A Systematic Review and Meta-Analysis on the Impact of Screen-Time on the Social-Emotional Development of Children Under Five Years

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ABSTRACT

Given the rising consumption of electronic media by children under five years of age, it is crucial to study the impact of screen time (ST) on the social-emotional development (SED) of children. Heterogenous past studies have reported emotional and behavioural problems, delayed language and motor milestones, and increased peer victimisation due to increasing ST. This review consolidates existing literature on the link between ST and children's SED, providing a comprehensive analysis of its impact. A detailed literature search across PubMed, Scopus, CINAHL, Cochrane Database of Systematic Review, and manual citation searching was conducted. Inclusion criteria were studies from 2012 up till July 2023, participants under age 5 years, and studies reporting the impact of ST on SED of children. This systematic review was performed using the PRISMA guidelines. Meta-analysis was conducted on articles that reported OR and used the strengths and difficulties questionnaire (SDQ) as the assessment tool. This review included 12 studies from 7 countries. The methodological quality of studies was good (n = 2), fair (n = 9), and poor (n = 1). Descriptive analysis revealed that ST was generally associated with poorer SED. The meta-analysis revealed that ST was significantly related to SED in children with an overall OR (using a random-effects model) of 1.24 (95% CI: 1.16-1.33). ST had a significant positive impact on hyperactivity and emotional problems with an OR of 1.39 (95% CI: 1.15-1.67) and 1.21 (95% CI: 1.15-1.27), respectively. These findings support the recommendations outlined by the AAP to limit ST for children. Caregivers and policymakers need to be recruited to prevent harmful impacts on SED outcomes of children.

Key Words: *Child*, *Infant*, *Social*, *Emotional*, *Development*, *Screen-time*, *Technology*.

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INTRODUCTION

From TV shows aimed at children to the use of touchscreen devices, engaging with various forms of electronic media —hereafter described as screen time (ST)— has become a dominant activity for infants and toddlers. This rise in ST can be attributed to many factors such as the development of social economy,[1] parental workload,[2] maternal mental distress and depression,[3] and the neurodevelopmental status of children.[4]

Current ST habits among children often surpass the recommendations set by advisory bodies such as the American Academy of Paediatrics (AAP) and the World Health Organisation (WHO).[5,6]

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The AAP does not endorse the use of electronic devices for children under two years and recommends limiting ST to 1 hour per day for children aged 2 to 5 years. According to the AAP, until 18 months of age, the only form of ST considered acceptable is video chatting. For children aged between 18 months and 2 years, if caregivers choose to introduce them to technology, it should always be done under supervision, with careful selection of content and avoiding self-use by children. On the other hand, the WHO advises against any ST for infants under the age of one year and suggests restricting ST for children aged 2 to 4 years to just one hour. Despite these guidelines, all over the world, including Pakistan, ST of children is on the rise along with the autonomy of internet usage.[7-11]

Many parents are unaware of the detrimental effects of screen exposure on their children.[12] Children under 5 years are in a critical growth phase with higher brain plasticity impacted by environmental exposures.[13] Positive experiences can lead to changes in the brain that support learning and improve cognitive abilities, whereas negative experiences can result in brain changes that hinder cognitive development.[14] ST disrupts real-life social interactions of children with their caregivers, which may hinder their development.[15,16] Excessive ST has been shown to increase the risk of peer victimisation during early school

years,[17,18] and emotional and behavioural problems,[17,19-21] alongside delayed milestones in problem-solving, language development,[22,23] and motor skills.[24] Depending on the content consumed, ST can also have a positive impact on infants and toddlers. Action-based electronic games which promote characters working together, increase pro-social behaviour and visual attention skills.[25-27] TV shows can aid in teaching children numbers and alphabets and have been associated with increased language development among children aged 3–5 years, especially when co-watched with parents.[28-30]

Exposure to ST has been shown to impact socio-emotional development (SED).[31-34] SED pertains to a child's capability to effectively manage and express their emotions, as well as establish meaningful connections with peers and adults.[35] SED slowly develops throughout early childhood and significantly influences children's academic performance and lifelong learning.[35,36] The development of socio-emotional competence is a determinant for future success,[35] with inadequate SED in children posing significant challenges for both families and society at large.[37] Therefore, it is essential to recognise risk factors that can be modified to improve SED, including ST.

Previous reviews have analysed the effects of specific electronic media exposure,[24,38] expanded age groups,[39,40] and multiple developmental outcomes.[9] Swider *et al*. offer insights into the effect of screen-based media on SED outcomes of children under 5 years,[41] with a focus on how caregiver behaviour influences children's interactions with electronic media and examine various theories regarding the impact of ST on development. No review has yet conducted a meta-analysis on the SED outcomes. Existing studies investigating the link between ST and SED apply cross-sectional designs, and there is limited longitudinal research available as well. These studies conducted in multiple countries with variable sample sizes, need to be compared to draw more comprehensive conclusions.[32,33,42-45]

This review synthesises current literature to conduct a comprehensive breakdown of the association between infants' and toddlers' SED and ST through systematic review and meta-analysis. Given the escalating usage of electronic media devices by young children, examining this evidence is crucial. The study seeks to offer valuable insights for parents, educators, therapists, policymakers, and researchers in Pakistan, facilitating their understanding of how ST impacts crucial developmental outcomes in children.

METHODOLOGY

A comprehensive literature search was carried out to identify relevant articles for further analysis through systematic review and meta-analysis.

The inclusion criteria were studies conducted on children aged between 0 and 5 years, observational studies published on the topic since 2012 till July 2023, all studies assessing the SED of children, all primary and secondary sources including original research, systematic reviews, meta-analyses, scoping reviews, case reports, case series, and cohorts, conducted globally. Any animal studies, narrative reviews, commentaries, and editorials were excluded.

This meta-analysis was conducted up till July 2023 following the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) reporting guideline (Supporting Information S1).[46] The title of the review had been registered with PROSPERO in 2022 (ID CRD42022342602). The systematic review included all articles describing the impact of ST on SED of children under 5 years of age (Figure 1). Article selection was conducted through a systematic search of MEDLINE/PubMed (2012 to 18th July 2023), Scopus (2012 to 10th July 2023), CINAHL (2012 to 10th July 2023), and Cochrane Database of Systematic Reviews (2012 to 18th July 2023) to find articles reporting on associations between ST and SED.

The search strategy encompassed all study designs but was limited to only studies available in the English language. A time limit was set for articles from 2012, as ST has significantly increased over the last decade with the easy availability of handheld devices and internet access[47] till the last date of search (July 2023).

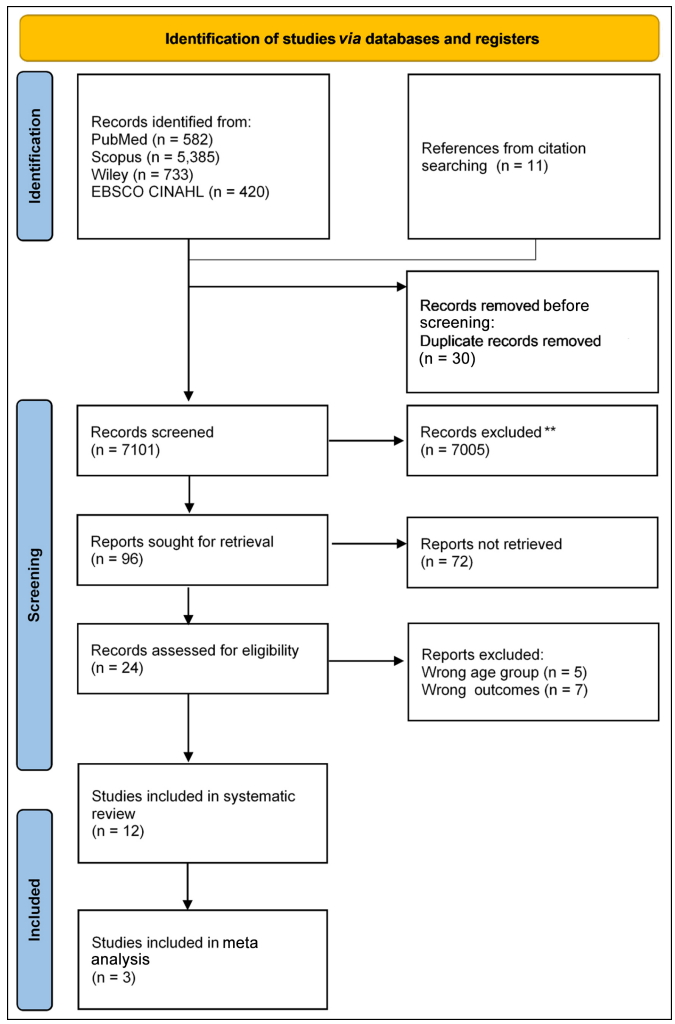

Figure 1: PRISMA flowchart for study selection.

Table I: Quality assessment of cross-sectional studies with questionnaires only based on the NHLBI checklist for observational cohort and cross-sectional studies (NHLBI).

Studies included	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total	Overall
Raman *et al.*,[42] 2017										N.A.		N.A.	N.A.		7/14	Fair
Hu *et al.*,[43] 2020			C.D.							N.A.		N.A.	N.A.		7/14	Fair
Lin *et al.*,[33] 2020										N.A.		N.A.	N.A.		8/14	Fair
Desmarais *et al.*,[32] 2021			C.D.									N.A.			7/14	Fair
Niiranen *et al.*,[44] 2021												N.A.			11/14	Good
Liu *et al.*,[1] 2021												N.A.	N.R.		11/14	Good
Hinkley *et al.*,[45] 2014												N.A.	N.R.		10/14	Fair
Jackson,[56] 2018			C.D.							N.A.		N.A.	N.A.		10/14	Fair
Carson and Kuzik,[52] 2021										N.A.		N.A.	N.A.		9/14	Fair
Monteiro *et al.*,[54] 2021		C.D.								N.A.		N.A.	N.A.		4/14	Poor
Poulain *et al.*,[55] 2019										N.A.		N.A.	N.A.		8/14	Fair
Babaroglu,[53] 2017			C.D.							N.A.		N.A.	N.A.		6/14	Fair
Wu *et al.*,[49] 2017										N.A.		N.A.	N.A.		8/14	Fair

Green: Yes, Yellow: No, N.A.: Not Applicable, C.D.: Cannot Decide, N.R.: Not Reported.
NHLBI guidance document states that question 6 and 7 should be graded as "No" for cross-sectional studies.
10 and 13 were both graded as "N.A." for the cross-sectional studies without follow-up periods.
12 was graded as "N.A" as outcome data were gathered *via* participant filled questionnaires.
1. Was the research question or objective in this paper clearly stated?
2. Was the study population clearly specified and defined?
3. Was the participation rate of eligible persons at least 50%?
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?
5. Was a sample size justification, power description, or variance and effect estimates provided?
6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?
7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?
8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?
9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?
10. Was the exposure(s) assessed more than once over time?
11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?
12. Were the outcome assessors blinded to the exposure status of participants?
13. Was loss to follow-up after baseline 20% or less?
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?

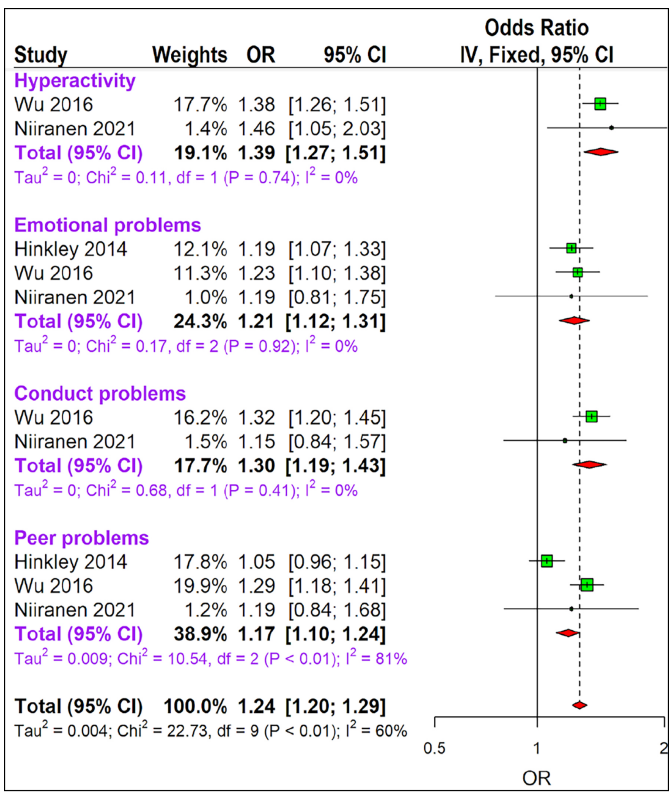

Figure 2: Forest plot depicting the association between screen time and socio-emotional development.

Further articles were identified through manual citation searching through the bibliographies of included studies and relevant systematic reviews. Endnote bibliographic software was employed to download the search results and deduplications. The first and second authors independently screened the titles and abstracts of all records, any disagreements regarding eligibility were resolved by the corresponding author. Any animal studies, narrative reviews, commentaries, and editorials were excluded, along with studies with participants older than 5 years of age.

Subsequently, articles meeting the inclusion and exclusion criteria were chosen for conducting odds ratio (OR) calculations and prevalence analysis. The first and second authors carried out data extraction from full texts. Data regarding the study, participants, exposure, and outcome characteristics were recorded.

The risk of bias assessment was also assessed by the first and second author independently using the Quality Assessment Tool for Observational Cohort and Cross-sectional Studies (Table I).[48] Both reviewers independently answered 14 individual questions in the tool. A point was rewarded for each question answered with 'Yes' and no point was considered for 'No/Cannot Decide/Not Reported/Not Applicable'. The ultimate score was computed, and quality was assessed to be either good (11–14 out of 14 questions), fair (5–10 out of 14 questions), or poor (0–4 out of 14 questions).

Among the 12 studies identified, only three studies[44,45,49] reported odds ratio (OR) as a measure of association between ST and SED and were pooled using random effect meta-analysis. The scale used in the studies was the strengths and difficulties questionnaire (SDQ). Nine studies were excluded from the analysis. Meta-analysis was conducted in RStudio[50] (version: 2023.9.0.463) using the metagen function from meta package.[51]

Table II: Study characteristics.

Study ID	Journal	Study design	Country	Age	Exposure	Sample size	Measurement tool
Babaroglu *et al*.[53] 2013	Journal of psychological and educational research	Cross- sectional	Turkiye	4-5 years	TV viewing	249 children	Social relationship sub-dimension of the behaviour grading scale
Carson and Kuzik[52] 2020	Child: Care, health, and development	Cross- sectional	Canada	Preschool aged children	Cell phone/smartphone, tablet, iPad, television, computer, and video game console)	100 children	Child self-regulation and social behaviour questionnaire: Early years toolbox (Howard and Melhuish, 2017)
Desmarais *et al*.[32] 2021	Infant behaviour and development	Cross- sectional	United States, Brazil, Spain, Mexico, Italy, Russia, Finland, Romania, Belgium, The Netherlands, China, South Korea, Turkiye, and Chile	15.87 to 40.97 months of age	TV viewing	841 children	The Early Childhood Behaviour Questionnaire. The child behaviour checklist
Hinkley *et al*.[45] 2014	JAMA Paediatrics-the science of child and adolescent health	Prospective cohort	8 different European countries (Belgium, Cyprus, Estonia, Germany, Hungary, Italy, Spain, and Sweden)	2 to 9 years	Electronic media: Weekday and weekend television and electronic game (e-game)/computer use	16 864 children	Strengths and Difficulties questionnaire
Jackson[56] 2016	Infant and child development	Data were employed from an early childhood longitudinal study, birth cohort, and a quasi-experimental, propensity score matching design.	USA		TV viewing		Preschool and kindergarten behaviour scales- second edition (PKBS-2; Merrell, 2003)
Lin *et al*.[33] 2020	Infant behaviour and development		Taiwan	18 to 36 months	Touch screen devices	161 children	Child behaviour checklist for ages 1½–5 (CBCL 1½–5) communication and language screening test for birth to three Chinese-speaking infant toddlers (CLST)
Monteiro *et al*.[54] 2021	Frontiers in psychology	Exploratory	Portugal	6 months to 6 years and 12 months	TV, computer, videogames, tablet, cell phone, and internet	193 children	Baby paediatric symptom checklist (BPSC) (Perrin *et al*., 2016), for children younger than 18 months. - preschool paediatric symptom checklist (PPSC) (Perrin *et al*., 2016), for children from 18 to 66 months
Niiranen *et al*.[44] 2020	BMJ	Cross- sectional	Finland	Children aged 5 years	Electronic media (programme viewing, and electronic game playing)	699	Strengths and Difficulties Questionnaire (SDQ)
Poulain *et al*.[55] 2019	International journal of environmental research and public health	Cross- sectional	Germany	2 to 9 years children	TV viewing, computer, tablets, and mobile phones both online and offline	553	Strengths and Difficulties Questionnaire (SDQ)
Raman *et al*.[42] 2017	Clinical paediatrics	Cross-sectional		12 to 36 months	Electronic platform including TV/ DVD, tablet, cell phone, and computer	210	Ages and Stages Questionnaire (ASQ)
Wu *et al*.[49] 2016	European child and adolescent psychiatry	Cross- sectional	China	3 to 6 years	TV viewing, computer games, cellphone, iPad, and other electronic devices	8900	Strengths and Difficulties Questionnaire (SDQ) clancy autism behaviour scale (CABS)
Hu *et al*.[43] 2020	Journal of research in childhood education		China	5 years	Active screen time (computers etc) and passive screentime (TV viewing etc).	579	Social skills improvement system – rating scales (SSIS–RS; Gresham and Elliott, 2008)

RESULTS

A detailed summary of search results based on PRISMA guidelines is depicted in Figure 1. About 7120 references were screened manually. After removing duplicates, 7,090 articles were eligible for initial screening of titles and abstracts. Out of 7,090, full texts of 24 articles were critically evaluated for suitability for data extraction. Twelve articles were found to be eligible for data extraction. Out of the 12 studies, only three were eligible to be pooled for meta-analysis and the remaining were descriptively analysed.

Twelve studies (Table II) were included, out of which the majority of the studies were cross-sectional studies,[33,42-44,49,52-55] three were observational studies,[44-46] and one was exploratory.[54] The study settings included the USA,[42,56] Canada,[52] Turkiye,[53] China,[33,43,49] Germany,[55] Finland,[44] and Portugal.[54] Two studies were multi-centred.[32,45] The children included in the studies were either under 5 years of age or had a subgroup with under five assessments. The tools used included an evaluation scale of social behaviours, self-regulation, social behaviour questionnaire, strengths and difficulties questionnaire, early childhood behaviour questionnaire, preschool and kindergarten behaviour scales, child behaviour checklist for ages 11 / 2–5, preschool paediatric symptom checklist, and ages and stages questionnaire: Social-emotional (ASQ: SE) and social skills improvement system–rating scales.

The association between ST and children's SED was examined. Babaroglu *et al*. reported no significant correlation between children's TV viewing duration and their social interaction behaviours ($F = 0.335$; $p > 0.800$).[53] Nevertheless, they observed that children who watched TV for seven hours or more had lower scores in social interaction.

Carson and Kuzik investigated the impact of parent-child technology interference on various aspects of cognitive and social-emotional development in preschool-aged children.[52] Their study revealed significant associations between higher technology usage and lower response inhibition ($B = -0.015$,

95% CI: -0.028, -0.002), reduced emotional self-regulation (B = -0.095, 95% CI: -0.163, -0.028), and elevated log internalising scores (B = 0.034, 95% CI: 0.013, 0.056).

Desmarais *et al*. reported that excessive screen time was linked to enhanced scores of negative emotions, attention problems, emotional reactivity, aggression, and inconsolability.[32]

Jackson demonstrated that increased screen exposure in the form of TV viewing was notably linked with both social challenges and behavioural issues throughout primary school years (social difficulties: t = 2.70, p <0.05; conduct problems: t = 3.71, p <0.05).[56] Yet, upon matching the participants, the connections between prolonged TV watching, school-related social challenges, and behavioural problems lost significance. However, the susceptibility to social difficulties notably increased when TV viewing was unsupervised (t = 2.90, p <0.05), persisting even after matching (from 0.11 to 0.18, representing a 64% increase).

Lin *et al*. illustrated that children who devoted more time to touch screen devices were inclined to exhibit various issues including emotional problems (β = 0.219, p <0.010, 95% CI: 0.279–1.518), anxious/depressive symptoms (β = 0.206, p <0.050, 95% CI: 0.170–1.244), somatic complaints (β = 0.291, p <0.001, 95% CI: .455–1.462), social withdrawal symptoms (β = 0.194, p <0.050, 95% CI: 0.133–1.150), attention problems (β = 0.300, p <0.001, 95% CI: 0.432–1.267), and aggressive behaviours (β = 0.247, p <0.010, 95% CI: 0.967–3.983).[33] These findings highlight that excessive screen time among children aged 18–36 months correlated with emotional disturbances, anxious/depressive symptoms, somatic complaints, social withdrawal symptoms, attention problems, and aggressive behaviours.

Monteiro *et al*. demonstrated that attention problems assessed through the PPSC scale exhibited positive associations with the overall duration of screen exposure during weekday confinement (r = 0.288, p <0.001) and weekend confinement (r = 0.257, p = 0.001).[54] Poulain *et al*. reported that increasing ST was associated with a remarkable rise in conduct problems (β = 0.12, p = 0.013) and symptoms of hyperactivity/inattention (β = 0.13, p = 0.005), while there was a decrease in prosocial behaviour (β = -0.12, p = 0.007).[55]

In 2017, Raman *et al*. demonstrated that 86% (18 out of 21) of children identified as being at risk for social-emotional delay had engaged in screen time for five or more daily routines.[42] In contrast, only 51% (96 out of 189) of children not at risk for delay did the same. The odds ratio calculation demonstrated that the likelihood of being at risk for social-emotional delay is 5.8 times higher for children who had five or more daily routines occurring with an active screen compared to those with fewer than five routines involving a screen (p = 0.002; 95% confidence interval = 1.66-2.39).

Hu *et al*. examined the association between screen time and social development in Chinese children, it was observed that passive screen time (defined as screen time with minimal viewer interaction, such as TV viewing) was negatively associated with children's social skills (B = -1.894, β = -0.113, t = -2.639, p <0.01, CI [-3.305, -0.484]).[43] Children with higher passive screen time exhibited poorer performance in mathematics, science, executive function, and social skills. Conversely, children with more active screen time (defined as screen time involving feedback and interactivity, such as iPad or smartphone use) scored higher in receptive vocabulary and science achievement. However, no significant predictive effect on social skills was observed (p >0.05).

The findings of the meta-analysis are illustrated using a forest plot as shown in Figure 2. The overall synthesis of reported data showed that ST was significantly associated with SED in children with an overall OR (using a random-effects model) of 1.24 (95% CI: 1.16–1.33). As far as the subgroup's estimates are concerned, ST had a significant positive impact on hyperactivity and emotional problems with an OR of 1.39 (95% CI: 1.15–1.67) and 1.21 (95% CI: 1.15–1.27), respectively. However, the ST had a positive but non-significant impact on conduct problems and peer problems with an OR of 1.30 (95% CI: 0.80–2.12) and 1.17 (95% CI: 0.87–1.57), respectively.

DISCUSSION

The studies included in this review demonstrated that spending too much time watching TV can lead to social difficulties as well as conduct problems. Specifically, negative emotionality, attention problems, aggression, social difficulties, and conduct problems were noticeably increased due to ST. Children who allocated increased time to the usage of touch screen devices demonstrated a higher likelihood of encountering emotional, behavioural, and attention-related issues.[32,33]

While the finding that ST has a significant impact on SED is congruent with existing literature,[57,58] the exact sub-scales of SED assessment being affected by ST differ across studies. A cross-sectional survey conducted in Islamabad revealed a higher prevalence of autism spectrum symptoms, and internalising symptoms in preschool children exposed to increased ST, however, attention problems were not common.[10] Stiglic and Viner found insufficient evidence for the association between ST and behaviour problems, attention deficit, and hyperactivity.[59]

This difference may be due to different measuring tools to assess SED such as the Strengths and difficulties questionnaire,[60] preschool and kindergarten behaviour scales,[61] child behaviour checklist for ages 1½–5, preschool paediatric symptom checklist,[33] and ages stages questionnaire: social-emotional (ASQ: SE).[42]

This review showed that increased ST per day is primarily deleterious for children, which is congruent with the findings of

Roche and Nunes, and Streegan *et al*.[38-40] The cut-off for ST at which SED impairment becomes apparent differs between studies. Children who are exposed to more than one hour of screen time per day tend to have poor cognitive abilities, inattention, decreased sitting tolerance, and behavioural problems.[39,62] Children watching TV for ≥7 hours/day had lower social relation scores.[53] A study done in Canada reported that screen time >1 hour per day harms social competence and emotional maturity.[57] Another systematic review emphasised that social skill development was better when parents imposed restrictions on screen viewing time.[39]

Alongside the duration of ST, the nature of the content also makes a difference. Viewing violent content and cartoons has been associated with negative emotional symptoms, inattention, distractibility, and negative effects on development.[39] Many studies did not distinguish between exposure to active and passive ST. Amongst included studies, Hu *et al*. discovered that excessive screen time leads to poor academic performance in areas such as mathematics and science, as well as negatively affecting children's social skills. Contrary to this, children who spent more time engaged in activities on their screens scored higher in science and vocabulary tests.[43] This is in congruence with Ren's review, which reported that passive screen time led to increased conduct problems, social-emotional dysfunction, and problems with attention, while active screen time was linked to better academic performance.[58]

It would be valuable to explore the association between parental technology use and children's SED given the crucial role parents play in raising young children. Carson *et al*. found a significant association between higher parent-child technology interference and lower response inhibition, emotional self-regulation, and higher log-internalising scores in children.[52] Parents with higher ST were associated with increased ST in preschool children.[10]

The present review has some limitations. Only studies written in English were included. The study did not analyse in detail the impact of active and passive screen time on SED in young children, as most primary studies did not separately examine the impact of these two different types of exposures. This can be further explored by researchers in future studies.

In addition, the meta-analysis consisted of only three studies, as OR was not reported in other studies. This highlights the need for high-quality future research, including long-term follow-up of screen time exposure in the early years of life. It also emphasises the need for further exploration of the role of both active and passive screen time.

CONCLUSION

The study's findings substantiate the guidelines by the American Academy of Paediatrics to restrict ST for children. It is essential to engage the caregivers and policymakers in concerted efforts to mitigate the adverse effects of excessive screen exposure on children's SED outcomes.

COMPETING INTEREST:
The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:
AA, MR: Contributed to conception and design, drafted the manuscript, and critically revised it.
MA, ARR, JKD: Contributed to analysis and interpretation of the data, and drafted the manuscript.
SKJ: Contributed to conception, designing, drafting, and critically revising the manuscript.
All authors approved the final version of the manuscript to be published.

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