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The effects of screen time on children and adolescents: A systematic review

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Abstrakt (norsk)

Introduksjon: Skjerm tid har blitt en viktig del av barn og ungdoms liv. Denne systematiske gjennomgangen ser på hvilke psykologiske utfall skjerm tid er assosiert med for barn og ungdom i alderen seks til tolv.

Metode: 12 ulike journaler ble gjennomsøkt med «screen time» og «child*» i nøkkelord, tittel og abstrakt som ga totalt 123 371 treff. Etter å ha ekskludert duplikater og tatt vekk alle treff med «screening» i nøkkelord, tittel og abstrakt, ble 28421 ble igjen. Manuell gjennomgang av nøkkelord, tittel og abstrakt i disse artiklene ga til slutt 223 artikler som ble lest i fulltekst. 57 av disse passerte alle inklusjonskriteriene, en artikkel fra «screening»-gruppe ble også lagt til etter et manuelt søk. 49 av 58 artikler var individuelle studier, hvor av 38 var kryss-seksjonale og 11 var longitudinelle. 9 av artiklene var systematiske gjennomganger, oversiktsartikler eller metaanalyser.

Resultater: Alle de inkluderte studiene, sett bort ifra tre artikler, viste positive korrelasjoner mellom skjerm tid og et flertall utfall; økt depresjon, OCD, oppmerksomhetsvansker, ADHD og lavere akademiske scorer.

Konklusjoner: Dataene som er lagt frem i denne systematiske gjennomgangen viser til at skjerm tid kan ha en signifikant negativ effekt på barn og unges utvikling. Videre forskning burde fokusere på å redegjøre for kausale forhold. I tillegg, burde fremtidige retningslinjer inkludere de store variasjonene i utfall skjerm tid har blitt assosiert med.

*Nøkkelord***:** skjerm tid, barn, ungdom, mental helse, akademiske prestasjoner

Abstract (English)

Introduction: Screen time has become an important part of children and adolescents' lives. This systematic review looks at what psychological outcomes screen time is associated with for children and adolescents age six to twelve.

Methods: 12 different databases were searched with "screen time" and "child*" in keywords, title and abstract giving a total of 123 371 hits. After excluding duplicates and removing all hits that included "screening" in keywords, title and abstract, 28 421 articles remained. Manually screening keywords, title, and abstract of these articles led to a sample of 223 articles who were read in full-text. 57 of these passed all eligibility criteria, and 1 article from the "screening"-group was added after a manual search. 49 of 58 articles were individual studies, including 38 cross-sectional and 11 longitudinal studies. 9 of the articles were systematic reviews, reviews or meta-analyses.

Results: All but three of the relevant articles showed positive correlations between screen time and several different outcomes; increases in depression, OCD, attention issues, ADHD, behavioural issues, and lower academic performance.

Conclusions: The data presented in this systematic review point to screen time possibly having a significantly negative effect on children and adolescents' development. Future research should focus on how to determine causal relationships. In addition, future guidelines should take into account the range of negative outcomes screen time has been associated with.

Keywords: screen time, children, adolescents, mental health, academic performance

The effects of screen time on children and adolescents: A systematic review

Due to the increased availability of screens and the increase of screen time among children and adolescents (Trinh et al., 2019), it is important to determine the effects this consumption might have on their development, particularly psychological outcomes. The aim of this systematic review is to examine and sum up these effects. The focus will be on the effects of screen time on psychological development in children and adolescents aged six to twelve. This includes results relating to the effects earlier ages can have on school children aged six to twelve, and what effects can be seen to originate in this age group, that might affect later development. The age group was chosen due to their development stage giving room for them to consume screen time more than younger children, and without close adult supervision. It is also a period of intensive learning and developmental changes that might be difficult to reverse. At the same time this age group has in the past two decades become high consumer of video games. A large group of children and adolescents in this age group play video games several hours a day (Aydin et al., 2021).

Most of the research that has come out seems to point in a negative direction when it comes to the effects of prolonged screen time for several outcomes in young children and infants (John et al., 2023; Madigan et al., 2019; Mallawaarachchi et al., 2022). Therefore, a systematic review of the effect on children and adolescents in the age group of six to twelve is needed to draw further conclusions about the effects. This would help to determine the onset and potential cause of some developmental changes and if there is a need to intervene at an earlier age to help reverse or prevent potential negative development.

Excessive screen time seems to be a widely used term with no clear agreement about its definition. According to Pouretemad et al. (2022) excessive screen time can be defined as spending more than half of one's waking time-consuming screen media. Other authors have defined excessive or over-use as more than two hours (Anitha et al., 2021; Yeonkyu et al.,

2021), while others argue for a more nuanced view of what excessive or over-use actually means (Liebherr et al., 2022; Segev et al., 2015). Segev et al. (2015) argues for an age-based model of excessive screen time, namely that the definition somehow must encompass the different age-groups and their stage of development. The question of what defines excessive screen time is complex, and this systematic review will include studies that used different definitions in an attempt to encompass as much of findings about the effects of screen time as possible.

Some researchers have shown how children can develop psychological disorders, such as gaming and media addiction (Meng et al., 2022) through over-use of screen time. The fields of gaming and media addiction focus on the addictive tendencies of screen time, and the overarching impact it can have on young people's lives. The addition of gaming disorder in the 11th and newest version of the International Classification of Disease (World Health Organization, 2019) has made this a central topic of discussion in many academic circles.

Research on such severe psychological disorders have attracted attention to the possibly severe negative effects of screen time such as the development of autism-like symptoms. Post-Digital Nannying Autism Syndrome (PDNAS) is described as a subtype of autism spectrum disorder (ASD) caused by exposure to screens that is longer than half of the time children are awake during a day (Pouretemad et al., 2022). Pouretemad et al. (2022) have found no difference in the severity of autism symptoms between children with PDNAS and children with ASD, but that children with PDNAS have significantly better scores in executive functions and behavioural flexibility than children with ASD. The authors concluded that autism symptoms in children with PDNAS might be caused by excessive screen time. This showcases that research on this topic is important because it can ascertain what possible effects of screen time could be.

Researchers have established two prevailing hypotheses to explain screen time's effect on children and adolescents: the *media goldilocks* hypothesis and the *displacement* hypothesis. The *media goldilocks* hypothesis was first argued by Przybylski and Weinstein (2017). The hypothesis states that there is an ideal amount of screen time that will not be harmful and might even be beneficial to children and adolescents. This hypothesis is more in line with perspectives that argue screen time to be a central part of modern-day life (Milosevic et al., 2022). Screen time is not going anywhere, and both children, adolescents and adults have to find a way to coexist with it. In contrast, the *displacement* hypothesis (Bessière et al., 2008) argues that due to screen time's unique ability to hold attention it could substitute activities that are more beneficial to development. Further on, this could manifest as a possibly severe setback in children and adolescents' development.

The World Health Organization (WHO) has shown concern about the negative outcomes of excessive screen time in children, and has published guidelines (WHO, 2019) stating that infants under the age of one should not consume screens. Furthermore, the WHO recommends no more than one hour per day of screen time for children aged two to four years. These guidelines have been criticized (Ophir et al., 2021), due to the low quality of the studies used by the WHO to establish such strict guidelines. Another important aspect to take into account is that most of the studies the WHO analysed focused on the negative physical and somatic outcomes of extended screen time, such as obesity, sedentary behaviour, and unhealthy eating habits. It could be argued that the WHO did not adequately take into account psychological and developmental outcomes of screen time.

Several government bodies (e.g., AACAP, 2022; Helsedirektoratet, 2022; Public Health Agency of Canada, 2019) have published guidelines that are akin to those of the WHO. This shows that screen time as a topic is not only of interest to academia, but also to governing bodies focusing on public health. With the still unknown consequences of screen time public

debates on the subject have become more common. In Norway this debate was sparked when the public health authorities (Helsedirektoratet, 2022) announced that they would set the same guidelines as proposed by the WHO. They also cited the same WHO study criticised by Ophir et al. (2021). The prevailing notion that the WHO is an authority on public health-related issues becomes an issue when researchers show that WHOs guidelines are not anchored in the research findings that can be used to develop such guidelines.

The goal of this systematic review is to summarize research findings on the effects of screen time on psychological outcomes in children and adolescents between the ages of six and twelve. At age six children in most countries attend primary education and are more exposed to screens then they were during preschool years. This is partly due to their increased personal freedom, but also due to increased use of digital devices in modern education. Therefore, the differences between children in the amount of screen time become smaller when they reach this age. Age twelve was chosen as the upper limit because it marks a change for most adolescents; it is the time when they move from primary to secondary education in many countries. It is also the age that marks the onset of puberty when many other interests typical for that age start steering screen use, such as sexual attractiveness and group dynamics, and when social media become more accessible.

To the knowledge of the author, this review is novel with respect to the focus on the specified age range and range of outcomes. Only a few studies published so far (e.g., Oswald et al., 2020) have concentrated on all possible psychological outcomes in this specific age range. The age of the participants in our systematic review and in the scoping review by Oswald et al. (2020) partially overlap, although Oswald et al. (2020) focused on several age groups. Both the participant's age and the range of outcomes have been in focus in debates on the effects of screen time, which makes this review highly relevant and needed. A thorough

review of the effects screen time could have on children and adolescents' psychological outcomes will also show which aspects of this issue need more research.

Materials & methods

The systematic literature review was completed in accordance with the PRISMA guidelines for systematic reviews (Page et al., 2021). Databases used for this search comprised of: ERIC, Psych INFO, PubMed, Web of Science, ProQuest, the Cochrane Library, Psych net, Pub-Psych, Medline, Epistemonikos, Campbell Systematic Reviews, and Global Index Medicus. Search words used in all of them were "child*" and "screen time" in title, abstract, or keywords. The databases were selected to create a diverse perspective on the available research of screen time's effect. This is also the reason why such simple search words were used: to gather a large number of references which fully encompass the field.

All records were processed with Endnote 20 software. The initial search performed on 13th January 2023 yielded 123 371 references, with a total of 34 384 duplicates (se Figure 1). Due to time and resource constraints, it was decided to remove all references that held the word "screening" in the title, keywords, or abstract, as the studies focused on "screening" where from other research fields and/or did not refer to the research question set for this study. The 60 565 records that had the word "screening" in the title, keywords, or abstract were not included in further categorisation of studies. The remaining 28 421 records were screened by title, keywords, and abstract.

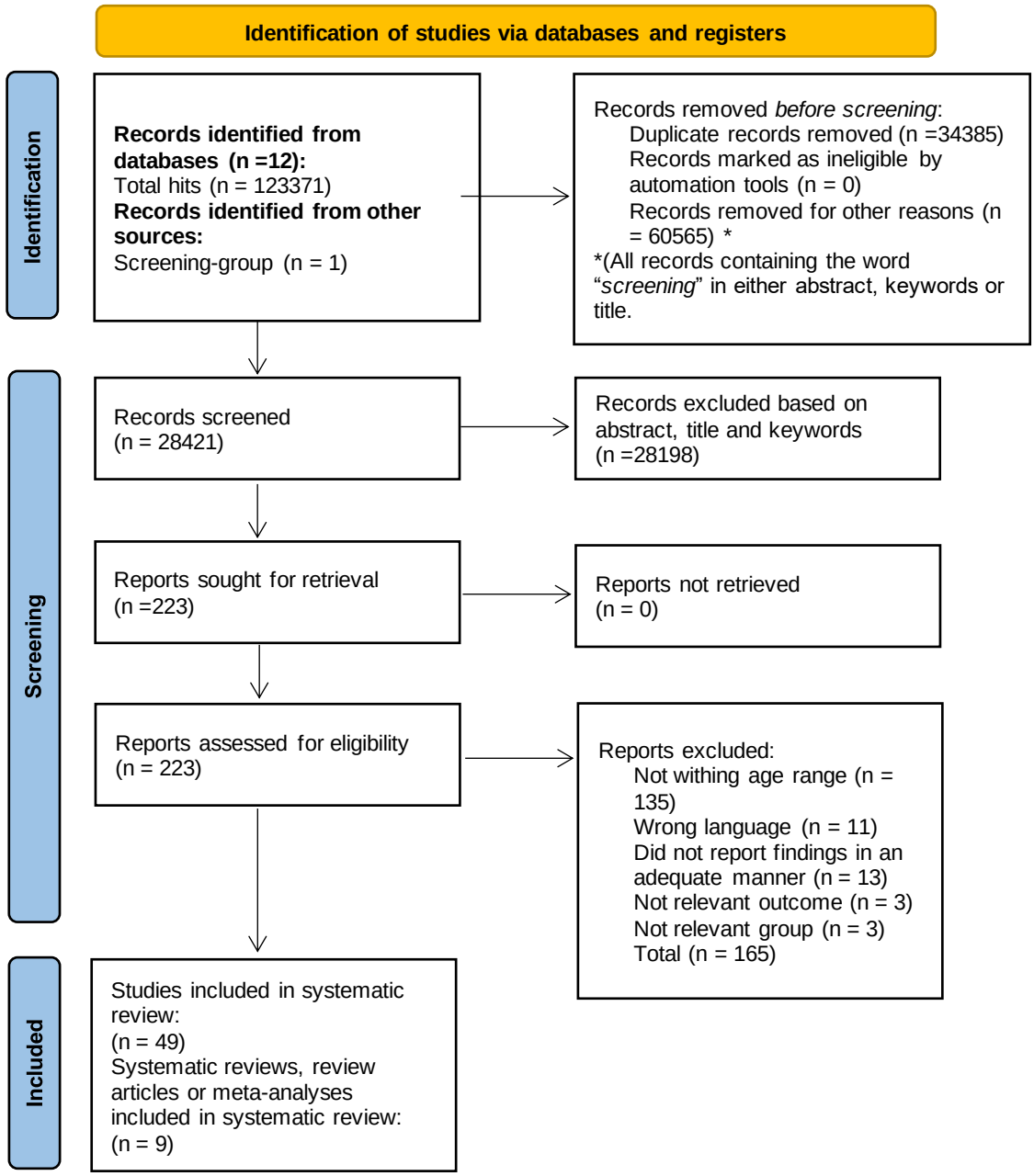
Eligibility criteria were that the studies covered age range six to twelve and investigated the effects of screen time on psychological outcomes. That meant that findings focusing on more biological or medical outcomes such as sleep duration, weight, or physical activity were excluded from further analysis although these outcomes can in theory also be related to psychological processes. Cross-sectional studies, systematic reviews and meta-analyses were all included, and grouped separately from individual studies. It was required that all records were written in English and had a form of new data that could be utilized in a systematic review. That meant that comments or opinion pieces were not analysed as they did not include

new data or new analyses. Lastly, participants in the eligible studies should be classified as the general population, and not limited to specific diagnostic groups or recruited for the study due to a particular condition or diagnosis.

A total of 223 records were classified as relevant after reading titles and abstracts. Of these records, 165 were excluded due to not satisfying the criteria set, out of which 135 did not meet the required age, eleven were in a different language than English, thirteen did not report findings, and six records were studies performed either not on a relevant target group or did not investigate a relevant outcome. The final review included 49 articles reporting primary studies, and nine systematic reviews, review articles and meta-analyses.

Figure 1

PRISMA flow chart (Page et al., 2021)



Results

The final 49 articles and nine meta-analyses that satisfised the eligibility criteria contained both longitudinal and cross-sectional studies (see Table A1). They described a wide range of psychological outcomes, in addition to some neurological and neurodevelopmental outcomes. These studies can be grouped into five categories: studies that focused on behaviour measures as an outcome, studies that used Strengths and Difficulties Questionnaire (SDQ) as an outcome, studies that focused on mental health measures as outcomes, studies that focused on cognitive abilities and skills as an outcome, and studies that focused on academic performance and skills as an outcome. Findings from the individual studies were categorised according to the five outcomes and reported below. After this the results from the nine reviews, systematic reviews, and meta-analyses are reported (see Table A2).

Behaviour measures as an outcome

This group encompasses ten articles that measured behaviour such as aggression, rule breaking, and irritability. Multiple articles measured more than behaviour but have been grouped together due to the common theme of aggression and irritability. Huang and Lu (2022) reported findings suggesting that screen time was associated most strongly with irritability. The researchers measured the effect at two different times; both in 2006 and 2014 they found that this effect was fairly stable. Furthermore, Cerniglia et al. (2021) showed a correlation between screen time at age four and increased amounts of dysregulation and lower scores in both mathematics and literacy at age eight. In the same line, Christakis and Zimmerman (2007) showed a positive relationship between consuming violent TV media at age four, and increased levels of aggression at age nine, but only for boys.

Yeonkyu et al. (2021) also looked at the differences in emotional and behavioural related issues between a screen overuse group and a non-overuse group. In this study, overuse

was defined as two or more hours per day of screen time. The study reported that the overuse group had statistically significant higher amounts of behaviour and emotional issues. In somewhat the same line, in a Finnish population cohort study Mannikko et al. (2020) found a significant positive correlation between excessive screen time and behavioural and emotional problems at age seven and eight, and rule-breaking when they became adolescents. In a longitudinal study by Levelink et al. (2021), on the other hand, no significant relationships between higher amounts of screen time and externalizing behaviour problems or ADHD was found.

The final four articles in this group focused on the relationship between screen time and externalizing behaviour (Chen et al., 2022; Nagata et al., 2023; Paulich et al., 2021; Zhao et al., 2022). All of the four articles utilized data from the Adolescent Brain Cognitive Development (ABCD-study). The ABCD-study measured several important variables, such as social, academic, and behavioural related factors. They also utilize many measures, including functional Magnetic Resonance Imaging (fMRI) to measure functional and structural changes in the developing brain, the project also includes a large number of subjects. Nagata et al. (2023) investigated the effect of screen time on symptoms of Oppositional Defiant Disorder (ODD). They found that adolescents with a higher consumption of screen time than four hours per day had a significant positive association with scores on measures of ODD.

Paulich et al. (2021) found small significant correlations between increased screen time and more behavioural problems, ADHD, worse academic performance, and sleep disturbances. These small effects explain less than two percent of the variance in behavioural problems, ADHD, academic performance, and sleep disturbances, while SES explained a larger part of the variance. Drawing from fMRI studies completed within the larger ABCD-study, Zhao et al. (2022) showed that there is a significant covariation between the areas of the brain activated during screen time and externalizing behavioural psychopathology.

Pointing to a link between these two activities and activation in the brain, one could argue for a possible causal link. Furthermore, Chen et al. (2022) showed a link between brain areas related to screen time and addictive behavioural problems using fMRI. They reported that children and adolescents with a higher consumption of screen time showed increased focus on rewards and lower activation of the inhibitory-control areas of the brain, and that this effect was sustained over a period of two years. This points to a possible link between screen time and lower inhibitory control and shows that this effect could increases over time.

SDQ as an outcome

Eleven of the studies in this review had the SDQ as their main outcome. This questionnaire is widely used in therapeutic situations and to collect information on a bigger scale (Hall et al., 2019) regarding emotional issues, conduct issues, hyperactivity, peer relations, and pro-social behaviour, divided into five different scales. Total score on these scales, with exception of the pro-social scale, define the *total difficulties*-score (Dickey & Blumberg, 2004). The SDQ has been utilized as a good general measure of children and adolescents' situation, however it is not a measure that can be used to set a specific diagnosis (Stone et al. 2010; Goodman et al., 1998; Warnick et al., 2008). The SDQ can be seen as a measure of behaviour, but it includes more than just measures of behaviour, so the studies utilizing the SDQ have been divided into a separate group.

Age of the participants in the studies that used SDQ as a measure was between four to 18, but we will report the findings related to the age range six and twelve. Four out of the eleven studies in this group were longitudinal studies, while the remaining seven were cross-sectional studies.

The number of participants in these studies varies greatly, from 185 participants in the study by Segev et al. (2015) to 11 014 participants in the study by Parkes et al. (2013). In their

longitudinal study, Parkes et al. (2013) analysed data from the UK Millennium cohort study and found a clear association between screen time at age five and scores on the SDQ at age seven. More specifically, three or more hours of screen time per day were associated with 0.13-point increase in the total score on the SDQ. This is in line with the results of a cross-sectional study by Cartanya-Hueso et al. (2022), who found that children and adolescents who consumed more than three hours of screen time had a higher percentage of negative outcomes on the SDQ.

The three remaining longitudinal studies (Allen & Vella, 2015; Nigg et al., 2021; Sanders et al., 2019) show varied results that help to build a clearer picture of the possible effects of screen time. Allen & Vella (2015) used data from the Longitudinal Study of Australian Children (LSAC), to see the possible long-term effects of screen time on SDQ scores. They found several negative effects, namely lower prosocial behaviour scores, higher values for hyperactivity, more peer problems, and more conduct problems. However, socio-economic status (SES) served as a powerful mediator of these effects. This showed that there was an increase in the negative effects of excessive screen time in children that had lower SES, compared to the rest of the sample.

Another longitudinal study by Nigg et al. (2021) showed that these effects were negative but lower than what the prior studies found. They did find some evidence to suggest negative effects of extended screen time on mental health measured by the SDQ, especially for girls. Further on, Sanders et al. (2019) showed that the type of activity in front of a screen can influence the size of the effect. Their results suggest that passive TV-viewing has a larger negative effect, compared to activities that require active participation, such as video games or educational games and tasks students need to solve as part of their homework. Results of Sanders et al. (2019) mainly point to reductions in prosocial behaviour associated with increases in screen time.

Besides Cartanya-Hueso et al. (2022), there are six other cross-sectional studies, and all of these show positive correlations between screen time and total scores on the SDQ. These correlations included higher scores on conduct disorders (Kostyrka-Allchorne et al., 2020; Song et al., 2020), but also decreases in prosocial scores (Limtrakul et al., 2018) as screen time increases. Ahmed et al. (2022) also reported a positive association between consuming one to two hours of screen time and lower scores on emotional regulation. Furthermore, Ahmed et al. (2022) showed an even greater relation between more than six hours of screen time and lower scores on emotional regulation. This shows the possible increase in negative outcomes based on the amount of consumption. In addition to this they included a measure that showed a positive association between screen time and scores on the Children Alexithymia Measure (CAM). Higher scores on the CAM broadens the perspective on what the answers of the SDQ tell us, pointing to the difficulties talking about emotions as a possible background for the scores in the SDQ. In addition, Page et al. (2010) came to a more specific conclusion that more than two hours of screen time per day are related to higher psychological difficulties scores on the SDQ in children aged ten and eleven.

Finally, Segev et al. (2015) looked at a smaller sample than other studies in this group (N= 185) and found positive correlations between computer screen time and SDQ scores. Findings from this study suggest that older children and adolescents consume larger amounts of screen time than younger children, and that they require a higher consumption of screen time for the negative effects to be measurable.

Mental health measures as outcomes

Thirteen articles investigated depression symptoms as an outcome measure. There does not seem to be a clear consensus among the authors of these articles about the mechanisms behind the relationship between screen time and depression symptoms, but they do agree that there is a significant positive relationship between screen time and depressive

symptoms. One of the most prominent and important findings from these studies is a dose-response relationship between screen time and depression in adolescents between ten and twelve years old (Yang et al., 2013). Yang et al. (2013) found a significant positive relationship between screen time and depression scores. The results suggest that more consumption of screen time could be linked to ~~h~~ more depressive symptoms. These results seem robust, supported by analysis of over 10 000 participants.

Four of the thirteen articles looking at depression symptoms or well-being were longitudinal studies. Both Pagani et al. (2019) and McAnally et al. (2019) focused on TV's effect on depression and internalizing disorders. Pagani et al. (2019) found a positive correlation between consumption of bedroom media at age four with depressive symptoms at age twelve. In addition, they showed significant links between bedroom media and BMI, poor diet, aggression, poor sociability, and emotional distress. McAnally et al. (2019) on the other hand, showed that this correlation prevails over longer time. They measured TV-viewing at age five to fifteen and showed a correlation between children and adolescents that consumed higher amount of TV and a diagnosis of depression as an adult.

The remaining two longitudinal studies used datasets from the longitudinal ABCD-study (Roberston et al. 2022; Lin et al. 2020). The ABCD-study measured several important variables, such as social, academic, and behavioural related factors. They also utilized many measures, including fMRI to measure functional and structural changes in the developing brain. Roberston et al. (2022) and Lin et al. (2020) both showed a positive relationship between screen time and depression. Robertson et al. in particular showed that nine-to-ten-year-olds that consumed two or more hours of screen time per day had a higher chance of reporting symptoms of depression.

Three of the seven cross-sectional studies showed positive relationships between screen time and depression: Sun and Zhan (2021), Delgado-Floody et al. (2019), and Li et al.

(2022). Sun and Zhan (2021) showed a relationship between depression and screen time while controlling for gender, BMI, educational level of both parents, age, ethnicity, perceived family affluence, and family composition. Furthermore, Delgado-Floody et al. (2019) reported a positive relationship between screen time and depression. Furthermore, they found a negative correlation between screen time and self-esteem. Finally, Li et al. (2022) showed a positive relation between screen time and both depression and anxiety.

Four of the remaining studies showed mixed results. Werneck et al. (2021) reported a significant relationship between mentally passive sedentary behaviour (TV-viewing, listening to music, and browsing the internet) and depression for adolescents aged eleven to fourteen. Kidokoro et al. (2022) found one of the more contradictory effects, showing a negative relationship between time spent watching TV and depression, while they also reported a positive correlation between PC use (video games and watching videos) and depression. Kandola et al. (2021) looked at the relationship between several different measures of screen time and several different measures of mental health. They found a positive relationship between social media use most days at age eleven and a thirteen percent increased depression scores at age fourteen for girls. Furthermore, time spent playing video games was shown to have a negative relationship with depressive symptoms; subjects that answered that they played video games most days had reduced depression scores by 24.2 percent, at least once a week by 25.1 percent, and at least once a month by 31.2 percent.

The final study in this section, by Nagata et al. (2022) looked at screen time association with nine-and-ten-year-olds developing obsessive compulsive disorder (OCD). Using the data from the ABCD-study, they found that every hour of screen time increased the risk of nine- and ten-year-olds developing OCD two years later. This effect was most prominent when the researchers looked at two types of activities in front of the screen: playing video games and watching videos.

Cognitive measures as an outcome

We have found sixteen studies that used cognitive measures, such as attention. Three of the thirteen articles used ADHD-diagnosis at a later age (Gunuc, 2022; Soares et al., 2022) or the Behaviour Rating Inventory of Executive Functions (BRIEF) questionnaire as a measure of parent-reported difficulties with children's executive functions (Sinvani et al., 2022). Gunuc (2022) reported that infants between the age of zero to 36 months that consumed one hour or more of screen time per day, had a higher score on the Conners Parent Rating Scale (CPRS) at age four to eleven. The CPRS questionnaire was used as a measure of possible ADHD at age four to eleven. The CPRS and questions about screen time were answered by mothers of children aged four to eleven; due to this a level of bias could be expected.

Soares et al. (2022) however, linked screen time at the age of eleven to a diagnosis of ADHD at the age of 22. They also measured screen time at age fifteen and eighteen, but the strongest correlation was between age eleven and 22. Sinvani et al. (2022) showed a correlation between passive consumption of screen time and worse scores on the BRIEF questionnaire for children aged five to seven. Consuming screen time through TV showed the most significant positive associations with worse scores, while playing video games showed no significant correlations. Sinvani et al. (2022) therefore showed a link between passive media consumption and worse executive functions among children. Two previously mentioned studies (Levelink et al., 2021; Paulich et al., 2021) also looked at the relationship between screen time and ADHD, where Levelink et al. (2021) found no significant relationship. Paulich et al. (2021) however, found a small positive correlation between screen time and ADHD.

Other studies in this group looked at other cognitive skills that can be related to attention. Horowitz-Kraus et al. (2021) focused on the differences between eight-to-eleven-

year old's reading abilities and executive functions in relation to the amount of screen time. They measured reading abilities, executive functions, screen time, as well as completing MRI scans of the participants. Authors reported a positive correlation between amount of screen time and increased risk of reading difficulties and worse executive functions scores. Another study that focused on a related topic was by Nichols (2022), who reported a one-point decrease in executive functions scores for both preschool and school children per hour spent playing on their own or sleeping with Background TV (BTV). The amount of BTV refers to time the child spent on their own while some form of screen was on in the same room. This effect remained even after controlling for parents' resources (SES, maternal education, single parent status, racial/ethnic background, and maternal age). Chaarani et al. (2022) used data from the ABCD-study and demonstrated a significant positive relationship between the time adolescents spend playing video games, and their working memory and attention scores, compared to adolescents that had never played video games.

The two other studies in this group showed either lacking or uncertain results of the correlation between screen time and attention. Garcia (2016) focused on many aspects of the differences between natural/green settings compared to screens' effects on attention. The most relevant results for this systematic review were the lack of a confirmation of one of their research questions. Garcia's (2016) hypothesis was that children and adolescents with an increase in screen-experience would score higher on executive function tests. This hypothesis was not substantiated by their study results; they found no significant correlations between being a digital native (higher screen time) and scores on Test of Everyday Attention for Children (TEA-Ch). Finally, Liebherr et al. (2022) did not find a stable and significant effect between screen time and attention.

van Endert (2021) measured delayed discounting, while Suggate and Martzog (2022) reported findings related to mental imagery, and finally, Meri et al. (2022) looked at changes

in brain structures related to learning and cognitive control. van Endert (2021) found that a higher amount of addictive media usage was associated with lower scores on delayed discounting, measured by how long one can wait for a bigger reward, rather than taking a smaller reward immediately. Suggate and Martzog (2022) however looked at screen time's effect on mental imagery, findings from this article suggests a relationship between increased screen time and lower scores on mental imagery tests. Meri et al. (2022) reported findings from a fMRI-study that showed lower functional connectivity in networks relating to attention, learning, and cognitive control. This effect was, however, mediated by adolescents' amount of communication with parents.

Sauce et al. (2022) utilized the data from the longitudinal ABCD-study and looked at screen time's possible effect on intelligence. The study showed a positive relationship between playing video games and intelligence, as well as a small benefit from watching videos. This effect, however, was not present when controlling for parent education and SES. The final study in this group (Cerniglia et al., 2021), showed a significant relationship between screen time at age four and increased dysregulation, measured by Teacher Report Form (TRF), as well as lower academic and mathematics score at age eight.

Academic skills and performance as outcomes

The final group included four studies that looked at measures related to academic skills and performance as outcomes. These articles mainly focused on academic performance: Sharif and Sargent (2006), Zapata-Lamana et al. (2021), and Mundy et al. (2020). Sharif and Sargent (2006) focused on weekday screen time and access to R-rated media (media including nudity, blood, and violent language), and found that more screen time and access was correlated with lower academic performance for adolescents. Furthering this point, Zapata-Lamana et al. (2021) reported lower academic performance for eleven- to thirteen-year-olds who had a higher amount of screen time, including video gaming and computer time. This

effect was reported for both sexes and was shown in most academic fields. Another important point of view was proposed by Mundy et al. (2020) who asked what the cumulative effects of children's consumption of screen time are. They completed a longitudinal study in Australia where they created a model showing that the cumulative risk of two or more hours of screen time per day coincided with a possible four-month delay in academic performance for adolescents. The final study included in this group is Paulich et al. (2021), this previously mentioned study also found a small significant positive correlation between screen time and lower academic scores.

Systematic reviews, review articles and meta-analyses

A total of nine articles met all inclusion criteria for this group, and they analysed the data from over 430 studies and 360 000 subjects. Almost all of these articles have wider age ranges than the original research question of the current systematic review. However, these studies report findings that may still be relevant for the age group of six to twelve, as there is a large number of data collected and of the conclusions at least partly pertain to this age group.

Two of the articles in this group utilize varying methods to ascertain the relationship between screen time and the relevant outcomes: Eirich et al. (2022) and Oswald et al. (2020). The authors of both articles argued that the varying methods could explain in part why the results of many studies are uncertain or do not show significant effects. Furthermore, Oswald et al. (2020) reported findings almost exactly within the parameters of the current systematic review, focusing on five different age groups (young children = <5 years, schoolchildren = 5-11 years, early adolescents = 12-14 years, older adolescents = 15-18 years, and mixed). The authors of this study found a general consensus for the correlation between excessive screen time and worse psychological development, especially compared to time spent in nature (green-time). However, the study by Oswald et al. (2020) still differs from the current study

due to their overwhelming age range and the focus on green-time. The broad goal set forth by these researchers sets their article apart, but this is why a more focused systematic review would be beneficial to the field. Eirich et al. (2022) looked at articles relating to externalizing (behavioural problems, ADHD, aggression) and internalizing (depressive symptoms, anxiety) psychopathology in children between the ages of zero to twelve. They found mainly smaller but still significant positive correlations between screen time and externalizing (aggression and ADHD) and internalizing psychopathology (depression and anxiety). However, the more important point these researchers made was the methodological differences between the studies they have analysed, namely the way studies measure screen time and the choice of participants. Eirich et al. (2022) argue that these differences could explain partly why there is no clear consensus. This article differs from the current systematic review in the way they categorise their outcomes, specifying inclusion criteria to be internalizing and externalizing behaviour and psychopathology. The current systematic review included a broader range of outcomes.

Another two studies focused on several outcomes of screen time, namely physical, cognitive, psychological, and neurobiological. Domingues-Montanari (2017) wrote a review article that summed up the most recent research showing evidence suggesting a positive correlation between screen time and worse physical, cognitive, and mental health outcomes for children. This study differs from the current systematic review with regards to the lack of a systematic search, and unspecified inclusion criteria, that lead to inclusion of only the most recent articles. Findings reported by Domingues-Montanari (2017) also suggest that physical activity is not a strong mediator between these effects. This points to the possibility that enough physical activity would not necessarily weigh up for the negative effects of prolonged screen time. The other article that focused on several factors was Lissak (2018), showing positive correlations between screen time and ADHD-like symptoms, as well as negative

psychological (e.g., depression, increased suicidality, increased media addiction), physical (e.g., worse sleep, increased risk of cardiovascular disease, overweight), and neurobiological outcomes (e.g., addiction related networks). Lissak (2018) also used a case-study to show how children could develop ADHD-like conditions due to excessive screen time.

Hoare et al. (2016) and Liu et al. (2016) both focused on only depression as an outcome of excessive screen time in children and adolescents. Their findings suggest that a consumption of more than two hours of screen time per day at the age of five to eighteen (Liu et al., 2016) and ten to nineteen (Hoare et al., 2016) was associated with negative mental health at those ages. Along the same lines, Liu et al. (2016) argued for a dose-response relationship between screen time and risk of depression. They argue for a non-linear relationship where the least amount of depressive symptoms were shown at one hour of screen time, and from there all increases of screen time was associated with a higher amount of depression.

Two other systematic reviews focused on attention as an outcome of excessive screen time: Silva Santos et al. (2022) and Thorell et al. (2022). Silva Santos et al. (2022) reported that ten out of the eleven studies in their review showed a negative correlation between screen time and attention scores. Along the same lines, Thorell et al. (2022) showed that the relationship between screen time, ADHD, and ADHD-like symptoms can be characterized as reciprocal. In other words, they found evidence suggesting that screen time effects ADHD and ADHD-like symptoms, as well as these factors increasing the likelihood of screen over-use. They looked at children and adolescent with and without the diagnosis of ADHD and found positive correlations between screen time and ADHD-symptoms in both groups. Therefore, they point to screen time having two different effects: increasing the chance of children and adolescents developing ADHD or ADHD-like symptoms, and worsening ADHD symptoms. The final study that the current systematic review included was by Sifri (2023). This article

showed that the relationships between video gaming and several different outcomes are uncertain and still difficult to determine. Sifri (2023) looked at video games effect on the younger population through a biopsychosocial-lens. This review showed several mediating factors that could possibly explain the relationship between video games and outcomes. These range from whether the subject had good peer relationships, level of emotional regulation skills, how games were used (playing alone or with people), and to what extent they played games, whether it bordered on an addiction.

Discussion

The goal of this systematic review was to review the research findings related to the effects of screen time in children, and more specifically, varying effects in children between the ages of six to twelve. Results of the reviewed studies suggest screen time to have several negative effects on children and adolescents. More screen time has been related to increases in depression, OCD, attention issues, and behavioural problems. In addition, more screen time has also been correlated with lower academic performance. Only a small portion of the relevant articles did not show correlations between psychological outcomes and screen time. However, in a minority of the reviewed articles (Sanders et al., 2019; Kandola et al., 2021), video gaming and educational apps have been shown to have a positive or at least not severely negative effect on children and adolescents.

Articles in the current review show some limitations in the field. Two of the mentioned systematic reviews (Eirich et al., 2022; Oswald et al., 2020) point to the methodological inconsistencies within the studies they have analysed. Consumption of screen time is an activity that seems to be difficult to measure without either being inconsistent or invasive. This is partly due to screen time being a very personal and solitary phenomenon, and partly due to the potential bias when answering questionnaires. Review of the literature has shown that screen time in children and adolescents has been measured in two ways: parent-report (Cartanya-Hueso et al., 2022; Kostyrka-Allchorne et al., 2020; Parkes et al., 2013) or self-report (Nigg et al., 2021; Page et al., 2010; Segev et al., 2015). Both of these methods have a potential for bias. There have been no studies that attempted to measure screen time through any other measure than questionnaires.

There are large differences in the types of questionnaires used by the different studies, both for screen time and psychological outcomes. This variance creates a problem in the field regarding how to accurately measure results, as well as how to compare them. Screen time has

referred to different activities such as video games, mobile phones, TV, and computers, and that creates a problem in determining the accurate way of measuring screen time. In addition, the age of the studies could affect what type of, and the amount of screen time subjects were exposed to.

Another important aspect that some of the articles pointed out was how a mediating role of SES. It is possible that SES can explain a larger part of the variance in effects of screen time on the psychological outcomes in children and adolescents (Paulich et al., 2021; Allen & Vella, 2015). Screen time might therefore have a less significant effect than when SES is not taken into account, but more studies on the mediating role of SES are needed to determine this.

Furthermore, there seems to be evidence supporting both the *media goldilocks* hypothesis and the *displacement* hypothesis. The goal of this systematic review was to sum up the research on the field of screen time, but due to the vast differences between the studies, it is difficult to draw any conclusions with regards to these hypotheses. More research is needed to understand the causality of the outcomes presented in this study. To show whether screen time, and in what amount of it, really can be considered the cause.

Role of content and type of screen time

Two main aspects of screen time that have been brought to light in the reviewed studies is content and type. Content refers to what children and adolescents are watching, whereas type is referring to how they are watching it, whether they are passively watching or actively engaging with the content on a computer, phone, or TV. Some studies have shown differences in effects based upon type of screen time (Kidokoro et al., 2022; Sanders et al., 2019). Only one study in our sample was focused on the content. Christakis & Zimmerman,

(2007) reported a correlation between violent screen content and higher aggression scores in children and adolescents.

Some articles (Kidokoro et al., 2022) focused on social media's effect on children and adolescents, and found that increased amounts of time spent on social media are associated with higher depression scores. It is difficult to ascertain from the current sample of studies whether social media is the cause of the increase in screen time. There is plenty of evidence (e.g., Cunningham et al., 2021; Keles et al., 2019; McCrae, 2017) to suggest a link between increased use of social media and increases in depression, anxiety, and other mental health related issues.

Central findings

Most of the systematic reviews and meta-analyses in the current sample used several factors as outcomes. Some focused on more specific measures, like depression or attention issues. However, only one out of the nine reviews included in this systematic review showed no negative effects of increased screen time (Sifri, 2023). This means that eight out of nine studies pointed in the direction that screen time was in some way associated with a negative outcome for children and adolescents. It is also important to point out that Sifri (2023) looked at only video games, which was in line with other studies showing less detrimental effects of playing video games (Brunborg et al., 2013; Pine et al., 2020). This suggests that video games might be qualitatively different than other more passive forms of screen time.

A large amount of the articles presented here show an association between higher amount of screen time and increased depression. Furthermore, two of the articles (Liu et al., 2016; Yang et al., 2013), one cross-sectional and one systematic review, point to a possible dose-response relationship between screen time and depression. They show evidence suggesting that a higher consumption of screen time is associated with higher scores on

depression measures, while a lower consumption of screen time is associated with lower scores on depression measures. This relationship points to a possible causal link between the two, however there is a need for further research to prove such a connection.

Some of the articles in the sample utilized fMRI-data which pointed in two main directions, namely that video games might have a positive effect on response inhibition and working memory (Chaarani et al., 2022), and that brain connectivity is associated with reduced inhibitory control (Chen et al., 2022). Showing that screen time is associated with brain development provides a foundation for looking into the possible causes of the negative outcomes of screen time.

One of the most severe results in this sample comes from Mundy et al. (2020), who point to the cumulative risks of screen time. This is to our knowledge a novel perspective, that sets a powerful precedent. More research should be devoted to exploring the possible cumulative risks of screen time, both for academic performance and other psychological outcomes like depression and attention issues.

Another important point related to all of the psychological outcomes is the difficulty determining whether the outcome is the cause of increased screen time or if the inverse is true. For example, whether parents more often utilize screen time to soothe children who struggle with attention issues, or children may develop such issues from over-exposure (Thorell et al., 2022). This argument can also be made for other psychological outcomes such as depression, ASD, and it shows the importance of further research on direction and causality.

Limitations

The current systematic review has some limitations, one of which relates to the lack of quantifiable evidence. Without a meta-analysis of the effects, it is difficult to quantify evidence and to make conclusions in an unambiguous manner. A systematic review still has

value because it gives a thorough overview of the findings, with all the differences between the studies that should be taken into account. In addition to this the choice of removing all hits that included the word "screening" in title, keywords and abstract, could have removed relevant papers.

Another limitation is the lack of clear definitions regarding screen time in the sample. It creates a methodological problem when only a few of the given studies agree on a definition of screen over-use or excessive use. However, most articles show correlations based on a general increase in screen time, rather than a specific cut-off. It is still problematic that the articles are so different, both in definitions and in how they measure different variables. Large number of different questionnaires and methods to quantify the different variables creates difficulties in comparing the studies.

Another important limitation is the number of correlational studies: 39 out of 49 studies were correlational. This type of study says nothing about causation or direction of the significant correlations. It is, however, important to note that almost all of the evidence in this systematic review point in the same direction, with only two individual studies and one systematic review showing no correlations or not enough evidence. This could be understood either as these outcomes causing children and adolescents to consume more screen time, or that screen time could potentially cause some of these issues. The relationships between the screen time and negative psychological outcomes are strong, but the direction of causality still needs to be further determined. In addition to this, there is a possibility that some third variable causes both the increase in screen time and in the scores on the specific measures of mental health, behaviour, cognitive skills, and academic performance.

Conclusions

Children and adolescents are high consumers of screen time (Rideout & Robb, 2019), and due to their increasing independence when they start primary school, there is a need for clearer guidelines. Parents have a more limited ability to control the time usage of this age group, and this may create a subject of contention between parents and their children and adolescents. With a lack of concrete guidelines founded on rigorous research, parents struggle to make good choices for their children in today's digital age.

This systematic review has shown that there is plenty of research pointing to significant relationships between higher amount of screen time and outcomes such as higher scores in depression, lower academic performance, lower attention, reduced neurological connections, and others. More research is needed, but it is clear from the results of this systematic review that the goal should be to determine causality, as there is little arguments to be made for screen time not being correlated with negative outcomes for children and adolescents in the age group six to twelve.

Statements

Data availability statement

The author of this paper confirms that all necessary data and findings used in this article are available in the paper.

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The author reports no conflict of interest for this project.

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Appendix A

Table of contents for individual studies (table A1) and for systematic reviews and meta-analyses (table A2).

Table A1

Information on cross-sectional and longitudinal articles

Authors	N (age range)	Screen time measure	Outcome measures	Central findings	Design	Country
Ahmed et al. **(2022)**	564 (6 - 14)	Parent reported: internet gaming application.	SDQ, Children Alexithymia Measure (CAM), socioeconomic scale, Children's Sleep Habit Questionnaire Abbreviated (CSHQ-A), Clinical Evaluation of Emotional Regulation-9 (derived from SNAP-IV).	The study used four groups (1 = 1-2 hours per day, 2 = 3-4 hours per day, 3 = 5-6 hours per day, 4 = >6 hours per day). In this sample children and adolescents that spent more than six hours per day on internet gaming application had a higher chance (75% of sample) of having poor sleep quality. In addition, this group had the highest reported CAM score (The Childrens Alexithymia Measure).	Cross-sectional study	Egypt
Allen & Vella **(2015)**	7818 (6 - 12)	Parent reported: TV and video games.	SDQ	Showing associations between screen time and low prosocial behaviour (p=<.05), higher values of hyperactivity (p=<.01), more peer problems (p=<.01) and more conduct problems	Cross-sectional study	Australia

				(p=<.01). SES and parent education level was a powerful covariant. Showing larger effects of screen time on hyperactivity in low SES and low education level groups.		
Anitha et al. **(2021)**	613 (1.5 - 12)	Parent reported: TV, smart phone, computer, video games and other. Other questions of note: nature of co-viewing and parent screen media consumption. In addition, the Problematic Media Use Measure Short Form (PMUM-SF) was used.	SDQ, BEARS questionnaire, Ages and Stages Questionnaire, Child Behaviour Check-List (CBCL)	This study measured screen time and categorized more than two hours per day as excessive. They found 28.1 percent of the sample to score high enough on the Problematic Media Use Measure Short-Form (PMUM-SF) to be considered media addicted. This group mostly consisted of boys, and was positively associated with worse outcomes on the Child Behaviour Checklist (CBCL) and SDQ.	Cross-sectional study	India

Cartanya-Hueso et al. **(2022)**	4073 (4 - 14)	Parent reported: leisure time in front of screen	SDQ	>180 minutes of leisure screen time per day is associated with a higher percentage of emotional and behaviour problems, emotional symptomology, conduct problems, peer problems and prosocial behaviour	Cross-sectional study	Spain
Cerniglia et al. **(2021)**	651 (4 - 8)	Parent reported: children's access to screens (modified StimQ), whether parent was active with the child and screen.	Parent reported: SCL-90 (parent information), CBCL, 422/652 reported over American Academy of Paediatrics' (AAP) recommended amount of screen time per day. Teacher reported: Teacher Report Form (TRF) (From the Achenbach CBCL).	Authors showed that amount of screen time at the age of four was significantly linked to both increased dysregulation and reduced scores on literacy and mathematics at age eight.	Longitudinal study	Italy
Chen et al. **(2022)**	8324 (9 - 11)	Participant reported: TV, videos and video games (weekday and weekend)	Sports and Activities involvement Questionnaire, BIS/BAS-activation (drawn from ABCD-dataset)	This article measured a decrease in the connection between frontoparietal brain and striatum. This is argued to be the same decrease in connection associated with addictive behavioural problems.	Cross-sectional	USA

Christakis & Zimmermann **(2007)**	330 (2 - 9)	Exposure to violent screen media	Behavioural Problem Index (BPI) (Derived from CBCL)	The authors showed a correlation between violent TV at age four and aggressive tendencies at age nine, but only for boys.	Cross-sectional	USA
Chaarani et al. **(2022)**	2217(9 - 10)	Participant reported: Video games on all consoles.	fMRI, Stop Signal Task (SST), n-back task.	Tasks were used to measure inhibitory control (stop signal task) and working memory (N-back task). With two groups, one whom had never played video games (VG), and one that played at least 21 hours per week. The BOLD signal was stronger for the VG-group during the stop signal task, but weaker than the control group during the working memory task.	Cross-sectional study	USA
Garcia **(2016)**	94 (Average 11.2 years)	Participant report: cell phone, computer, TV and video games.	TEA-CH	This study hypothesized a positive relationship between screen time and attention. The hypothesis was not substantiated. Suggesting that there is either no relationship, or the relationship could be negative.	Cross-sectional	USA
Gunuc **(2022)**	2835 (4 - 11)	Parent reported: screen time (while breastfeeding, to quite	Connors Parent Rating Scale-Revised Short (CPRS-RS)	This study gathered information from mothers and their children aged between four and eleven. The results showed that even just one hour of	Longitudinal study	Turkey

				screen time per day for infants aged 0 - 36 months, was linked with ADHD.		
Horowitz-Kraus et al. **(2021)**	57 (8 - 11)	Parent reported: computer, TV and smart devices.	Executive function: Walk-don't walk task, score!, sky search DT (from TEA-CH), Stroop test, fluency test, coding and symbol search, digit span, number and letter naming (Comprehensive Test Of Phonological Processing (CTOPP)). Including BRIEF scores. Reading ability: Elision (CTOPP), Phonetic decoding efficiency (PDE) (from Test of Word Reading Efficiency (TOWRE)), letter-word test (Woodcock Johnson (WJ-III), TOSREC (Test of Silent Reading Efficiency and Comprehension), nontimed reading comprehension (from WJ-III). In addition, fMRI testing was done.	This study measured screen time and executive functions (EF). As well as looking at neuroimaging correlational differences between traditional readers and children with reading difficulties. The study showed that increased screen time was associated with more reading difficulties and lower EF.	Cross-sectional	USA
Huang & Lu **(2022)**	9864 (11 -15)	Participant reported: PC (chatting, browsing, email, homework etc.) (2006). Participant reported: PC,	Health Behaviour in School-aged Children (HSBC) and participant reported regarding communication with parents.	This study focused on the relationship between screen time and three psychological symptoms (irritability, feeling sad and feeling anxious). They measured these	Cross-sectional	Czech Republic

		tablet, smartphones.		factors at two different times (2006 and 2014). The most powerful correlation was between screen time and irritability. This was however mediated by adolescent-parent communication.		
Kandola et al. **(2021)**	11341 (11 - 14)	Participant report: Video games, social media and spare time internet use.	short Moods and Feelings Questionnaire (sMFQ)	Findings suggest that higher amounts of social media consumption at age 11 was associated with higher scores on measures of depression at age 14 by thirteen percent for girls. In addition, video games was shown to have the opposite association with depression. The associations showed that playing video games most days reduced depression scores by 24.2 percent, at least once a week by 25.1 percent and at least once a month by 31.2 percent.	Cross-sectional	UK
Kidokoro et al. **(2022)**	23573 (8 - 15)	Participant report: TV, video, DVD, online videos, social media and online games.	Self-reported physical activity and sleep. Modified depression questionnaire.	A study that focused on different forms of screen time and depression. Found a negative correlation between TV-viewing and depression, but a positive one for online games and social media.	Cross-sectional	Japan

Kostyrka-Allchorne et al. **(2020)**	520 (3 - 11)	Parent reported: TV, listening to music, smartphone use, tablet use, computer use, video gaming and reading on screens. Parent reported: Media multitasking	SDQ	Found a bidirectional correlation between conduct problems and screen time (P=.015). Also, increased media multitasking was associated with increased scores for ADHD-like symptoms scored on the SDQ (P=.026)	Cross-sectional study	UK
Levelink et al. **(2021)**	2768 (0 - 10)	Parent reported: screen time.	Parent reported ADHD diagnosis at age 8 to 10. CBCL (at age 2)	Authors found no significant effects between screen time and externalizing behavioural problems or ADHD.	Longitudinal study	Nether lands
Li et al. **(2022)**	1603 (<11 and >11)	Participant report: Video games.	Depression Anxiety Stress Scale (DASS-21)	Measured screen time and its association with depression and anxiety. Showed an association between hours spent on video games per week and depression scores (P=<0.001), anxiety scores(P=<0.05) and stress scores (P=<0.1).	Cross-sectional	China
Liebherr et al. **(2022)**	77 (6 - 10)	Parent reported: Tv, smart phone, computer, table and gaming console.	Switching attentional Demands (SwAD)	Found no significant interactions between screen time and attention. But the paper suggests a non-linear model where the negative impact of screen time occurs only after a significant amount of hours per day.	Cross-sectional	Swiss

Limttrakul et al. **(2018)**	317 (10 - 15)	Participant reported: TV, video games, tablets, smart phones, and internet (average weekday). Participant reported: multi-media (more than one media at a time (counts as x2 amount of screen time)).	SDQ	Found a correlation between higher average screen time and lower scores in prosocial behaviours.	Cross-Sectional	Thailand
Lin et al. **(2020)**	11875 (9 - 10)	Participant reported: TV, video games, videos, social media, text and video chat (weekday and weekend). In addition, number of R-rated movies and mature video games were measured.	K-SADS-5, BIS/BAS-scale, Parental Monitoring Survey,	Pointing to a relationship between age-inappropriate screen time and worse mental health. Showing an association between both R-rated movies and mature video games, and anger, anhedonia depressive mood, irritability, elevated mood and decreased need for sleep.	Cross-sectional	USA
Mannikko et al. **(2020)**	6479 (7/8 and 15/16)	Participant reported: TV, video games, computer work.	Teacher completed Children's Behaviour Questionnaire (CBQ) (at age 8). Youth Self Report (YRS) (age 16).	This Finnish birth cohort study found that increased scores on behavioural and emotional problems at age seven/eight was together with adolescent rule-breaking, correlated with a higher consumption of screen media over all. Even after controlling for risk factors and sex.	Cross-sectional	Finland

McAnally et al. **(2019)**	1037 (5 - 15 & 18 - 38)	Parent report (ages 5 -11): TV. Participant report (ages 13 - 15): TV	Diagnostic Interview Schedule (DIS), Rutter Child Scale	In this study tv viewing was measured between ages of five to fifteen. And then correlated with internalizing disorders at several ages between 18 and 38. The study showed an increased amount of depressive symptoms for participants that watched an increased amount of tv (P=<0.01).	Longitudinal study	New Zealand
Meri et al. **(2022)**	29 (8 - 12)	Participant reported: Screen-Q questionnaire (Access to screens, frequency, content, parent dialogue)	Behavioural measures: Peabody Picture Vocabulary Test (PPVT-4) and Test of Nonverbal Intelligence (TONI-3). Cognitive control: Processing speed and working memory tasks (from WISC). Attention measure (TEA-CH). BRIEF	In this fMRI study, the researchers found a link between access to screens and the functional connectivity between areas of the brain that are associated with attention, learning and cognitive control. This effect seemed to be mediated by children and adult communication during screen time.	Cross-Sectional	UK
Mundy et al. **(2020)**	1239 (8 - 11)	Parent reported: TV, video, video games and computer.	National Assessment Programme-Literacy and Numeracy (NAPLAN)	Showing that increased screen viewing leads to lower academic performances. Putting the focus on the cumulative risk of screen viewing. Authors states that on average children who view more than 2 hours per day, could be set	Longitudinal study	Australia

				back an average of 4 months.		
Nagata et al. **(2023)**	1875 (9 - 11)	Participant reported: TV, video games (computer, console, smartphone), videos, social media, text and video chat (weekday and weekend)	KSADS-5	Found a correlation between increased screen time and behavioural problems in children. Notably the correlation between more than four hours per day of screen time and oppositional defiant disorder (ODD) was <0.001.	Cross-sectional	USA
Nagata et al. **(2022)**	9208 (9 - 12)	Participant reported: TV, videos, video games, texting, video chat and social media.	KSADS-5	This study found a positive correlation between higher screen time and higher chance of developing OCD. Specifically, per hour of nine- and ten-year-olds watching videos and playing video games were associated with a significantly higher risk of developing OCD two years later.	Longitudinal study	USA
Nichols **(2022)**	1180 (2 - 8)	Parent report: Background TV diary	BASC-2	Authors focused on the effect background TV(BTV) could have on attention, for pre-schoolers and school aged children. One of the clearest findings was a one-point decrease in scores on executive measure tests, per hour spent playing alone with a TV in the background. In addition to this, the study suggests a	Cross-sectional	USA

				negative effect on EF even for children with high resource parents.		
Nigg et al. **(2021)**	686 (5 - 18)	Participant reported: TV and videos	SDQ	Negative correlation between mental health and screen time	Longitudinal study	Germany
Delgado-Floody et al. **(2019)**	605 (11 - 13)	Participant report: Tv and video games	Coppersmith self-esteem inventory	Through questionnaires this study showed relevant associations between screen time and higher levels of depression (P=0.002) and lower self-esteem (p=<0.001).	Cross-sectional	Chile
Pagani et al. **(2019)**	1859 (4 - 12)	Parent report: hours of bedroom TV viewing at age 4.	BMI and dietary habits. Teacher reported emotional distress and sociability. CDI	Focused on bedroom media at age four. Found a positive relationship between screen media in the bedroom at age four and emotional distress (<P=0.001), depression (<P=0.001), aggression (<P=0.001) and lower amounts of sociability (<P=0.001), all found at age 12.	Longitudinal study	Canada
Page et al. **(2010)**	1013 (10 - 11)	Participant reported: Tv and playing on computer, not for homework	SDQ	Children that spent more than two hours a day either watching TV or using a PC had increased risk of higher scores on the SDQ (TV, OR = 1.61) (PC, OR = 1.59). With a higher risk with lack of physical	Cross-sectional study	UK

				activity, according to guidelines.		
Parkes et al. **(2013)**	11014 (5 - 7)	Parent reported: TV, video and DVD	SDQ	Having more than three hours of screen time at age five, was associated with a 0.13-point increase in conduct problems on the SDQ at age seven.	Longitudinal study	UK
Paulich et al. **(2021)**	11727 (9 - 10)	Participant reported: TV, video games, videos, social media, text and video chat (weekday and weekend)	CBCL, parent reported academic performance, parent reported sleep habits, participant reported number of friends and quality of relationships.	Found small relationships between screen time and more behavioural problems, ADHD, worse academic performance and sleep. However, they did find positive associations with peer relationships. These effects are however small and account for less than two percent of the variance.	Cross-sectional	USA
Robertson et al. **(2022)**	11780 (9 - 10)	Participant reported: TV, video games (computer, console, smartphone), videos, social media, text and video chat (weekday and weekend)	K-SADS-5	Showing associations between screen time and depressive symptoms. Higher relative prevalence in boys (3.6% in control vs 5.9% in sample) than girls (2.6% in control vs. 5.9% in sample). In addition, the screen time group had a high relative amount of suicidal ideation and self-harm.	Cross-sectional	USA
Sanders et al. **(2019)**	4013 (10 - 13)	Participant reported: Screen time diary	SDQ, Paediatric Quality of Life inventory (PedsQL). School Age temperament	Researchers found a positive correlation between total screen time and all measured	Longitudinal study	Australia

			Inventory, National Assessment Program - Literacy and Numeracy (NAPLAN).	negative outcomes. More specifically, passive consumption of TV was associated with the most severe negative effects. Consumption of educational screen media was correlated with positive academic related factors. Finally, consumption of interactive screen time was correlated with positive academic related factors, but also poorer outcomes on the SDQ. The researchers point out that all effects are small (<0.07).		
Sauce et al. **(2022)**	9855 (9 - 12)	Not specified	Polygenic scores, Picture Vocabulary Task, Flanker Task, Oral Reading Recognition Task, Rey Auditory Verbal Learning Task and Little Man Task.	Using several measures for intelligence this study showed an association between playing video games and higher scores on the intelligence tests. They also point to social economic status being a large mediating factor.	Cross-sectional study	USA
Segev et al. **(2015)**	185 (3 - 18)	Participants and parent reported: weekday and weekend use, type of screen, parental stance on internet communication, non-computer use and how hard it is to regulate use	SDQ	Showing small correlations between screen time and psychopathology. But found evidence suggesting an age-based model, showing solidification of psychopathology with age.	Cross-sectional	Israel

Sharif & Sargent **(2006)**	4508 (9 - 15)	Participant reported: Weekday TV and Video games, Weekend Tv and Video games. Content: Cable access, parental television content restrictions and R-rated movie restrictions.	Participant report: Grades last year	The authors found significant correlations between academic performance with weekday screen time and with availability of R-rated content. While weekend consumption of screen time did not seem to have significant effect on academic performance.	Cross-Sectional	USA
Sinvani et al. **(2022)**	194 (5 - 7)	Parent report: TV, video, video games, smart devices.	BRIEF	Showed a link between passive screen watching and poorer BRIEF scores, specifically lower global executive composite score (P=0.05). In addition, higher passive screen time showed a significant relationship with lower EF (P=0.004).	Cross-sectional	Israel
Soares et al. **(2022)**	3057 (11 - 18)	Participant report: TV, video games and computer use.	Hyperactivity scale of the SDQ and modified version of the Mini International Neuropsychological Interview.	This study used data from a Brazilian longitudinal study, and looked at the link between screen time and ADHD. The authors showed that screen time at age eleven was linked with ADHD at age 22.	Cross-sectional	Brazil
Song et al. **(2020)**	5959 (9 - 14)	Parent and participant reported: TV, computer, smart phone or	SDQ, Adolescent Self-Rating Life Events Checklist (ASLEC)	Screen time was correlated with higher amounts of emotional symptoms (OR=1.39),	Cross-sectional study	China

		other electronic devices		conduct problems (OR=1.77), hyperactivity problems (OR=1.60), peer problems (OR=1.48) and total issues (OR=3.23). In addition to this, the researchers found that negative life events were also positively associated with emotional and behavioural issues. Furthermore, these effects were greater when accounting for both measures at the same time.		
Suggate & Martzog **(2021)**	109 (4 - 8)	Parent reported: TV, computer, tablet, console, smartphones (passive vs. Active media consumption). Including a media title test (testing what characters the children recognized from popular media)	Mental imagery: Mental comparison task and mental transformation task. Vocabulary: Kaufmanns ABC. Working memory: backwards digit-span.	The study reported a correlation between higher amounts of screen time and lower mental imagery scores over a two-year period.	Longitudinal study	Germany
Sun & Zhan **(2021)**	1331 (7 - 17)	Participant reported: TV, video games and other activities with an electronic device (weekday and weekend)	Children's Depression Inventory (CDI), Health Behaviour School-aged Children (HBSC)-questionnaire	Found higher screen time to be the only factor that showed a significant positive relationship with depression, when accounting for several confounding variables.	Cross-sectional	China
van Endert **(2021)**	75 (10 - 13)	Participant reported:	Monetary Choice Questionnaire and	This article found in a small German	Cross-Sectional	Germany

		Digital Addiction Scale for Children (DASC)	Brief self-control scale.	sample, a link between delayed discounting and addictive use of screen media. However, the relationship was mediated by self-control. In addition to this, scores on self-control and the amount the participants reported using screen media was associated with academic performance.		
Werneck et al. **(2021)**	7124 (11 - 14)	Parent report: hours of tv and homework. Participant report: music, reading, games and internet use (spare time). Divided into active and passive activities.	Mood and Feelings Questionnaire (MFQ)	Findings suggest that mentally passive sedentary behaviour (tv-viewing, listening to music and using the internet) at age 11, increased depression among only girls at age 14. But the effect was mediated by BMI.	Cross-sectional	UK
Yang et al. **(2013)**	10829 (10 -12)	Participant report: TV, online games, offline games, internet communication or chatting and other.	SCL-90	This study shows a dose-response relationship between screen time and mental health. Showing that high amounts of screen time can severely effect children and adolescents mental health.	Cross-sectional	Iceland
Yeonkyu et al. **(2021)**	331 (7 - 10)	Parent reported: TV, PC, tablet, smartphone, gaming console and portable video games.	Korean Child Behaviour Checklist (K-CBCL)	This article separated their sample into two different groups, screen overuse and not-overuse. Screen overuse was defined as two or	Cross-sectional	Korea

				more hours of screen time per day. This group was significantly correlated with higher amounts of behavioural and emotional issues, compared to the not-overuse group.		
Zapata-Lamana et al. **(2021)**	733 (11 - 13)	Participant reported: TV, video games, tablet, computer, cell phone.	Grade point average (GPA), Daily Stress Inventory (DSI)	Authors reported that increased screen time, both playing video games and using the internet, was associated with lower academic performance in most areas.	Cross-Sectional	Chile
Zhao et al. **(2022)**	9738 (9 - 11)	Participant reported: TV, videos, video games, texting, video chat and social media.	MRI data, Sleep Disturbance Scale for Children (SDSC), CBCL, NIH Toolbox Cognitive Battery (NIHTB-CB)	Showing a link between screen time and externalizing psychopathology. This is shown through a covariation in the structures of the brain associated with screen time and externalizing psychopathology.	Cross-sectional	USA

Table A2

Description of all review, systematic review and meta-analyses articles

Authors	Year of publication	Description of article
Domingues-Montanari	2017	The author concluded with three main points regarding the results from this review article. They pointed out that excessive consumption of TV related screen time, had a negative impact on diet, strength, coordination and increased the chance of being overweight. Further, the researchers found evidence suggesting worse cognitive and emotional development for children. In addition to this, they found associations between screen time and worse mental health for adolescents. Finally, they pointed to research showing that physical activity does not make up for the negative effects of screen time.

Eirich et al.	2022	This article looked at studies related to screen time's effect on children's behaviour, both internalizing and externalizing. The researchers reported minor, but significant effects, suggesting a positive relationship between screen time and increased behavioural issues. The authors also pointed to the inconsistent methodological choices made in the different studies.
Hoare et al.	2016	This study examined the effect of screen time on adolescent's mental health. The authors concluded that there is a substantial amount of research pointing towards a positive correlation between screen time and worse mental health for adolescents.
Lissak et al.	2018	Authors of this article combined a systematic review with a case-study, this was to exemplify their main point in the article. It seems possible that children and adolescents exposed to excessive screen time at a young age could develop ADHD-like symptoms. The authors found several effects; physical (worse sleep, increased risk for cardiovascular diseases, overweight, higher blood pressure ...), psychological (depression, increased suicidality, media addiction, ADHD-like symptoms, activation of the reward-network in the brain (associated with antisocial behaviour)) and neurological (addictive pathways and media addiction (associated with less mental and behaviour control)).
Liu et al.	2016	These authors found a correlation between higher screen time and higher risk of depression. The most important aspect of this meta-analysis is the dose-response perspective. Authors also reported findings that suggest a non-linear relationship between screen time and depression. Suggesting a curvilinear dose-response relationship.
Oswald et al.	2020	Researchers used a large sample of over one hundred studies, and found a large disparity in the methodological choices of the studies. Furthermore, the studies point in the direction that excess screen time is associated with worse psychological outcomes for children and adolescents' development.
Sifri et al.	2023	Looking at the effect of video gaming on children and adolescents. Reported results seem to go in very different directions, there does not seem to be any clear consensus regarding the effects of video games. However, the authors of this systematic review argue for the importance of research, as this modern technology has become a necessity for modern life.
Silva Santos et al.	2022	The authors of this paper reported findings that 10/11 of the relevant articles, showed a positive relationship between screen time and attention issues for children and adolescents.
Thorell et al.	2022	This systematic review looked at the longitudinal and reciprocal effects between screen time and ADHD. They found significant support for a reciprocal relationship, showing that excess screen time both increased the likelihood of developing ADHD, and could worsen pre-existing symptoms. In addition to this, they found studies that reported children and adolescents with ADHD were more likely to develop an addictive media consumption pattern.

Appendix B

Formatting guidelines for Journal of Adolescence.

Journal of adolescence (n.d.) *Author Guidelines.* Retrieved May 14, 2023, from https://onlinelibrary.wiley.com/page/journal/10959254/homepage/author-guidelines

Author Guidelines

The *Journal of Adolescence* is an international, broad based, cross-disciplinary journal that addresses issues of professional and academic importance concerning development between puberty and the attainment of adult status within society. Our focus is specifically on adolescent *development:* change over time or negotiating age specific issues and life transitions. The aim of the journal is to encourage research and foster good practice through publishing empirical studies, integrative reviews and theoretical and methodological advances. The *Journal of Adolescence* is essential reading for adolescent researchers, social workers, psychiatrists, psychologists, and youth workers in practice, and for university and college faculty in the fields of psychology, sociology, education, criminal justice, and social work.

Research Areas Encompassed:

- Adolescent development with particular emphasis on social, cognitive, and emotional functioning
- Resilience, positive development, and effective coping within the context of adolescent development
- Disturbances and disorders of adolescence, approached from a developmental perspective
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JoA actively seeks papers that are strongly grounded in theory and have a clear developmental focus. We are particularly interested in research focusing on less studied populations or that examine contextual variation in developmental processes. In addition to empirical research articles, JoA also publishes systematic Review Articles and papers that focus on areas of methodological import.

The Journal publishes quantitative, qualitative, and mixed method research and welcomes systematic review articles and papers providing reviews or practical guidance on important or novel topics relevant to developmental methodology. We do not publish papers whose primary purpose is the validation of established measures in new cultural contexts. If required, additional words may be permitted to report such validations within a standard empirical research article.

1. Submission and Peer Review Process

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Journal of Adolescence follows APA form for final publications (see format exceptions below). However, we will accept **Free Format submission** for a simplified and streamlined submission process.

Before you submit, you will need:

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ii. A short running title of less than 40 characters;
iii. The full names of the authors;
iv. The author's institutional affiliations where the work was conducted, with a footnote for the author's present address if different from where the work was conducted;
v. Complete postal and email address for the corresponding author;
vi. Acknowledgments.
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  - Results: Results should reflect the problem statement in the Introduction, use the same names for constructs used in the Methods section, accurately describe the analytic techniques used, and refer to clearly tabled results and/or figures. Please table descriptions of complex multivariable analyses rather than reporting them in the text. Per APA guidelines, effect sizes should be reported whenever possible.
  - Discussion and Conclusion: Discussion of the results should clearly reflect back on the literature cited in the introduction, draw a clear conclusion, and suggest future areas of research. Limitations of the current work should be clearly and succinctly described.

- References;
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