablets, smartphones, streaming and on-demand video) differs from that of earlier decades, and the period from 2020 coincides with the COVID-19 pandemic, during which household media use is widely reported to have increased; earlier exposure measures, such as hours of television, may therefore not be directly comparable. Second, the WHO guidelines for children under five years, published in 2019 [1], provide a contemporary policy benchmark against which later studies can be read. Third, earlier evidence on screen exposure and behavioural outcomes has been synthesized in broader reviews [2]. The restriction means that longitudinal studies published before 2020 were not captured. This is acknowledged as a limitation (Section 4.1), and extending the search to earlier longitudinal cohorts is recommended for an updated review.

Eligibility criteria

Eligible exposures included screen use on televisions, smartphones, tablets, computers or other digital devices. Outcomes included autism-related risk or diagnosis, ADHD/attention and behavioural symptoms, language, cognition, motor development, social communication and broader developmental skills. Observational longitudinal studies were the principal design of interest. Some studies outside the target age window and non-longitudinal studies were retained in the narrative synthesis for context; these are less directly applicable to the primary 12–36-month exposure question, and their designs are identified in Table 1.

Study selection and data extraction

Records were screened in Covidence [4]. Fifty records were identified, 15 duplicates were removed, and 35 records were screened by title and abstract, of which 15 were excluded. Twenty full-text reports were assessed and four were excluded, one for each of the following reasons: exposure measured outside the age range (children older than four years); no screen-time measure, or screen time not separable from other exposures;

a sample that included premature children with diagnosed cerebral palsy; and a sample that included visually impaired children. This left 16 reports (Figure 1). One of these, a methods paper, did not provide exposure–outcome data and was excluded from the empirical synthesis.

Accordingly, 15 empirical studies were considered: five were pooled and ten were synthesized narratively. Data were extracted into a standardized table covering study characteristics, setting, design, sample size, age at exposure and follow-up, screen-time measurement, outcome domain and instrument, confounder adjustment and available effect estimates (Table 1).

Risk of bias and certainty of evidence

A formal study-level risk-of-bias assessment using ROBINS-I [5] was not performed. Methodological concerns—including confounding, parent-reported exposure, outcome measurement, attrition and design differences—were considered descriptively. The certainty of evidence was rated using GRADE [6]; these ratings should be treated as provisional.

Statistical synthesis

Five studies reporting usable effect-size information were pooled using a random-effects model with the DerSimonian–Laird estimator [7]. Results were expressed as odds ratios (ORs) with 95% confidence intervals; in one study, a reported correlation coefficient was converted to an OR. Because the number of studies was small, Hartung–Knapp-adjusted intervals [8,9] were also reported. Between-study heterogeneity was evaluated using Cochran's Q, I^2 and τ^2, and a 95% prediction interval was calculated [10]. Analyses were conducted in R (version 4.6.1) using the metafor package (version 5.2-1) [11]. Because fewer than ten studies contributed to the synthesis, funnel-plot assessment and Egger's test were not performed.

Sensitivity analyses and exploration of heterogeneity

Leave-one-out sensitivity analysis assessed the influence of individual studies. Subgroup estimates were reported for ADHD/behavioural and autism-related outcomes as an exploratory analysis of outcome domain. Meta-regression was not undertaken: with five pooled studies it would be underpowered and prone to spurious findings, and it is generally not recommended when fewer than ten studies are available [12].

A sensitivity analysis excluding studies at high risk of bias was not possible because a formal risk-of-bias assessment was not performed, and a comparison with alternative between-study variance estimators (for example, restricted maximum likelihood and Paule–Mandel) was not part of the analyses reported here; both are priorities for an updated synthesis (Section 4.2).

RESULTS

Study selection and characteristics of included reports

The study selection process is shown in Figure 1. The 16 reports were published between 2020 and 2026, with six published in 2025. They described studies from ten countries, most commonly the United States (three reports), Japan (two), Germany (two) and Canada (two). Eleven reports were prospective or longitudinal cohorts. Fourteen reported a sample size, with a combined reported sample of 157,621 and a median of 1,520 (IQR 185–6,976; range 44–84,030).

Screen exposure was parent- or caregiver-reported in 13 reports. Differences in study design, exposure definitions, developmental instruments and follow-up periods limited comparability. Sample size, participant age, screen-time measurement, follow-up, outcomes, effect estimates and confounder adjustment for each of the 15 empirical studies [13–26] are given in Table 1.

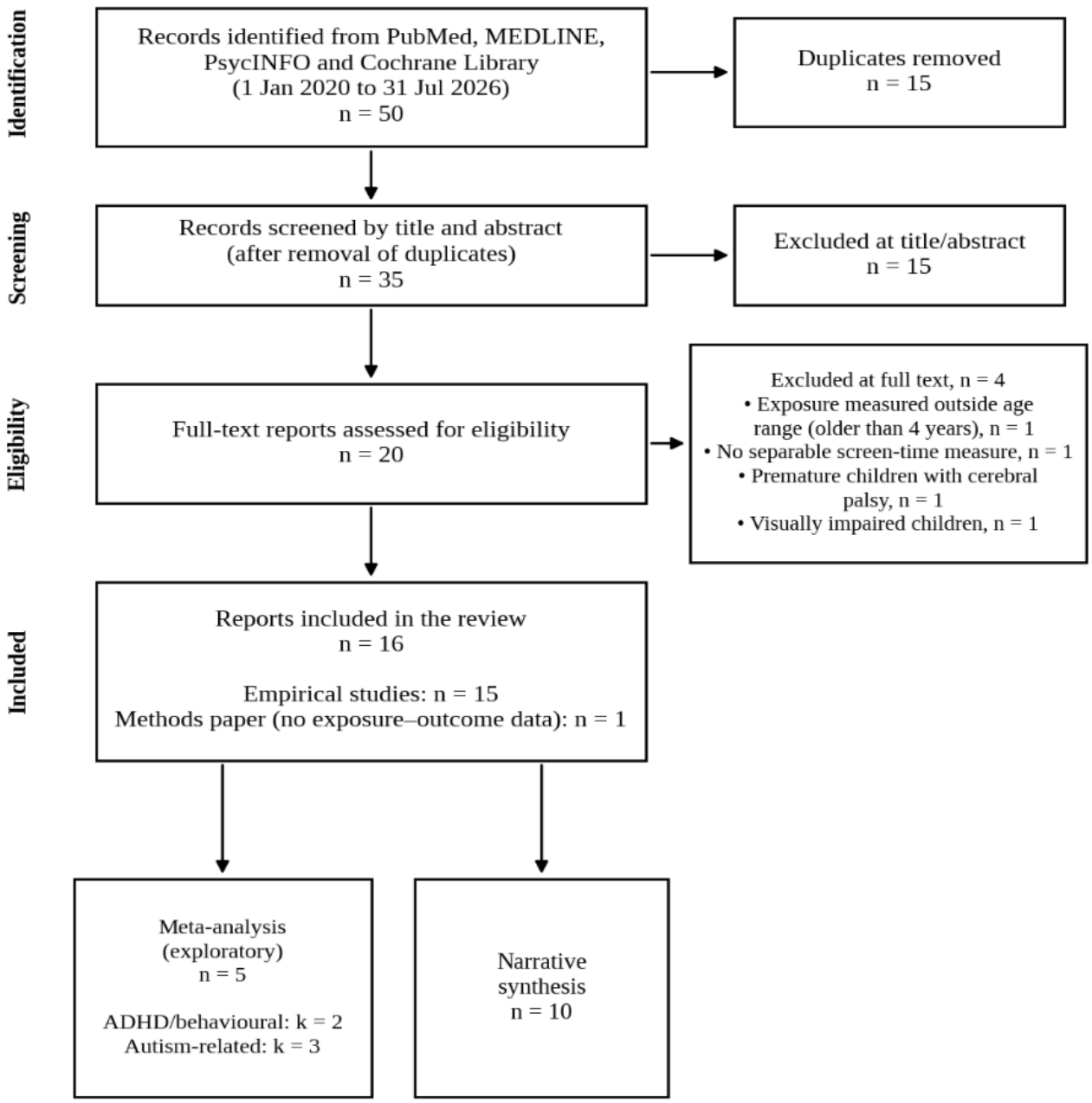


Figure 1. PRISMA 2020 flow diagram of study selection.

Table 1. Characteristics of the 15 included empirical studies.

Study	Country / cohort	Design	Sample size	Age at exposure → follow-up	Screen-time measurement	Outcome(s) (instrument)	Effect estimate / key finding	Confounders adjusted	Synthesis
Heffler et al. (2020) [13]	USA	Prospective cohort	2,152	Exposure: first 18 months (12-month report) → age 2 y	Parent-reported TV/video viewing (yes/no at 12 months; high viewing at 18 months)	ASD-like symptoms (M-CHAT-R total score); ASD risk (M-CHAT)	Pooled . Greater screen exposure and less caregiver–child play associated with higher	Perinatal and demographic variables	Meta-analysis

							ASD-like symptoms; no association with ASD risk		
Kushima et al. (2022) [14]	Japan (Japan Environment and Children's Study)	Prospective birth cohort	>80,000 (exact n (84,030)	1 y → 3 y	Maternal-reported daily hours of TV/DVD viewing (questionnaire)	ASD diagnosis at 3 y (330 cases, 0.4%)	Pooled. Longer screen time at 1 y associated with higher odds of ASD at 3 y in boys, not in girls	ASD predisposition at 1 y; maternal maltreatment factors; other covariates - Questionnairs	Meta-analysis
Takahashi et al. (2024) [15]	Japan (Tohoku Medical Megabank BirThree cohort)	Prospective cohort	-	2 y → 3 y	Parent-reported daily screen time	Internalizing and externalizing behaviour and CBCL subscales (CBCL 1½–5 y)	Pooled . Associations with withdrawn, somatic complaints, anxious/depressed and attention-problem subscales not significant after adjustment	Maternal age at delivery, maternal educational attainment, household income, child's sex, co-residence with grandparents or other adults, presence of younger siblings, presence of older siblings, maternal psychological distress at 2 years postpartum, and maternal bonding disorder at 2 years postpartum. The fully adjusted Model 3 additionally controlled for behavioral-problem scores at age 2.	Meta-analysis (ADHD, behavioural)
Wu et al. (2025) [16]	China (Longhua Child Cohort Study)	Cross-sectional questionnaire survey	41,494	Exposure at 1–3 y → preschool age , ADHD-risk assessment at ages 4–7 y	Screen time and screen content , Parent-reported screen duration and content (educational videos,	Risk of ADHD	Pooled	Child's age and gender, parental marital status, maternal and paternal educational attainment, household monthly	Meta-analysis (ADHD, behavioural, Attention related)

					cartoons, interactive videos)			income, single-child status, and parental explanation of screen-time programme content	
Bilgin et al. (2025) [17]	Ireland (Growing Up in Ireland)	Prospective cohort	10,170	Exposure at 3 y → symptoms at 3, 5, 7 and 9 y (infant regulatory problems at 9 months)	Screen media exposure; excessive = >2 h/day	Internalizing and externalizing symptom trajectories	>2 h/day at 3 y associated with higher symptom scores; excessive exposure did not significantly moderate the association between infant regulatory problems and symptom trajectories	Child's sex, ethnicity, maternal psychological distress, equivalized annual household income, gestational age, birth order (parity), and parental marital status.	Narrative
Murray et al. (2025) [18]	UK (population-representative cohort Population-representative UK cohorts of that kind are often the Millennium Cohort Study)	Prospective cohort; counterfactual (IPTW) analysis	18,785 children, made up of 9,634 boys and 9,151 girls.	3 y → 5 y	TV/video hours per day (reference: 1–3 h/day)	ADHD symptoms.Instrument : parent-reported hyperactivity/inattention subscale of the **Strengths and Difficulties Questionnaire (SDQ)** (Goodman, 1997).	No viewing and >3 h/day each associated with more ADHD symptoms than 1–3 h/day; the no-viewing effect was mirrored in a negative-control analysis (residual confounding)	Inverse probability of treatment weighting; negative-control outcome analysis	Narrative
Gath et al. (2025) [19]	New Zealand	Longitudinal cohort	6,281	2 y → later follow-up with outcomes at ages 4.5 and 8.	Direct screen time; >1.5 h/day	Language, early educational skills, peer social functioning	>1.5 h/day at age 2 associated with lower language/educational performance and more peer problems	ethnicity, child gender, childcare attendance, socioeconomic deprivation (NZDep area index), maternal age and maternal education.	Narrative
Sim et al. (2025) [20]	**Australia**, specifically Western Australia	Prospective cohort	887	1 y → 3 y	Device-specific child and maternal screen use (TV; mobile	Behaviour and development (Conners Early Childhood)	Weak and inconsistent associations	Maternal age, child sex, number of children in household, maternal	Narrative

					phone/tablet; TechU-Q)			education, socioeconomic status, maternal mental health	
Rai et al. (2023) [21]	Canada	Pilot study (correlational; not longitudinal)	44	3-year-olds (single assessment)	Screen-time diary by type, device, content and co-use	Working memory, inhibitory control, self-control and language (virtual testing)	Educational screen use positively correlated with vocabulary (r_s = 0.38); total screen time negatively correlated with working memory (r_s = −0.32, p = .056)	Child age; parental education	Narrative
Eggeling et al. (2026) [22]	Germany. The data came from the **LIFE Child cohort**, a longitudinal study at Leipzig University. It follows healthy children from birth to young adulthood, and most participants come from Leipzig	Longitudinal cohort	109	• **Exposure :** mean age about 3.4 years, with a range of 2.0 to 4.4. • **Follow-up :** mean age about 4.4 years, 1.0 to 1.5 years	Television/media use (parents reported use of TV/video, laptop/tablet/computer and mobile phone separately for a normal weekday and a normal weekend day. Time when the child only listened to music was excluded.)	Cognitive performance and language	Higher television use associated with poorer cognitive performance; language associations varied by maternal education	Maternal education examined as moderator; child sex and age	Narrative
Kracht et al. (2020) [23]	USA	Prospective cohort (1-year follow-up)	107 cross-sectional; 53 longitudinal	Mean age 3.4 ± 0.6 y → +1 y	Screen time relative to guideline (≤1 h/day)	Fundamental motor skills (TGMD-3)	Meeting the screen-time guideline at baseline positively associated with total TGMD-3 score at follow-up (p < .05)	Covariates in linear regression	Narrative
Webb et al. (2024) [24]	USA	Laboratory experiment (real toy vs tablet content)	62	18–32 months (single session)	Tablet content (commercial game and other conditions) vs real toy	Responses to joint-attention prompts and behavioural requests	Fewer responses to joint-attention prompts during commercial tablet game than real-toy play (−0.15	Experimental design; child age and home media use examined as moderators	Narrative

							prompts; 95% CI −0.24 to −0.06)		
Carson et al. (2022) [25]	Canada. Edmonton, Alberta and surrounding areas	cross-sectional.	47 dyads recruited and 44 completed. 42 were analysed for parent–child interactions and cognitive tests (2 excluded because the child did not speak English). Per-test n: working memory 40, inhibitory control 34, vocabulary 42, self-control 41.	36–48 months at enrolment	36–48 months at enrolment	Working memory: word span test (forward and backward), range 0–5. Inhibitory control: Head-Toes-Knees-Shoulders (HTKS), range 0–52. Language: expressive vocabulary test from the iPad-based Early Years Toolbox, range 0–45. Self-control: modified snack delay task, range 0–144. Parent–child interaction quality: PARCHISY, adapted to a 5-point scale, range 0–90. Interactions were observed during a video, an electronic game and a storybook task.	No screen-specific estimate in the extracted data	Partial Spearman correlations adjusted for child age and parental education. Residual confounding was acknowledged.	Narrative
Schwarz et al. (2025) [26]	Germany. “Screen-free till 3” is a prospective Germany-wide randomized intervention study that started in May 2022 and runs for 3 years. It was run with the Professional Associatio	cross-sectional	17,436 parents were invited, and 4,021 answered the baseline questionnaire. it lists 10,391 parents completing the sociodemographic questionnaire and 6,469 completin	planned questionnaires are at 6 months (pre-intervention), 1 year, 2 years and 3 years of age. Those later waves are reported separately.	The questionnaire is parent-reported via the pediatricians’ practice app. It includes 6 questions on the child’s and parents’ screen media use, plus 5 questions on parents’ internet use from the short Compulsive Internet Use Scal	The combined developmental score correlated negatively with parental screen time and positively with time in nature.	Baseline associations only; temporal direction cannot be established	The authors state that this is a “straightforward analysis of the data”. They say adjusted analyses covering child and family factors “could be applied in further publications.”	Narrative

	n of Pediatricians (BVKJ) and the University of Witten/Herdecke.		g the screen-time and development questionnaire						

ADHD, attention-deficit/hyperactivity disorder; ASD, autism spectrum disorder; CBCL, Child Behavior Checklist; IPTW, inverse probability of treatment weighting; M-CHAT(-R), Modified Checklist for Autism in Toddlers (Revised); OR, odds ratio; TGMD-3, Test of Gross Motor Development, third edition; y, years. One methods paper without exposure–outcome data was excluded from the empirical synthesis and is not listed.

Meta-analysis

Across the five pooled studies, higher early screen exposure was associated with higher odds of an adverse neurodevelopmental outcome (OR = 2.04, 95% CI 1.25–3.34; p = .005). The Hartung–Knapp-adjusted 95% confidence interval was wider (1.05–3.96). Heterogeneity was substantial (Q = 36.98, df = 4, p < .001; I^2 = 89%; τ^2 = 0.26). The 95% prediction interval ranged from 0.33 to 12.54, indicating considerable uncertainty about the magnitude and even the direction of the association in a new setting.

The pooled estimate for ADHD/behavioural outcomes was OR = 2.18 (95% CI 0.78–6.10; k = 2). For autism-related outcomes, the pooled estimate was OR = 1.93 (95% CI 1.16–3.21; k = 3). The subgroup comparison did not indicate a difference between these domains (Q-between = 0.05, p = .83). Leave-one-out estimates ranged from OR 1.68 to 2.34, suggesting that no single study wholly accounted for the pooled association. These sensitivity results do not remove concerns about heterogeneity or the small number of studies. The results are summarized in Table 2.

Table 2. Summary of the exploratory meta-analysis.

Analysis	Estimate	Interpretation
Overall pooled effect	OR 2.04 (95% CI 1.25–3.34); p = .005	Higher exposure associated with higher odds
Hartung–Knapp interval	95% CI 1.05–3.96	Wider interval reflects uncertainty
Heterogeneity	I^2 = 89%; Q = 36.98, p < .001; τ^2 = 0.26	Substantial between-study variation
Prediction interval	0.33–12.54	Effect in a future setting may differ considerably
Leave-one-out range	OR 1.68–2.34	No single study wholly accounts for the pooled estimate
ADHD/behavioural subgroup	OR 2.18 (95% CI 0.78–6.10); k = 2	Imprecise; interval includes no association
Autism-related subgroup	OR 1.93 (95% CI 1.16–3.21); k = 3	Positive association; limited study count
Subgroup difference	Q-between = 0.05; p = .83	No evidence of difference between domains

Narrative synthesis

Ten empirical studies were not pooled because the extraction did not provide comparable adjusted estimates with confidence intervals. Six reports described an adverse association for at least one outcome, while four reported weaker, inconsistent, non-significant or non-screen-specific findings.

In an Irish cohort (Bilgin et al., 2025 [17]; n = 10,170), screen exposure above two hours per day at age three was associated with higher internalizing and externalizing symptom scores across follow-up from ages three to nine; however, excessive exposure did not significantly moderate the association between infant regulatory problems and symptom trajectories. In the UK analysis reported by Murray et al. (2025) [18], both no viewing

and more than three hours per day at age three were associated with more ADHD symptoms at age five than the reference category of one to three hours, suggesting a potentially non-linear pattern; the association for no viewing was mirrored in a negative-control analysis, pointing to residual confounding. Gath et al. (2025; n = 6,281) [19] reported associations between more than 1.5 hours per day of direct screen time at age two and lower language/educational performance and more peer problems at later follow-up.

Other findings were less consistent. Sim et al. (2025; n = 887) [20] reported weak or inconsistent associations between screen use at age one and behaviour and development at age three. Rai et al. (2023; n = 44) [21], in a pilot study, reported a non-significant negative correlation between total screen time and working memory, alongside a positive correlation between educational screen use and vocabulary. Eggeling et al. (2026; n = 109) [22] reported poorer cognitive performance with higher television use, with language associations varying by maternal education. Kracht et al. (2020) [23] reported that preschoolers meeting the screen-time guideline at baseline had better total gross motor scores one year later. In a laboratory experiment, Webb et al. (2024; n = 62) [24] found fewer joint-attention responses during tablet-game play than during play with a real toy; this immediate experimental result is not evidence of a long-term effect. Carson et al. (2022) [25] did not provide a screen-specific estimate in the extracted data, and Schwarz et al. (2025) [26] reported baseline associations that cannot establish temporal direction.

DISCUSSION

In this systematic review, higher early screen exposure was associated with approximately twice the odds of adverse neurodevelopmental outcomes in the five-study exploratory meta-analysis. The direction of the pooled result was broadly consistent with several narrative findings, particularly for behavioural, language, educational and social-communication outcomes. However, the pooled estimate should not be treated as a stable estimate of a universal effect: heterogeneity was high, the prediction interval was very wide, and the number of pooled studies was small.

One plausible explanation is displacement: prolonged or poorly structured screen use may reduce time available for reciprocal caregiver–child communication, active play, movement, sleep or other enriching experiences. The narrative evidence on joint attention and the importance of family context is compatible with this possibility. Nevertheless, displacement is a proposed explanatory pathway, not a mechanism established by this review. Screen content, interactivity, co-viewing and family circumstances may influence associations alongside duration.

The results also require consideration of confounding and reverse causation. Parental education, socioeconomic circumstances, parental screen use, caregiver mental health, sleep and parent–child interaction may affect both screen exposure and child outcomes. Children with emerging developmental or regulatory differences may also experience different patterns of screen use. The included evidence cannot fully separate these explanations; the negative-control finding in one included cohort illustrates how residual confounding can contribute to apparent associations [18]. Autism-related screening results and symptom scores should not be interpreted as clinical diagnoses, and outcomes across domains are not interchangeable.

Strengths and limitations

Strengths include the focus on early childhood, the combination of quantitative and narrative synthesis, a study-level summary of design, exposure measurement, follow-up, outcomes, effect estimates and confounder adjustment (Table 1), and the use of random-effects methods, a Hartung–Knapp interval, a prediction interval and leave-one-out analysis.

Limitations include only five pooled studies; substantial clinical and methodological heterogeneity; differences in exposure thresholds, outcome instruments and follow-up; frequent reliance on parent-reported screen time; and variable adjustment for confounders. The pooled analysis combines outcomes that differ conceptually and clinically. Because the search began in January 2020, earlier longitudinal studies were not captured, and the review may omit relevant older evidence. A formal risk-of-bias tool was not applied, so a sensitivity analysis excluding high-risk studies could not be performed, and the GRADE assessments were

provisional. Only leave-one-out and Hartung–Knapp sensitivity analyses were conducted; alternative variance estimators were not compared, and with five studies neither meta-regression nor a well-powered subgroup comparison was feasible. The subgroup estimates (k = 2 and k = 3) were exploratory and should not be over-interpreted. In one pooled study a correlation coefficient was converted to an odds ratio, which adds uncertainty to the pooled estimate. Finally, some reports retained for narrative context measured exposure outside the primary 12–36-month window or used non-longitudinal designs, limiting their direct relevance to the primary question.

Implications and future research

Clinicians and families may reasonably discuss the amount, content and context of screen use without assuming that screen exposure alone causes a disorder. Developmentally appropriate advice can emphasize limiting prolonged passive use, selecting age-appropriate content, co-viewing where appropriate, and protecting time for responsive interaction, sleep and active play. These implications should be framed supportively rather than as parental blame.

Future studies should use repeated and preferably objective measures of screen exposure, standardized developmental outcomes, transparent reporting of adjusted effect estimates and confidence intervals, and stronger control of family and environmental confounding. Researchers should distinguish screen content and context, test dose–response patterns, address reverse causation, and include populations from low- and middle-income settings. An updated synthesis should extend the search to earlier longitudinal cohorts, apply a formal risk-of-bias tool and test the effect of excluding high-risk studies, compare between-study variance estimators (for example, restricted maximum likelihood and Paule–Mandel with Hartung–Knapp adjustment), and undertake meta-regression on age at exposure, exposure threshold, outcome instrument, follow-up length and degree of confounder adjustment once at least ten comparable studies are available [12].

CONCLUSION

Higher early-childhood screen exposure was associated with increased odds of adverse neurodevelopmental outcomes in this review, but the evidence was heterogeneous and of very low certainty. The pooled OR of 2.04 should be interpreted cautiously in view of $I^2 = 89\%$, the wide prediction interval and the limited number of pooled studies. The findings do not establish that screen exposure causes autism, ADHD, language delay or other developmental conditions. A prudent interpretation is to support balanced, developmentally appropriate media use while preserving caregiver–child interaction, play, sleep and physical activity, and to prioritize stronger longitudinal research.

Declarations

Ethical approval: Not applicable. This review synthesized published studies and did not involve direct recruitment of human participants or animals.

Conflict of interest: no conflict of interest."

Funding: "This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors."

Data availability: The study-level extraction is provided in Table 1. The underlying extraction dataset and R analysis code are available from the corresponding author on reasonable request.

Registration: PROSPERO CRD420261511593.

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