Are screens to blame? Children's digital media use and emotional problems during the COVID-19 pandemic.

by

Jasmine (Yuxin) Zhang

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

This study examined the relationship between digital media ("screen use") and mental health in children during the COVID-19 pandemic. A multinational sample of caregivers (n = 549) provided bi-monthly reports on their families and two children aged 5–18 (n = 1098) between May and November 2020. Measures included children's screen time, mental health symptoms (depression, anxiety, anger), and lifestyle factors, as well as family-wide COVID-19 disruptions and parental screen time. A longitudinal, multilevel sibling comparison design was employed to disentangle child-specific versus family-wide associations, in addition to the direction of effects. Specifically, associations were assessed via multilevel cross-lagged panel models, in which siblings (Level 1) were nested within families (Level 2). Three-level growth curve models were also fit to examine child-specific and family-wide predictors of children's screen time. The directional associations between mental health symptoms and screen time were inconsistent within families. Between families, sibling pairs with higher depressive and anxiety symptoms in July showed more screen use two months later. Additionally, higher screen time in July predicted more anxiety in September. Growth models revealed that mental health challenges had little predictive effect on screen time in the context of other lifestyle factors, but parental screen use was a salient predictor. These results collectively demonstrate that family-wide contextual effects cast important influences on screen use, emotional well-being, and their associations. Moreover, the findings emphasize the need for a whole-family approach to studying and managing children's screen use.

Keywords: screen time, digital media use, emotional difficulties, sibling comparison, multilevel model

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"When you are a Bear of Very Little Brain, and you Think of Things, you find sometimes that a Thing which seemed very Thingish inside you is quite different when it gets out into the open and has other people looking at it."

— A.A. Milne, *The House at Pooh Corner* (1982)

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Literature Review

Introduction

In recent decades, rapid technological advancements have facilitated the seamless integration of digital media into nearly every aspect of modern life. More and more generations are being dubbed digital natives—those who grow up immersed in a media-saturated environment and are highly literate in and engaged with technology (Prensky, 2001). Consequently, children and youth are spending more time on screen-based devices (e.g., smartphones, computers, tablets, televisions [TVs]) earlier in life. While this provides a myriad of enriching experiences, alarming estimates of screen time reaching 9 hours per day have generated much concern regarding the impacts of digital media on children's well-being (American Academy of Child and Adolescent Psychiatry, 2020b). The risks of excessive screen time are well-documented in some domains, including (but not limited to) poor-quality sleep (Carter et al., 2016), lower academic performance (Adelantado-Renau et al., 2019), and worsened physical health (Hoare et al., 2016; Lizandra et al., 2019). However, conflicting results regarding the associations between screen use and socioemotional outcomes persist as one of the most controversial topics in developmental psychology.

Some researchers argue that high amounts of screen time have undeniable harmful effects on children's psychological well-being, citing associations with concurrent increases in mental health difficulties to support this claim (Twenge et al., 2019). An opposing camp of scholars rebukes this perspective with evidence suggesting that the impacts of high screen time on children's mental health are inconsequential (Orben & Przybylski, 2019a; Vuorre et al., 2021). Unfortunately, empirical efforts to reconcile the ongoing screen time debate have been largely unsuccessful as most studies are affected by two important methodological shortcomings. First,

an overreliance on cross-sectional studies has made it difficult to distinguish cause from effect (Blum-Ross & Livingstone, 2018; Kaye et al., 2020; Odgers & Jensen, 2020). Moreover, cohort-based designs that only consider one child per family do not aptly situate findings within the family environment, an essential developmental context that influences both screen time and mental health (Barr, 2019; Browne et al., 2020; Jennings, 2017). As parents and caregivers face growing difficulties with managing children's screen time (Hammons et al., 2021; Wartella et al., 2014), there is a strong need to obtain high-quality evidence that clarifies the role of screens in the developmental landscape and informs stronger media use guidelines. Should longitudinal, family-based evidence reveal negligible consequences, guidelines must move beyond screen time and better account for other dimensions of media use (e.g., content types). In contrast, findings in support of a place for screen time would allow policymakers to create more robust time-based recommendations for parents and clinicians.

Recent global events—namely, the onset of the COVID-19 pandemic—have further complicated the relations between screen time and emotional well-being. In March 2020, governments around the world imposed sweeping public health measures to slow the spread of the SARS-CoV-2 virus. Although lockdowns and physical distancing measures effectively reduced disease transmission (Ayouni et al., 2021), they drastically altered the developmental landscape by limiting children's social, educational, and recreational activities to virtual modalities. At the same time, children's mental well-being declined sharply (Gadermann et al., 2021; Marchi et al., 2021; Racine et al., 2021). Many point to screens as the culprit of increased mental health challenges in children and youth during the pandemic (Kiss et al., 2022; Rosen et al., 2021; Sultana et al., 2021). However, such claims remain largely theoretical as they draw from a narrow set of research findings with several methodological limitations.

Achieving a stronger understanding of the relations between mental well-being and digital media use continues to be a research priority, especially as screen time estimates in children have remained high despite the loosening of COVID-19 restrictions (Bickham et al., 2021). Thus, this review aims to address the current state of the literature on screen time and psychological outcomes in children and youth by (1) providing an overview of the theories that posit links between mental health and screen use, (2) examining the screen time literature that emerged during the COVID-19 pandemic, and (3) identifying the most prevalent methodological issues that may underly discrepant results. This knowledge will inform theoretical and statistical suggestions for future research.

A Brief History of Children and Screens

Rates of screen-based device ownership burgeoned at the turn of the millennium, and devices became commonplace in the family home (Shields & Behrman, 2000). By 1999, the average American child was surrounded by TVs, video game consoles, and computers (Rideout et al., 1999). Device ownership among United States households with children aged 2–17 rose from 48% to 70% between 1996 to 2000, and the proportion of homes with Internet connections grew from 15% to 52% (Woodard & Gridina, 2000). Novel handheld devices such as smartphones and tablets began to proliferate shortly after (Rideout, 2013). Hence, it is no surprise that device ownership is now nearing market saturation for some groups (Anderson, 2015). Recent estimates from the Common Sense Census, a series of ongoing representative surveys of media use in youth from the United States, suggest that an overwhelming majority of young people have access to a smartphone (94–97%), a TV set (87–96%) or a computer (87%; Rideout, 2013; Rideout et al., 2022; Rideout & Robb, 2019, 2020) at home. Many children and adolescents also have their own devices (Lenhart, 2015; Rideout et al., 2022; Rideout & Robb,

2019, 2020). As a result, those who grow up in a technology-saturated world—often referred to as digital natives (Prensky, 2001), iGens (Twenge, 2017), or Digitods (Holloway et al., 2015)—are spending more time on screens than ever before.

As avid media consumers, school-aged children and youth can effortlessly navigate nearly any device to meet their social, educational, and entertainment needs. Their technological prowess develops from having much practice and experience on devices starting at an early age. Screen exposure begins very early in life in North America; in the early 2000s, approximately three in four U.S. infants watched TV on a typical day (Rideout et al., 2003), and preschool-aged children under the age of 6 generally spent 2 hours on screen media daily (Rideout et al., 2006). These estimates have increased in recent decades (Barr & Linebarger, 2017; Duch et al., 2013). Daily media use also increases notably throughout childhood (4–6 hours) and averages 7–9 hours per day for adolescents in the United States (American Academy of Child and Adolescent Psychiatry, 2020b; Rideout & Robb, 2019). As such, rising amounts of screen use are notable not only at generational levels but also in individuals across the lifespan.

New Technologies, New Concerns

The constant addition of new technologies into children's lives elicits both optimism and apprehension, although the latter is generally more prevalent. Early concerns focused on the effects of violent TV content on youth's conduct and behavioural problems (Christakis & Zimmerman, 2007; Committee on Public Education, 2001; M. Singer et al., 1998). Some of these worries were abated by the emergence of more educational and prosocial programming (Coates & Pusser, 1975; Fisch et al., 1999). However, concerns recently shifted to the potential negative impacts of seemingly constant screen-viewing behaviours on well-being. In line with this perspective, early studies noted links between TV watching time and mental health challenges

(Hamer et al., 2016; Licence, 2004; Tomopoulos et al., 2007). More recent systematic and narrative reviews have produced similar results (Carson et al., 2016; Lissak, 2018; Suchert et al., 2015; X. Wang et al., 2019), warranting more thorough examinations of how screen exposure may place children at risk of mental health challenges.

Theories of Screen Time and Psychological Well-Being

Early Perspectives: The Displacement Hypothesis

As TV sets gained popularity in the mid-20th century, parents and clinicians became increasingly concerned about the impacts of sedentary screen viewing on child development (Buss et al., 1980). One theory of the effects of screen time became particularly widespread—the Displacement Hypothesis. At its core, Displacement Theory posits that TV viewing casts indirect, proportional harm on children's well-being by way of supplanting activities that are beneficial to development (Neuman, 1988). In support of this notion, multiple forms of media consumption (e.g., video viewing, computer gaming) have been associated with indicators of poorer physical health, such as higher body mass index and greater obesity risk (Lizandra et al., 2019; Mannell et al., 2005; Viner & Cole, 2005). Other work has illustrated that media displacement impacts sleep quantity and quality (Cain & Gradisar, 2010; Nuutinen et al., 2013). As such, some researchers have conceptualized high screen time as a sedentary behaviour that is intrinsically linked to physical inactivity and short sleep duration (Faulkner et al., 2020; Tremblay et al., 2016). This collection of "movement behaviours" holds important consequences for mental well-being (Hoare et al., 2016; Suchert et al., 2015). Studies adopting a person-centred approach (e.g., latent profile analysis) demonstrate that children who engage in combined higher physical activity and lower screen use generally exhibit more positive well-being (Brown, Cairney, et al., 2021; Brown, Kwan, et al., 2021). Moreover, adhering to the full

set of Canadian 24-Hour Movement Behaviour Guidelines for children and youth—at least 1 hour per day of physical activity, between 9–11 hours of uninterrupted sleep every night, and limiting recreational screen use to 2 hours per day (Tremblay et al., 2016)—is associated with lower psychological distress and higher flourishing (Faulkner et al., 2020; Weatherson et al., 2020). These findings collectively illustrate the role of screen time as a sedentary behaviour that negatively impacts well-being by displacing health-promoting activities.

Importantly, meeting the screen time guideline alone is also related to positive outcomes (Faulkner et al., 2020; Weatherson et al., 2020). In line with this, Page et al. (2010) reported positive associations between higher psychological difficulties and media use (i.e., TV viewing and computer use) in preadolescent children after adjusting for physical activity and overall sedentary time. Such findings suggest the likely presence of additional displacement effects that link screen viewing and mental health challenges. As proposed by Twenge, Joiner, Martin et al. (2018), screen use may operate through a "relatively straightforward dislocation in which digital media displaces time once spent on face-to-face social interaction" (p. 1). Reduced time for essential in-person socialization with family members and peers may dispose children to a host of negative psychosocial outcomes (Sigman, 2012; Vandewater et al., 2006). A large-scale examination of media use and loneliness in four generations of U.S. adolescents (N = 8.2 million) exemplifies this process (Twenge et al., 2019). The authors found support for media-related time displacement at the cohort level; iGen'ers—the first generation to enter adolescence immersed in technology—engaged in less face-to-face social interaction and more digital media use compared to earlier generations. iGen'ers also reported cohort-level increases in loneliness from 2010 to 2017 (Twenge et al., 2019). Notably, associations were more nuanced at the individual level. Positive correlations between in-person interactions and social media use

suggested the presence of complementarity; yet, youth who engaged in a combination of less in-person socializing and more social media use reported the highest levels of loneliness (Twenge et al., 2019). Taken together, these findings appear to support a broadly negative effect of media use on psychological well-being via displacement mechanisms.

Curvilinear Relations Between Screen Time and Mental Health

The extent to which the displacement effect fully accounts for the relations between screen use and mental health is a topic of ongoing debate. Mutz and colleagues (1993) were among the first to suggest a non-linear association. In examining data across an 8-year period that spanned the introduction of TV to South Africa, the authors reported an asymmetrical displacement effect: although TV viewing did displace some leisure activities, reductions in the former did not result in fully proportional increases in the latter. Hence, whether harmful displacement occurs depends on the activity that the child would otherwise be doing. As Mutz et al. (1993) describe, "to the extent that the displaced activity is unimportant, the effect will be relatively benign" (p. 13). Screen-viewing may therefore negatively impact children when it substitutes developmentally enriching activities (e.g., homework, sports, and hobbies), whereas replacing time fillers such as daydreaming or idling is unlikely to result in detrimental outcomes (Mutz et al., 1993). Moreover, there is growing recognition that some media content can provide children with access to experiences that promote well-being (Granic et al., 2020; Scott et al., 2017). This has prompted alternative and perhaps more flexible theories that aim to capture the potential of screens to confer both risks and benefits in relation to mental well-being.

The Exposure-Response Curve Hypothesis. Modelled after research describing the effects of common substances (e.g., alcohol and marijuana), the Exposure-Response Curve Hypothesis suggests that beyond a certain threshold, higher amounts of recreational or total

screen time have progressively more negative impacts on mental health (Twenge & Campbell, 2019). In this way, well-being would peak at low levels of screen time, then worsen progressively as use becomes moderate or heavy; the inflection point representing shifts from positive to negative well-being typically emerges around 1 hour of daily use in younger children and may fall closer to 2 hours in adolescents (McAllister et al., 2021; Roberston et al., 2022; Twenge, Joiner, Rogers, et al., 2018; Twenge, Martin, et al., 2018; Twenge & Campbell, 2018, 2019). This pattern has emerged in studies that focus exclusively on recreational screen use (e.g., social media use, internet browsing, video gaming, and TV or video viewing), as well as in those that report on composite measures encompassing all forms of social, academic, and recreational use.

Twenge & Campbell (2018) reported that in children and youth aged 2–17, heavy screen users (5+ hours per day of total use) showed considerably poorer psychological well-being compared to low screen users (1 hour per day of total use) across a wide range of indicators, including (but not limited to) lower self-control, higher distractibility, and more difficulty making friends. Similar patterns have emerged between adolescents' screen use and depressive symptoms, with associations being particularly prevalent in girls (McAllister et al., 2021; Twenge & Campbell, 2019). From a criteria-based standpoint, Roberston and colleagues (2022) found that after adjusting for demographic characteristics, preadolescent youth in the United States were twice as likely to meet criteria for depressive disorders when their daily total screen time surpassed 2 hours per day. Participants who reported spending over 2 hours on recreational media activities (i.e., social media, gaming, texting, and watching online videos) were also more likely to meet criteria for anxiety disorders in this study (Roberston et al., 2022). Furthermore, findings that suggest links between media use and suicide-related outcomes are particularly

alarming. Drawing from two nationally representative datasets of adolescents from the United States, Twenge, Joiner, et al. (2018) demonstrated that 5-year increases in adolescents' suicide-related outcomes were correlated with more time spent on social media and electronic devices, as well as less time dedicated to non-digital activities. In line with this, Roberston et al. (2022) also found that preadolescents reported engaging in more self-harm behaviours and suicidal ideation or attempts when they exhibited more than 2 hours of recreational daily media use.

Initial Screen Time Guidelines: More Weaknesses than Strengths. Taken together, these findings seem to suggest that 2 hours of daily screen time marks the point at which use begins to cast harmful effects on well-being. This formed the foundation for the American Academy of Pediatrics' (AAP) screen time guidelines. First formulated in 1999, the AAP's recommendations urged parents to prevent screen exposure in infants under the age of 2, and restrict use to 2 hours per day for children aged 2–5 (Committee on Public Education, 1999). This became widely known as the "2x2 rule" (Blum-Ross & Livingstone, 2018).

On the surface, 2-hour screen time limits appear to provide a simple and evidence-based method for parents to manage their children's screen time. However, in-depth examinations of data supporting the 2x2 rule have resulted in significant skepticism regarding its validity. The most frequent criticism of this work surrounds the application of regression techniques to large-scale, cross-sectional datasets to assess the links between media use and mental health challenges (Blum-Ross & Livingstone, 2016; Odgers & Jensen, 2020; Orben & Przybylski, 2019a; Twenge, Joiner, Rogers, et al., 2018). One-time measures of outcomes do not permit researchers to delineate the directionality of associations, and therefore preclude conclusions regarding causality. Notwithstanding, correlational studies often allude to causal effects when interpreting their findings. Other critiques center around the interpretation of effect sizes; studies that include

a large number of variables across hundreds of thousands of participants may inflate the significance of small effects, particularly in the context of regression techniques that rely on thresholds of $p < .05$ (Orben & Przybylski, 2019a). For instance, Twenge, Joiner, Rogers et al.'s (2018) landmark study found that screen time accounted for less than 1% of the variation in depressive symptoms. This would suggest that other factors likely underly differences in mental health challenges, yet, the authors assert that "new media screen time should be understood as an important modern risk factor for depression and suicide" (Twenge, Joiner, Rogers, et al., 2018, p. 13). As Odgers and Jensen (2020) explain, small effects surrounding screen use may hold important clinical implications but can only be substantiated when "causally estimated and there is compelling evidence of directionality and impacts" (p. 342). Given that these requirements cannot be met when relying on cross-sectional data, conclusions regarding the harmful effects of 2 hours of use may be premature or unwarranted.

The Goldilocks Hypothesis: A "Just Right" Amount of Screen Time. In an attempt to overcome the methodological limitations of correlational studies, research efforts have recently shifted to more statistically rigorous examinations of screen time and mental health. Findings from this body of literature generally diverge from the 2x2 rule and demonstrate little to no psychological harm in relation to moderate or even high amounts of screen use (Orben & Przybylski, 2019a, 2019b; Przybylski et al., 2020; Przybylski & Weinstein, 2017; Vuorre et al., 2021). In examining early studies of associations between screen time and depressive symptoms, Liu et al. (2016) performed a meta-analysis to synthesize results across 16 studies (total N = 127,714 children and adolescents). Interestingly, compared to a reference group who did not engage in any screen use, youth with under 2 hours of screen use per day showed lower risk of depression. Those with 2 hours per day of use had a similar risk of depression as the reference

group, and risk began to increase beyond 2 hours of daily use (Liu et al., 2016). These findings indicate the presence of nuances in the psychological correlates of screen time.

Przybylski and Weinstein (2017) propose a classic quadratic curve to capture the relations between screen exposure and mental health. This forms the Goldilocks Hypothesis, which proposes that there are equal harms associated with too little or too much media use; the former may result in missing out on social opportunities, while the latter may displace social activity (Przybylski & Weinstein, 2017). Following the well-known Goldilocks fable, well-being peaks when the amount of screen time is "just right". The inflection point designating the amount at which screen time's effects shift from positive or benign to negative would therefore fall beyond 1–2 hours.

In line with the Goldilocks Hypothesis, several rigorous large-scale studies illustrate a lack of robust associations between moderate amounts of screen use and poorer psychological well-being (Orben & Przybylski, 2019a, 2019b; Przybylski et al., 2020; Przybylski & Weinstein, 2017). Results from specification curve analyses suggest that screen time accounts for merely 0.4% of the variance in adolescents' psychological well-being outcomes—an effect that Orben and Przybylski (2019a) deem "too small to warrant policy change" (p. 173). This statement is particularly striking when contrasted with other studies that have applied alternative analytical techniques to the same datasets and reported that more than 2 hours of daily screen use is consistently associated with poorer mental well-being across child and adolescent samples (McAllister et al., 2021; Twenge et al., 2019; Twenge, Martin, et al., 2018; Twenge & Campbell, 2018; Twenge & Farley, 2021). Additionally, screen time at both extremes of the quadratic curve (i.e., media abstinence and excessive use) are associated with negative mental health outcomes, albeit weakly. Ferguson (2017) reported that adolescents who were high screen users (over 6

hours per day) showed only slightly worse outcomes in relation to delinquency, academic achievement, and depression compared to low screen users. The effect sizes of screen time were extremely small and accounted for less than 1% of the variance in negative outcomes. Taken together, these findings ultimately suggest that over 2 hours of screen time may not be as harmful as proposed by the Displacement or Exposure-Response Hypotheses.

Bidirectional Associations Between Screen Time and Mental Well-Being

While the various theories that link screen use and mental health outcomes have received notable empirical support, it is important to acknowledge that they predominantly rely on cross-sectional research findings. Lacking information on the direction of effects over time undermines the validity of the claim that screens are causally responsible for psychological distress (Blum-Ross & Livingstone, 2016). Furthermore, cross-sectional studies cannot account for the potential of bidirectional associations (Neville et al., 2021). These limitations must be addressed by studies that include multiple assessments of screen use and mental health over time.

Interestingly, the findings of longitudinal studies depict a much more inconsistent evidence base compared to cross-sectional data. Wang and colleagues (2020) examined media use and self-harm behaviours in a cohort of adolescents over one year. The authors reported predictive effects of excessive internet and mobile phone use (≥ 2 hours per day on weekdays, ≥ 3 hours per day on weekends) on self-harm behaviours. Boers et al. (2020) also noted that more social media use, TV viewing, and computer use predicted anxiety over the course of 4 years. In contrast, an 8-year study that followed adolescents' social media use and mental health symptoms (i.e., depression and anxiety) found no significant predictive effects (Coyne et al., 2020).

Other longitudinal studies suggest the presence of bidirectional associations. Recently, S. Tang and colleagues (2021) conducted a systematic review to examine longitudinal studies of screen time and internalizing symptoms (e.g., depression, anxiety, low self-esteem) in young people. In contrast with cross-sectional studies claiming large effects, the authors found only "small to very small" (p. 12) positive relations between screen time and internalizing symptoms. Effects were clearest for depressive symptoms; in this association, screen time was more likely to predict subsequent depression than vice-versa (S. Tang et al., 2021). Accordingly, Neville et al. (2021) utilized random-intercept cross-lagged panel models to demonstrate that preschoolers' externalizing and internalizing behaviours at age 3 predicted increased screen time 2 years later. Higher screen use at ages 3 and 5 predicted later internalizing difficulties at ages 5 and 7, respectively. Interestingly, more screen time at age 7 was associated with fewer internalizing behaviours at age 9 (Neville et al., 2021). Moreover, Zink et al. (2020) reported some reciprocal associations between certain dimensions of depression and the use of computers and video games in adolescents, with differential associations by sex. However, directional associations did not emerge for TV viewing. These findings collectively suggest that the links between screen time and mental health are non-uniform in nature. Variations exist across child characteristics, specific forms of media use, and different aspects of mental well-being.

The inconsistent findings across longitudinal studies highlight a lack of stability in the associations between screen use and mental health. Achieving a clear understanding of the strength and direction of effects continues to be an important area of inquiry, particularly given that cross-sectional studies far outnumber longitudinal ones (Odgers & Jensen, 2020). From a policy standpoint, discrepant empirical findings from robust longitudinal work hold important implications for the validity and utility of the AAP's 2x2 screen time recommendations.

Mismatches Between Empirical Data and Screen Time Guidelines

There have been recent calls for updated media guidelines that can better account for literature illustrating that screen time may not be as harmful as once thought (Ashton & Beattie, 2019; Blum-Ross & Livingstone, 2018). This is a particularly pressing issue in the context of globalized shifts toward digitization, which have made it increasingly difficult for children and adolescents to lead screen-free lives. Following an extensive updated evidence review in 2016, the AAP concluded that "the effects of media use…are multifactorial and depend on the type of media, the type of use, the amount and extent of use, and the characteristics of the individual child or adolescent using the media" (Chassiakos et al., 2016, p. e13). Yet, the organization's subsequent revisions to guidelines did not fully capture this perspective. Despite a greater emphasis on parental involvement in screen use (e.g., co-viewing high-quality TV programs, guiding children's understanding of media content, developing Family Media Plans, and modelling positive screen use behaviours for children), the new recommendations broadly reflected extensions of the 2x2 rule by retaining several time limits. The AAP continued to recommend that infants and toddlers should have no screen exposure except for interactive media such as video chatting. The guidelines also upheld a 1-hour daily limit on screen time for preschoolers. Additionally, parents were instructed to enforce limits to ensure that screen time does not displace beneficial activities such as sleep, play, face-to-face interaction, and physical activity (Council on Communications and Media, 2016).

The AAP's 2016 update attracted noteworthy media attention and has been portrayed as a major paradigm shift in how experts conceptualize screen time and its effects on children's psychological well-being (Blum-Ross & Livingstone, 2018). However, these guidelines have not overcome longstanding flaws that were prevalent in previous renditions of recommendations

(Ashton & Beattie, 2019). Broadly, the guidelines remain rooted in the perspective that screen time is inherently harmful to mental health, despite a lack of robust empirical evidence that clearly illustrates such effects. The 2016 guidelines also hold limited consideration for bidirectional associations between media use and both mental well-being and challenges. As such, finding healthy ways to integrate screen-based devices into the lives of children and youth remains a significant challenge for parents and caregivers, particularly those who reside in technology-reliant countries (Blum-Ross & Livingstone, 2018).

The COVID-19 Pandemic: Redefining Screen Time

The need for high-quality evidence has become more pressing than ever in recent years. The onset of the COVID-19 pandemic greatly reduced any hopes of abiding by screen time rules in children and youth. As SARS-CoV-2 variants spread around the world, attempts to limit virus spread through lockdowns and physical distancing prohibited nearly all non-essential gatherings and in-person contacts. Approximately half of the global population was under some form of lockdown by April 2020, and shelter-in-place orders affected over 3.9 billion people worldwide (Sandford, 2020). Child care centers and schools were no exception to pandemic closures; children and youth faced enduring disruptions to their education, with UNICEF estimating that by March 2021, schools had been closed for almost a full year for 168 million students worldwide (UNICEF, 2021). Increases in digital media use were inevitable as the inability to engage in face-to-face social interactions, as well as the substantial loss of recreational opportunities, left most children with few activities to pursue at home. Moreover, children became highly reliant on screen-based devices in order to engage in learning via virtual platforms (e.g., Zoom, Google Classroom). Consequently, youth's digital media use rose to unprecedented levels. Early estimates from China revealed that children and adolescents' screen

time increased by 30 hours per week following the implementation of pandemic-related public health measures (Xiang et al., 2020). Drastic increases were also reported by the ParentsTogether Foundation (2020) in the United Kingdom: On average, children spent at least 6 hours on screens daily in April 2020, representing a doubled amount of screen use compared to pre-pandemic times in this sample. Similarly, findings from the All Our Families cohort in Canada noted that children's screen time increased by 1 hour per week between the ages of 5–8 pre-pandemic, but 1.5 years later, use increased by 11 hours per week during COVID-19 (McArthur, Racine, et al., 2021).

Naturally, parents and caregivers grew much more concerned about children's screen time during the pandemic (Gonzalez & MacMillan, 2020; Hammons et al., 2021; ParentsTogether Foundation, 2020). Echoing these worries, statements from professional health organizations such as the American Academy of Child and Adolescent Psychiatry urged parents to prevent digital media from overtaking children's lives and stressed the importance of achieving a balance between media use and off-screen activities (American Academy of Child and Adolescent Psychiatry, 2020a). The AAP also provided updated guidance for parents and caregivers during the pandemic. Given an unprecedented reliance on technology during this period, the AAP encouraged parents to rethink screen time rules, and instead focus on the type of screen-based activities that children were partaking in (Joyce, 2020). However, despite the relaxation of previous time-based recommendations, most parents and caregivers continued to struggle with managing their children's screen use. Qualitative findings revealed that parents often perceived children to be overly attached to screens, describing "addictive" behaviours (Hammons et al., 2021). Reinforcing this perspective is the observation that children appeared to show higher resistance (e.g., arguing, irritability, and refusal) when parents asked them to stop

using devices during the pandemic (Hammons et al., 2021). As such, many more questions emerged regarding the negative impacts of screen use on children's mental well-being.

Simultaneous Increases in Mental Health Problems and Screen Use

The COVID-19 disruption both exacerbated pre-existing family challenges and introduced a multitude of novel stressors. Although the burdens of economic uncertainty, child care demands, and other changes appear to fall predominantly on the shoulders of caregivers, these disruptions have significant impacts on children via transactional processes within the family (Browne, Wade, et al., 2021; Prime et al., 2020). Caregivers may transfer psychosocial stress to their children through relational processes (e.g., parenting practices, family interactions) in the context of lockdowns and shelter-in-place orders (Prime et al., 2020). Accordingly, a scoping review from Marchi et al. (2021) noted that parental mental health problems during the pandemic were significantly related to poorer outcomes in children and adolescents. In addition, children faced a conglomeration of pandemic-related changes, including disrupted routines, reductions in face-to-face social interactions, and the loss of support figures from outside of the immediate family (Gadermann et al., 2021; Grooms & Childs, 2021). Exposure to these (and many more) stressors have additive effects, which led to notable rises in children's mental health challenges.

In the early months of the pandemic, studies from China—the first country to enter lockdown—reported significant increases in children's mental health difficulties (Ren et al., 2020). Soon after, high rates of pediatric psychological problems were documented worldwide. Children's general distress increased due to COVID-19 closures, and those with pre-existing mental health challenges were particularly hard-hit (Shoshani & Kor, 2021). Meta-analytic findings reported updated pooled prevalence rates of depression and anxiety to be approximately

25–29% and 21–28%, respectively (Ma et al., 2021; Racine et al., 2021; Ren et al., 2020). These findings highlight the critical importance of identifying and mitigating risk factors that may be impacting children's mental health during the pandemic.

Despite significant heterogeneity in previous research findings, researchers were quick to document associations between media use and psychological difficulties. Their conclusions claimed that screen time is a particularly strong risk factor for psychopathology within pandemic contexts. As with previous research, most studies relied on cross-sectional data and standard regression analytical approaches. In community samples from China, high screen exposure (i.e., over 2 hours per day) was related to a number of mental health challenges, including depressive and anxiety symptoms, and general socioemotional difficulties (Cao et al., 2021; W. Li et al., 2021; Xiao et al., 2021). Some studies focused on the mental health correlates of specific forms of media use. For instance, Chen et al., (2021) reported that adolescents showed higher levels of psychological distress, both generally and in relation to problematic screen use behaviours, when they spent more time on devices for social media and gaming during the pandemic. Similar patterns emerged with regard to general smartphone use. Nicolì and colleagues (2022) also found that solitary screen use was associated with more behavioural problems in a sample of children and youth from Italy. However, time spent on social networking was associated with more emotional difficulties in children, but fewer challenges in adolescents (Nicolì et al., 2022). These discrepancies once again indicate mixed signals for links between mental health and screen time.

As previously discussed, cross-sectional findings cannot be generalized to claims about causality. The results from a small base of longitudinal studies during the pandemic vary, perhaps due to heterogeneity in the measurement of media use. For instance, Adachi et al. (2021) relied on children's smartphone ownership prior to COVID-19 as a proxy for screen time. Linear

mixed models revealed that participants who had their own device showed significantly heightened depressive symptoms throughout 8 months of the pandemic compared to children who did not own a device. Other studies investigated self- or parent-reports of screen time. Spencer et al. (2021) found that children whose screen time increased during the pandemic exhibited significantly higher overall mental health challenges (i.e., internalizing, externalizing, and attention problems) as compared to those whose screen use decreased or remained stable. In line with this, both Kiss et al. (2022) and Rosen et al. (2021) noted directional associations between consuming COVID-19-related media and anxiety. Passive screen time, internet browsing, and playing single-player video games also emerged as significant predictors of psychological distress (Kiss et al., 2022). However, other findings upheld the perspective that screen time and mental health are not directionally related to each other during the pandemic. For instance, Rakickienė et al. (2021) compared outcomes in a cohort of children before (November 2019–February 2020) and during (May–June 2020) COVID-19 in Lithuania, finding that while mental health challenges and screen time did increase contemporaneously, no predictive effects emerged. Rather, parental distress was the only significant predictor of preschoolers' emotional and behavioural difficulties when accounting for pre-pandemic symptoms. This suggests the presence of alternative, extraneous factors that may influence the associations between screen use and mental health.

Overall, the evidence base on screen time and mental well-being remains highly heterogeneous, even during periods when the role of digital media has been significantly elevated and perhaps more well-defined compared to previous decades. Obtaining high-quality evidence is a particularly urgent matter, especially as the COVID-19 pandemic has shown that the role of screens in young peoples' lives will only continue to expand over time. Researchers

must work to rectify methodological issues in the screen time literature which, if left unaddressed, will continue to hinder efforts to create empirically supported and feasible guidelines for managing children's media use.

Methodological Issues in Screen Time Research

The most frequent criticism of screen time studies surrounds the longstanding overreliance on cross-sectional methodology. Highly discrepant correlational findings provide limited support for strong and consistent associations between screen use and mental health challenges, much less statements about causality (Odgers & Jensen, 2020). Yet, the interpretations of cross-sectional studies often imply that screen use leads to mental health challenges, even though it may be the case that children and youth with existing vulnerabilities are simply more likely to use technology. As such, longitudinal designs that allow researchers to establish temporal precedence will provide further insight into the directionality of effects.

Moreover, most extant studies of screen time and mental health have included samples of one child per family. As such, their findings are restricted to a general understanding of whether children who spend more time on devices are at greater risk of mental health difficulties than those with lower amounts of screen use. However, only examining variability at the between-person level cannot control for environmental factors that may impact both mental well-being and screen time (Tooth et al., 2021). Failing to parse apart between-person differences from within-person effects—whether more digital media use than is typical for a child within a certain period may correspond to, or even predict more mental health challenges—may result in erroneous generalizations from children to families, and vice versa (Browne et al., 2021; Whitlock & Masur, 2019).

D'Onofrio and colleagues (2013) explain that "environmental risks can be correlated with—confounded by—all differences among families in genetic factors, environmental influences that make family members similar, and environments that make family members dissimilar" (p. S47) in studies comprising one child per family. As such, single-child samples cannot fully account for family-wide contextual effects that are closely linked with both media use and mental health outcomes. In line with Odgers and Jensen's (2020) recommendations, quasi-experimental, multilevel designs are necessary for discerning the extent to which family environmental factors contribute to the associations between screen time and psychological well-being. Examining within- versus between-family effects may detect shared family confounds and provide insight into whether screen time is inherently linked with mental health challenges for individual children. As Browne et al. (2020) state, over-reporting on mean effects at the sample or population level risks overlooking the fact that screen use impacts some children more than others. Family-wide contextual effects likely influence the associations between screen time and mental well-being, especially under circumstances such as the COVID-19 pandemic, wherein the family system plays an elevated role in influencing children's outcomes across multiple domains and levels of development (Prime et al., 2020; Thomeer et al., 2020). This warrants stronger efforts to distinguish the associations between screen time and mental well-being across various levels of analysis in the family.

Relatedly, recent developments in the literature emphasize the importance of understanding digital media use as a family-wide activity (Balayar & Langlais, 2021; Browne et al., 2020; Coyne et al., 2017; Jago et al., 2012; Lauricella et al., 2015). The presence of several risk factors within the family ecology is associated with higher durations of child screen time and mental health challenges. For instance, strong positive correlations between parental and child

screen time indicate that modelling behaviours (Jago et al., 2014; Lauricella et al., 2015), parental attitudes toward media use (Lee et al., 2022), and access to technology in the home all influence children's media use (Jago et al., 2012). The media use practices of caregivers may also negatively impact children's well-being by interfering with opportunities to create parent-child bonds (Jiang, 2018; McDaniel, 2020; Zhang et al., 2022). In contrast, instances of media co-use, such as viewing movies or playing video games together, may facilitate family connections and thereby support children's well-being (Balayar & Langlais, 2021; Musick et al., 2021). These findings coalesce to demonstrate that the family setting casts important influences on children's screen use above and beyond child-specific factors.

Literature Review Conclusion

In recent decades, a considerable amount of literature surrounding the relations between screen time and mental health in children and youth has emerged. These studies have adopted a wide range of approaches to examining the effects of media use on psychological well-being, including representative sample sizes and highly rigorous statistical methods. Yet, while some cross-sectional findings suggest a signal for correlations between screen time and mental health challenges, rigorous large-scale studies have reported small associations that are unlikely to be of clinical or practical significance. A relative dearth of longitudinal work further makes it difficult to distinguish cause from effect. As a result, the mixed evidence base has led to significant apprehension for parents and clinicians as screens continue to permeate most aspects of children's lives. Despite a growing emphasis on the contents and contexts of children's screen-based activities, guidelines have yet to abandon the idea of screen time. Parents are left with outdated recommendations (i.e., the 2x2 rule) that are incompatible with the current technological zeitgeist, particularly under the circumstances of the COVID-19 pandemic. These

limitations collectively indicate a high need for longitudinal, family-based approaches to studying screen time and mental health. High-quality findings that elucidate the role of screen time in the developmental landscape will enable researchers and policymakers to create updated media use guidelines. Such recommendations will ultimately help caregivers better understand and manage the effects of media use on children's well-being, and therefore foster optimal development in a highly digitized society.

The Present Study

As highlighted in the literature review, there remains a paucity of robust evidence concerning the associations between youths' screen time and mental health (Odgers & Jensen, 2020; Orben & Przbylski, 2019; Kaye et al., 2020). Two main methodological downfalls are evident. First, the dominance of cross-sectional studies precludes an understanding of the directional relations. Longitudinal studies are needed to better delineate the directionality of effects. Second, it is essential to understand whether associations between screen time and mental health vary based on within- and between-family differences.

The present study adopted a longitudinal, quasi-experimental approach to examining the associations between children's screen time and mental health problems during the COVID-19 pandemic. I aimed to 1) examine the degree of child-specific and family-wide differences in children's screen use throughout COVID-19; 2) conduct a robust assessment of the direction and magnitude of the relations between children's screen time and mental health outcomes; and 3) explore the most salient child-specific and family-wide predictors of screen time. As such, this study sought to understand the extent to which associations are influenced by factors at multiple levels of analysis within the family. Taken together, these objectives sought to overcome the

methodological limitations present in previous studies and elucidate the directions of associations between screen use and mental health.

Method

Participants and Procedure

Data were obtained from the *Child Resilience and Managing Pandemic Emotional Distress in Families* study, an ongoing longitudinal project that aims to evaluate various aspects of family well-being in the context of the COVID-19 pandemic. Caregivers (n = 549) with at least two children aged 5–18 (n = 1098) were recruited through the Prolific® research panel.[1] After providing informed consent, caregivers completed surveys on Qualtrics® with questions regarding life changes related to the pandemic, mental health, family functioning, and other family-based processes. Caregivers provided information for themselves, the overall family unit, and the two youngest children between the ages of 5–18. Assessments took place across four time points in May (Time 1 [T1]), July (Time 2 [T2]), September (Time 3 [T3]), and November 2020 (Time 4 [T4]), all of which are included in the present study. All study procedures were approved by the Office of Research Ethics at the University of Waterloo (ORE #42112).

At study baseline, the youngest child over the age of 5 years (referred to as the younger sibling) was 9.2 years old (SD = 3.0) on average, and their next sibling closest in age (referred to as the older sibling) was 12.2 years old (SD = 3.1). Approximately 46% of younger siblings and 49% of older siblings were female. On average, caregivers were aged 41.3 years (SD = 6.3) at study baseline. Most were married or common-law (90.5%) White (72.3%) females (67.8%) residing in the United Kingdom (76.0%). Other participants were of Asian (12.4%), Black (3.5%), mixed (2.2%), or other (2.2%) descent, and resided in the United States (18.9%), Canada

[1] Note, the sibling requirement was applied as this project was inherently interested in isolating within- versus between-family processes and using sibling comparisons to enhance internal validity when studying child-specific exposures. Caution should be exercised when generalizing study findings to other family constellations.

(4.0%), and Australia (1.0%). The median past-year income of families in the present study was $50,000–$74,999 USD, which is comparable to that of U.S. households in 2019 (Semega et al., 2020). Table 1 and Table 2 show the full sociodemographic characteristics of the sample.

Table 1

Sociodemographic Characteristics of Children in the Sample at Study Baseline

	Sibling 1		Sibling 2	
	M	(*SD*)	*M*	(*SD*)
Age	9.2	(3.0)	12.2	(3.1)
	n	%	*n*	%
Sex				
Female	250	45.5	269	49.0
Male	293	53.3	275	50.0
Unreported	6	1.1	5	0.9

Note. Percentages may not add to 100% due to rounding.

Table 2

Sociodemographic Characteristics of Caregivers in the Sample at Study Baseline

	M	(*SD*)
Age	41.3	(6.3)
	n	%
Sex		
Female	372	67.8
Male	158	28.8
Unreported	19	3.5
Relationship Status		
Lone Parent	44	8.1
Couple Living Apart [a]	8	1.5
Married/Common-Law	497	90.5
Ethnicity		
Asian (East, South, or Southeast)	68	12.4
Black (African, Caribbean, or North American)	19	3.5
White (European or North American)	397	72.3
Mixed heritage	12	2.2
Other	11	2.2
Unreported	81	14.8
Employment		
Full-Time	276	50.3
Part-Time	129	23.5
Unpaid Work [b]	93	16.9
Unemployed	14	2.6
Other	17	3.1
Unreported	20	3.6
Past-Year Household Income (USD)		
<$15,000	21	3.8
$15,000–$24,999	49	8.9
$25,000–$49,999	154	28.1
$50,000–$74,999	133	24.2
$75,000–$99,999	90	16.4
$100,000–$124,999	48	8.7
$125,000–$149,999	17	3.1
$150,000–$174,999	19	3.5
$175,000+	17	3.1
Unreported	1	0.2

Note. Percentages may not add to 100% due to rounding.

[a] Refers to being a lone parent at home with a romantic partner outside of the household

[b] Includes homemaker, retired, disabled.

Measures

Children's Screen Time

Caregivers reported the total amount of time that each of their children spent using smartphones and/or other screens (e.g., computer, TV, tablet) on a typical day. Responses were provided on a 7-point Likert scale, with the options of 1 = *less than 10 minutes*, 2 = *11–60 minutes*, 3 = *1–2 hours*, 4 = *3–4 hours*, 5 = *5–6 hours*, 6 = *more than 6 hours*, and 7 = *do not use any screen devices on a regular basis* (Rideout & Robb, 2019). Responses of 7 were recoded to 0 to correctly reflect rank order. Given that screen time was assessed via a single item, internal consistency could not be assessed in the present study. However, previous studies involving parent-reported assessments of child screen time demonstrate acceptable reliability (Raj et al., 2022; Ramirez et al., 2011).

Children's Mental Health Symptoms

Children's mental health challenges were assessed using the Patient-Reported Outcomes Measurement Information System (PROMIS®) Parent Proxy forms (PROMIS Health Organization, 2021). The following domains were assessed: Anger (Form 5a, version 2.0), Anxiety (Form 8a version 2.0), and Depressive Symptoms (Form 6a, version 2.0). Parents reported the frequency of domain-related difficulties that children exhibited in the past week using a 5-point Likert scale ranging from 1 = *never* to 5 = *almost always*. Sample items include "*my child could not stop feeling sad*" (Depressive Symptoms Form), "*my child felt like something awful might happen*" (Anxiety Form), and "*my child was so angry he/she felt like yelling at somebody*" (Anger Form; PROMIS Health Organization, 2021). Total scores on each of the three domains were derived by summing all items corresponding to that scale, with higher scores reflecting more difficulties in that area. The PROMIS® scales are robust, widely employed

measures with strong psychometric properties (Irwin et al., 2012; Varni et al., 2012), and internal consistency was high for all three domains of mental health problems in the present study. For Depressive Symptoms at each study time point, Cronbach's α ranged from .88–.91 and .90–.93 for younger and older siblings, respectively. Cronbach's α for Anxiety was .93–94 for younger siblings and between .91–.93 for older siblings. Finally, on the Anger scale, Cronbach's α was .90–.91 for younger siblings and .90–.92 for the older sibling at each study time point.

Covariates

Child-Level Covariates. Covariates at the child-specific level of analysis represent constructs that may be unique to each sibling from the same family. Thus, two children from within the same household may exhibit different scores on a child-level covariate, which signifies differences at the within-family level. This included the demographic characteristics of child age (measured in years) and gender (dummy-coded with female gender as the reference variable). Given that devices played a unique role in helping children build and maintain social connections during the pandemic (Imran et al., 2020; Suresh et al., 2021)—a notable protective factor against psychological distress during periods of lockdown (Magson et al., 2021)—caregivers also reported the extent to which each of their children used devices to contact people on social media or engage in video chatting (van Deursen et al., 2015). Responses were rated on a 5-point Likert scale ranging from 1 = *never* to 5 = *very often*. It is important to note that these options reflected frequencies, and therefore provides a general gauge of interactive screen use.

The present study also assessed several health-related behaviours that are closely associated with screen use. Caregivers reported the amount of time that their children spent engaging in at least moderate physical activity (i.e., exercise where breathing was a lot faster than normal but talking was still possible) each week, on a scale ranging from 1 = *none* to 5 =

over 3 hours. Children's sleep disturbances at each time point were assessed with the PROMIS Parent Proxy Sleep Disturbance scale (Form 8a, v1.0; Forrest et al., 2018; PROMIS Health Organization, 2021). This brief questionnaire included seven items regarding specific symptoms of sleep difficulties, such as "*my child's sleep was restless*", and responses ranged from 1 = *never* to 5 = *always*. An additional question regarding children's overall sleep quality over the past week was rated on a scale of 1 = *very poor* to 5 = *very good*. A total sleep disturbances score was calculated by summing all items on the scale (PROMIS Health Organization, 2021). As with other PROMIS® measures, this scale has been studied thoroughly and demonstrates strong psychometric properties (Forrest et al., 2018). Internal consistency was high in the present study; at all study time points, Cronbach's α was .92 and .93 for younger and older siblings, respectively. Finally, the present study included one item assessing the extent to which caregivers' parenting experiences with each of their children were stressful, on a scale ranging from 1 = *not at all stressful* to 7 = *extremely stressful* (Statistics Canada, 2009). This question was asked at all study time points.

Family-Level Covariates. Family-level covariates reflect measures of the environment and experiences that are shared by all members of the family unit. Hence, the same values are assigned to both children from the same household on these measures, but sibling pairs may differ from each other in their scores on such measures to depict variability at the between-family level. Life disruptions related to the COVID-19 pandemic were measured at study baseline using the COVID-19 Family Stressor Scale (CoFASS; Prime et al., 2021).[2]

[2] The CoFASS was administered at study baseline only as it was a newly designed scale and required psychometric validation. Prime et al. (2021) have since conducted detailed psychometric evaluations of the CoFASS.

This 16-item questionnaire queried disruption across numerous life domains of family life (e.g., finances, access to basic needs, personal and familial welfare, career/education, and household responsibilities) since the onset of the pandemic. Participants reported the extent of disruption to their households on a 3-point Likert scale ranging from 1 = *not true* to 3 = *very true*. Baseline results indicated that the CoFASS has strong internal consistency (α = .85) and further psychometric evaluation has supported its validity for use in family-based research (Prime et al., 2021). The family's total household income in the past year was assessed as a part of demographic characteristics at baseline (May 2020), on a scale comprising nine income brackets ranging from 1 = *less than $15,000 USD* to 14 = $*175,000+ USD*.

Two caregiver-related constructs were included in the present study. Parental screen time at each time point was measured through caregivers' self-reports of the total amount of time they spent using their smartphone and/or other screens (e.g., computer, TV, tablet) on a typical day. Response options were on a 7-point Likert scale ranging from 0 = *I do not use any screen devices on a regular basis* to 6 = *more than 6 hours* (Rideout & Robb, 2019). Caregiver psychological distress was assessed with the Kessler Psychological Distress Scale (K10) at each study time point (Kessler et al., 2002). This questionnaire includes 10 items querying feelings of anxiety and depression that respondents may have experienced over the past 30 days, rated on a 5-point Likert scale ranging from 1 = *none of the time* to 5 = *all of the time*. A global score was derived by summing responses across all items, with scores of over 20 indicating some level of mental health disorder (Andrews & Slade, 2001). The K10 has demonstrated strong psychometric properties across various sociodemographic subgroups (Kessler et al., 2002). Internal consistency was strong in the present study, as Cronbach's α ranged between .93–.94 within time points.

Analytical Plan

Data cleaning and structuring were conducted in Statistical Package for the Social Sciences (version 26). The *psych* (version 2.1.6; Revelle, 2022) and *dplyr* (version 1.0.7; Wickham et al., 2022) packages for RStudio (version 4.1.2) were employed to conduct descriptive analyses and examine the reliability of study variables.

Multilevel Cross-Lagged Panel Models

Robust tests of the directional, longitudinal relations between screen time and mental health difficulties (depressive symptoms, anxiety, and anger) were conducted via multilevel cross-lagged panel models (Hamaker et al., 2015; Kenny, 2005). These models enable examinations of both autoregressive effects in the same variable and time-lagged associations between different constructs. To account for the two-sibling data structure, models included two levels to delineate the relations between screen time and mental health problems as within- and between-family processes. Within-family effects (Level 1) depict the associations between screen time and mental health problems based on variability between sibling pairs in these outcomes, thus reflecting variance not shared by siblings. Hence, this component of the model constitutes a sibling comparison design (D'Onofrio et al., 2013; Lahey & D'Onofrio, 2010). Between-family effects (Level 2) describe the relations between screen time and mental health problems based on aggregated family means, and therefore signify variance components shared by children from the same home, but not by children from different households.

At each level, models were specified to include T-1 autoregressive effects, T-2 autocovariances, cross-sectional covariances, and T-1 cross-lagged regression paths. Autoregressions refer to the predictive relations between an outcome at one time point and its value at a subsequent time point (e.g., screen time in July as predicted by screen time in May).

Autocovariances between outcomes that were two time points apart (i.e., May–September and July–November) were also included, given that consecutive time points were only separated by two months, which represents a relatively short period during which screen time and emotional well-being likely remained somewhat stable. Cross-sectional covariances represent the bidirectional associations between screen time and depression at each time point. Finally, the predictive relations between screen time and depressive symptoms across two adjacent time points were assessed via cross-lagged regressions. This component of the model enables directional conclusions by establishing temporal precedence.

Multilevel cross-lagged panel models were fit using the *lavaan* package (version 0.6.8; Rosseel, 2012) in RStudio. Model fit was assessed using the chi-square, a measure that should be small and non-significant. However, the chi-square statistic is often significant with large sample sizes. To accommodate for this, several other specifications were also utilized to evaluate model fit: the comparative fit index (CFI; Marsh & Hau, 2007), the root-mean-square error of approximation (RMSEA; Cole & Maxwell, 2003), and the Standardized Root Mean Square Residual (SRMR; Hu & Bentler, 1999). Values close to or greater than .90 for the CFI suggest good fit. RMSEA values of less than or equal to 0.06 and SRMR values of less than or equal to 0.08 are desirable.

Multilevel Growth Curve Models

The second component of statistical analyses examined longitudinal child- and family-level predictors of children's screen use over time. This was assessed through multilevel modelling in the *lme4* (version 1.1.27.1; Bates et al., 2015) and *lmerTest* (version 3.1.3; Kuznetsova et al., 2017) packages in RStudio. Growth models were constructed and tested sequentially with screen time as the outcome variable. Models consisted of three levels, wherein

time (Level 1) was nested within individual children (Level 2), which was then nested in families (Level 3). Accounting for this clustering permits disaggregation of child- and family-level effects to isolate longitudinal changes in screen time, in addition to stable child individual differences. Parameters from multilevel models include fixed and random effects. Fixed effects refer to average (mean) effects across the sample; for instance, the fixed effect of time conveys the average rate of change in the outcome variable (screen time) for the overall sample. Conversely, random effects reflect differences in parameters across multiple levels of the model (family, child, time). These effects have corresponding variance components, describing the distribution of these parameters at Level 3 (family), 2 (child), or 1 (time and error).

A null model (Model 1) was estimated to obtain variance partitioning and intraclass correlations (ICCs) of screen time at each level of analysis. Next, a linear time component and child demographic characteristics (age and gender) were added to create a conditional growth model (Model 2). Subsequent models were built in a stepwise fashion by adding predictors of screen time in order of proximal child-specific effects to distal family-wide effects. Model 3 included screen time as predicted by depressive symptoms, anxiety, and anger over time. Additional child-level predictors of screen use for social purposes, physical activity, sleep quality, and parenting stress were included in Model 4. Finally, Model 5 included the family-level predictors of COVID-19 disruption, past-year annual household income, caregiver screen time, and caregiver psychological distress. All models were fit with restricted maximum likelihood estimates, and significance tests were conducted using Satterthwaite's method.

Missing Data

In terms of missing data, n = 443 (79.1%) of the original n = 549 families included at baseline were retained at the 6-month follow-up in November 2020. Approximately 33.2% (n =

182) of participants had complete data across all time points. Full information maximum likelihood estimation was applied to cross-lagged panel models as recommended by Graham (2009) to minimize potential bias associated with this missing data. The robust maximum likelihood estimator was also applied to incorporate participants with missing data based on the missing-at-random assumption to minimize attrition-related bias (Yuan & Bentler, 2000). This method produces standard maximum likelihood parameter estimates with standard errors that are robust to non-normality (Rosseel, 2012).

Results

Descriptive Statistics

Table 3 displays the descriptive statistics for the primary study outcome variables. Parents reported that children exhibited approximately 3–4 hours of daily screen time each day at study baseline (M = 4.1, SD = 1.2 for younger siblings; M = 4.4, SD = 1.2 for older siblings). This remained relatively stable throughout the study, with a median rating of 4.0 at all time points. Children's total scores on the PROMIS depressive symptoms, anxiety, and anger scales were converted to *T*-scores based on established guidelines (Table 4; PROMIS Health Organization, 2021). These use the following categories to indicate symptom severity: within Normal Limits (≤ 50), Mild (51–54), Moderate (55–64), and Severe (≥ 65). On average, children in the present sample did not exhibit clinically significant levels of mental health problems, except for a slight elevation in older siblings' depressive symptoms in July (T2; *T*-score = 50.6). As such, it is important to note that the findings from the present study refer to mental health symptoms rather than diagnoses. Descriptive statistics further illustrated that symptoms of emotional problems declined across the four study time points (Table 3 and Table 4). Independent sample *t*-tests comparing siblings on study outcomes (Table 5) revealed that across all time points, older siblings exhibited higher levels of screen time than younger siblings. Caregivers also reported that older siblings showed significantly greater levels of depressive symptoms in May (T1) and September (T3). Emotional problems did not otherwise differ across siblings. Bivariate correlations between study outcome variables across all time points for both siblings are presented in Table 6.

Table 3

Descriptive Statistics of Study Outcome Variables by Sibling

	Time 1				Time 2				Time 3				Time 4			
	Younger Sibling		Older Sibling		Younger Sibling		Older Sibling		Younger Sibling		Older Sibling		Younger Sibling		Older Sibling	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Screen time	4.1	(1.2)	4.4	(1.2)	4.1	(1.2)	4.3	(1.2)	3.6	(1.2)	3.9	(1.2)	3.6	(1.1)	3.9	(1.1)
Depression	10.5	(4.0)	11.2	(4.6)	10.0	(3.9)	10.3	(4.6)	9.3	(3.7)	9.9	(4.5)	9.4	(4.0)	10.0	(4.6)
Anxiety	12.7	(5.4)	12.8	(5.4)	12.1	(5.0)	12.1	(5.3)	12.4	(5.2)	12.2	(5.4)	12.1	(5.2)	12.4	(5.7)
Anger	9.7	(3.9)	9.8	(4.3)	9.4	(3.7)	9.2	(4.1)	9.0	(3.8)	8.9	(3.9)	8.9	(3.7)	9.0	(3.8)

Note. Measures for mental health challenges refer to symptom levels, rather than the severity of diagnoses.

Table 4

PROMIS Depression, Anxiety, and Anger T-Scores by Sibling

	PROMIS *T*-score							
	Time 1		Time 2		Time 3		Time 4	
	Younger Sibling	Older Sibling	Younger Sibling	Older Sibling	Younger Sibling	Older Sibling	Younger Sibling	Older Sibling
Depression	49.3	50.6	48.2	48.5	46.4	47.4	46.5	47.5
Anxiety	45.8	45.9	44.6	44.4	45.2	44.7	44.6	44.8
Anger	45.3	45.4	44.2	43.5	43.0	42.4	42.8	43.1

Note. Ranges for T-scores include Within Normal Limits (≤ 50), Mild (51–54), Moderate (55–64), and Severe (≥ 65).

Table 5

Independent-Samples t-Tests Comparing Siblings on Primary Outcome Variables

	Time 1		Time 2		Time 3		Time 4	
	t-statistic	*p*-value	*t*-statistic	*p*-value	*t*-statistic	*p*-value	*t*-statistic	*p*-value
Screen Time	-3.69	<.001	-3.19	.001	-3.13	.002	-2.83	.004
Depression	-2.76	.006	-1.39	.166	-2.22	.027	-1.91	.056
Anxiety	-0.26	.792	0.09	.927	0.55	.585	-0.58	.561
Anger	-0.33	.743	0.64	.519	0.62	.536	-0.43	.667

Note. The older sibling exhibited higher mean values on all statistically significant *t*-tests.

Table 6

Bivariate Pearson Correlations of Study Outcome Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. ST T1	—	.71**	.50**	.52**	17**	.18**	.09*	.10*	.14**	.12*	. 07	.11*	.07	.03	.02	.03
2. ST T2	.62**	—	.57**	.59**	.20**	.19**	.11*	.13**	.16**	.09	.09	.10*	.06	.05	.02	.04
3. ST T3	.57**	.60**	—	.69**	.13**	.22**	.20**	.20**	.13**	.11*	.15**	.16**	.10*	.06	.14**	.14**
4. ST T4	.55**	.56**	.73**	—	.14**	.19**	.16**	.16**	.08	.04	.10*	.08	.05	.03	.09	.08
5. Dep Symp T1	.15**	.08	.16**	.12**	—	.68**	.60**	.60**	.70**	.55**	.53**	.57**	.57**	.48**	.49**	.47**
6. Dep Symp T2	.10**	.11*	.13**	.14**	.68**	—	.66**	.64**	.54**	.70**	.58**	.56**	.47**	.60**	.53**	.51**
7. Dep Symp T3	.11**	.11*	.16**	.17**	.59**	.63**	—	.72**	.54**	.56**	.76**	.68**	.44**	.44**	.63**	.50**
8. Dep Symp T4	.11**	.09	.19**	.18**	.58**	.64**	.66**	—	.49**	.48**	.66**	.77**	.45**	.43**	.54**	.60**
9. Anxiety T1	.11**	.04	.14**	.08	.70**	.57**	.49**	.47**	—	.67**	.64**	.62**	.50**	.44**	.45**	.44**
10. Anxiety T2	.13**	.08	.15**	.13**	.52**	.73**	.51**	.52**	.68**	—	.68**	.65**	.39**	.55**	.44**	.42**
11. Anxiety T3	.10*	.08	.15**	.15**	.49**	.58**	.69**	.60**	.65**	.68**	—	.78**	.38**	.42**	.54**	.45**
12. Anxiety T4	.07	.04	.13*	.11*	.52**	.58**	.56**	.76**	.64**	.71**	.74**	—	.45**	.46**	.53**	.53**
13. Anger T1	.07	.02	.07	.00	.66**	.49**	.37**	.42**	.53**	.37**	.36**	.40**	—	.75**	.70**	.75**
14. Anger T2	.05	.08	.09	.09	.58**	.67**	.47**	.48**	.46**	.54**	.44**	.44**	.70**	—	.72**	.76**
15. Anger T3	.03	.05	.13**	.12*	.50**	.53**	.66**	.47**	.43**	.40**	.55**	.39**	.62**	.68**	—	.77**
16. Anger T4	.04	.03	.12*	.11	.51**	.52**	.53**	.64**	.41**	.40**	.45**	.58**	.63**	.67**	.71**	—

Note. ST = Screen Time; Dep Symp = Depressive Symptoms; * $p < .05$; ** $p < .01$. The top half (above diagonal) shows correlations for the younger sibling, and bottom half (below diagonal) shows correlations for the older sibling.

Table 7

Descriptive Statistics of Study Covariates

	Time 1				Time 2				Time 3				Time 4			
	Younger sibling		Older sibling		Younger sibling		Older sibling		Younger sibling		Older sibling		Younger sibling		Older sibling	
Child Covariates	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Tech Social	2.8	(1.3)	3.3	(1.3)	2.8	(1.4)	3.2	(1.3)	2.8	(1.3)	3.1	(1.3)	2.8	(1.3)	3.2	(1.3)
Phys Act	3.6	(1.3)	3.5	(1.3)	3.6	(1.2)	3.5	(1.2)	3.7	(1.2)	3.6	(1.2)	3.8	(1.1)	3.7	(1.2)
Sleep Dist	23.0	(2.9)	23.0	(2.6)	22.9	(2.5)	23.0	(2.5)	22.7	(2.7)	22.5	(2.5)	22.7	(2.6)	22.5	(2.6)
Parent Stress	2.0	(1.4)	2.9	(1.5)	2.7	(1.4)	2.5	(1.4)	2.5	(1.3)	2.6	(1.4)	2.5	(1.4)	2.6	(1.5)
Family Covariates	*M*		(*SD*)		*M*		(*SD*)		*M*		(*SD*)		*M*		(*SD*)	
CG Screen Time	4.6		(1.1)		4.5		(1.1)		4.5		(1.1)		4.5		(1.2)	
CG Distress	19.9		(7.9)		18.7		(7.6)		18.7		(7.6)		18.5		(7.7)	
COVID Disrupt [a]	38.9		(7.7)													

Note. Tech Social = Technology Use for Social Purposes; Phys Act = Physical Activity; Sleep Dist = Sleep Disturbances; Parent Stress = Parenting Stress; CG Screen Time = Caregiver Screen Time; CG Distress = Caregiver Psychological Distress

[a] COVID Disrupt = COVID-19 Disruption. This was only assessed at study baseline.

Cross-Lagged Panel Models of Screen Time and Emotional Problems

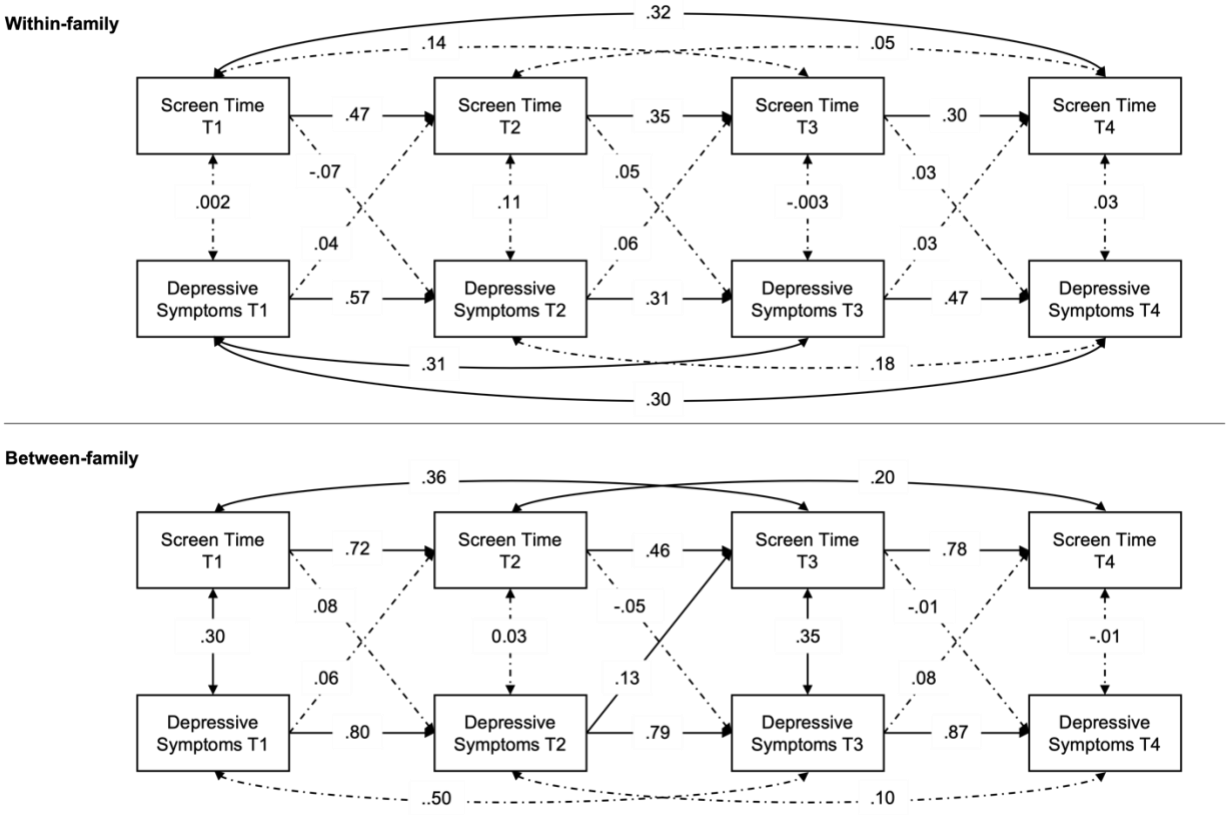
Model 1a: Associations Between Screen Time and Depressive Symptoms

The first multilevel cross-lagged panel model assessed the longitudinal, directional associations between depressive symptoms and screen time based on within- and between-family differences. The initial model showed good fit to the data, with room for improvement: $\chi^2(56) = 1948.98$, $p < .001$; CFI = .94; RMSEA = 0.09 [$CI_{.90}$ = 0.07, 0.11]; $SRMR_{within}$ = .07, $SRMR_{between}$ = .04. Examination of modification indices supported the addition of autocovariances between the first and final time points (May and November) for screen time and depressive symptoms at the within-family level. This resulted in stronger fit: $\chi^2(56) = 1948.98$, $p < .001$; CFI = .99; RMSEA = 0.04 [$CI_{.90}$ = 0.02, 0.06]; $SRMR_{within}$ = .03, $SRMR_{between}$ = .03. Figure 1 shows the full model (Model 1a). At the within-family level, positive, significant autoregressive parameter estimates suggested that siblings' screen time trajectories were relatively stable across adjacent time points. That is, the sibling who used screens more in May was likely to do so in July (β = .47, $p < .001$). Similar patterns emerged from July to September (β = .35, $p < .001$), as well as from September to November (β = .30, $p < .001$). Screen use differences between siblings were not related across T-2 time points (i.e., May and September, July and November), but a significant covariance emerged between May and November (β = .32, $p < .001$). With regards to depressive symptoms, the sibling who received a higher rating in May also showed more challenges at the subsequent time point in July (β = .57, $p < .001$). This pattern was maintained throughout the duration of the study (July to September: β = .31, $p < .001$; September to November: β = .47, $p < .001$). Positive T-2 (May and September: β = .31, p = .001) and T-3 covariances (May and November: β = .30, $p < .001$) also emerged, which further supports rank-order stability. Sibling differences in screen use and depressive symptoms were not significantly

related at any time point. Moreover, T-1 cross-lagged regression paths did not reach significance. Thus, the sibling who used screens more at a previous time point did not exhibit higher or lower depressive symptoms two months later. Effects in the opposite direction were also not observed.

Figure 1

Multilevel Cross-Lagged Panel Model of Associations Between Screen Time and Depressive Symptoms Over Time (Model 1a)



Note. T1 = May; T2 = July; T3 = September; T4 = November. Solid lines indicate statistically significant paths at the $p < .05$ level. Standardized path estimates are shown.

Analyses at Level 2 examined average screen use and depressive symptoms scores across sibling pairs to enable comparisons between different family units. Significant autoregressions indicated that sibling pairs who engaged in more screen use at a previous time point tended to

exhibit higher use two months later (May to July: β = .72, p < .001; July to September: β = .46, p < .001; September to November: β = .78, p < .001), compared to sibling pairs with lower screen time. Additionally, T-2 correlations were significant between May and September (r = .36, p < .001) and between July and November (r = .20, p = .047) which further supports that the rank-order of screen use amongst sibling pairs remained stable across the duration of the study. Similar patterns emerged in depressive symptoms. Sibling pairs who collectively showed higher depressive symptoms at a previous time point consistently did so at subsequent time points (May to July: β = .80, p < .001; July to September: β = .79, p = .001; September to November: β = .87, p < .001). Interestingly, cross-sectional covariances between screen time and depressive symptoms were statistically significant in both May (r = .30, p < .001) and September (r = .35, p = .033), but not in July or November. This indicates that sibling pairs who engaged in more screen use simultaneously exhibited higher levels of depression at some points within the study. Notably, a time-lagged regression path suggested that sibling pairs who exhibited more depressive symptoms in July tended to engage in higher screen time two months later (β = .13, p = .048), after controlling for previous levels of screen use. Based on Orth et al. (2022)'s proposed guidelines for interpreting cross-lagged regression parameters (.03 = small, .07 = medium effect,.12 = large effect), this may constitute a relatively large effect. The reverse relationship (i.e., screen time in July predicting depressive symptoms in September) was not significant. No other cross-lagged regression paths from earlier screen use to subsequent depressive symptoms emerged, nor vice-versa. Overall, Model 1a highlights a few noteworthy associations linking children's screen use and depressive symptoms across several months of the COVID-19 pandemic at the between-family level, but patterns generally showed limited support for directional relations.

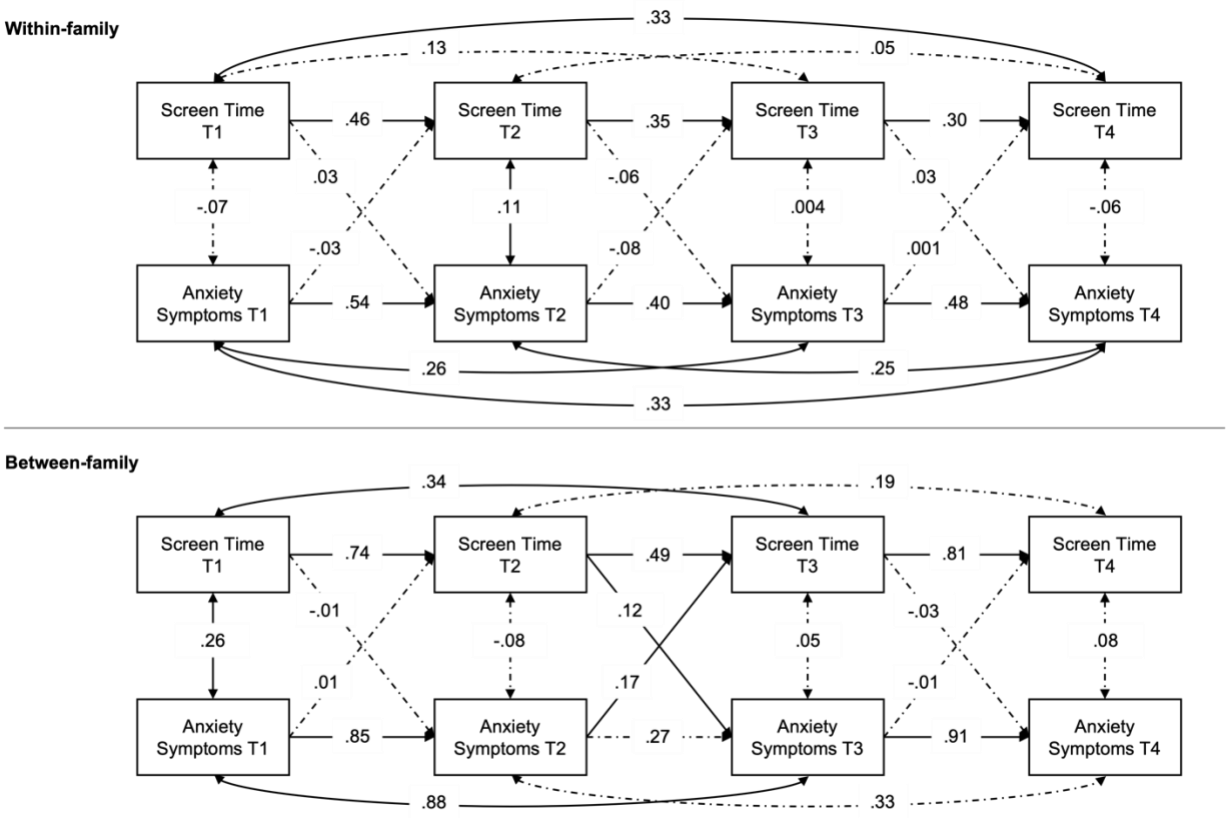
Model 1b: Associations Between Screen Time and Anxiety Symptoms

The original model assessing the associations between anxiety and screen time showed good fit to the data, with room for improvement: $\chi^2(56) = 2076.08$, $p < .001$; CFI = .94; RMSEA = 0.10 [$CI_{.90}$ = 0.08, 0.12]; $SRMR_{within}$ = .07, $SRMR_{between}$ = .06. Examination of modification indices suggested the addition of autocovariances between the first and final time points (May and November) for screen time and anxiety. This resulted in stronger fit: $\chi^2(56) = 2076.08$, $p < .001$; CFI = 1.00; RMSEA = 0.02 [$CI_{.90}$ = 0.00, 0.04]; $SRMR_{within}$ = .02, $SRMR_{between}$ = .03. Figure 2 displays the full model (Model 1b).

Significant positive autoregressions for screen time emerged between all adjacent time points at the within-family level. The sibling who engaged in more screen time in May also exhibited higher use in July (β =.46, $p < .001$), and the same pattern emerged from July to September (β =.35, $p < .001$) and from September to November (β =.30, $p = .001$). T-2 autocovariances in screen time did not reach statistical significance. However, screen time in May and November were significantly correlated ($r = .33$, $p < .001$). Similar to Model 1a, these findings suggest that screen time generally showed rank-order stability within families. The same was true of anxiety levels. Autoregressive parameters revealed that the sibling who showed higher anxiety at a previous time point also tended to exhibit higher scores two months later (May–July: $\beta = .54$, $p < .001$; July–September: $\beta = .40$, $p < .001$; September–November: $\beta = .48$, $p < .001$). Significant positive covariances also emerged across anxiety measures that were T-2 time points apart (May and September: $r = .26$, $p = .004$; July and November: $r = .25$, $p = .001$). Furthermore, sibling differences in anxiety levels were significantly correlated in May and November ($r = .33$, $p < .001$).

Figure 2

Multilevel Cross-Lagged Panel Model of Associations Between Screen Time and Anxiety Symptoms Over Time (Model 1b)



Note. T1 = May; T2 = July; T3 = September; T4 = November. Solid lines indicate statistically significant paths at the $p < .05$ level. Standardized path estimates are shown.

Model 1b found limited support for associations between screen use and anxiety at the within-family level. The cross-sectional covariance in July was statistically significant (β =.11, p = .013), suggesting that the child who used more screens at that time point simultaneously displayed greater anxiety compared to their sibling. However, within-family cross-sectional covariances did not reach significance at any other time point. In line with this, cross-lagged regression parameters suggested that earlier screen use did not predict later anxiety. Paths in the

opposite direction (i.e., anxiety predicting screen use after two months) were also not significant. Thus, Model 1b did not find evidence for directional associations between screen use and anxiety levels based on differences in scores from siblings within the same household.

At the between-family level, significant autoregressions indicated that some sibling pairs consistently showed higher screen use throughout the study (May–July: $\beta = .74$, $p < .001$; July–September: $\beta = .49$, $p < .001$; September–November: $\beta = .81$, $p < .001$) compared to others. This trajectory was further supported by a significant positive correlation in screen use between May and September ($r = .34$, $p = .001$). Autoregressive parameters for children's anxiety levels were statistically significant from May to July ($\beta = .85$, $p < .001$) and September to November ($\beta = .91$, $p < .001$), but not from July to September. Children's anxiety scores in May and September were significantly and positively correlated ($r = .88$, $p = .001$), but no association emerged between July and November. These results suggest rank order stability in sibling pairs' anxiety levels in the early months of the pandemic. Screen time and anxiety were significantly correlated between families in May only ($\beta = .26$, $p < .001$), which suggests that sibling pairs who exhibited greater anxiety simultaneously showed higher amounts of screen use at study baseline. Model 1b indicated some signals for directional associations: anxiety levels in July predicted screen use in September ($\beta = .17$, $p = .008$). In the context of the multilevel family design, this indicates that sibling pairs who averaged more screen use in July were rated to have higher anxiety symptoms two months later, controlling for previous levels. However, higher screen time in July also significantly predicted greater anxiety in September ($\beta = .12$, $p = .025$), suggesting a bidirectional effect. Guidelines from Orth et al. (2022) would again suggest that these may be considered relatively substantial effect sizes.

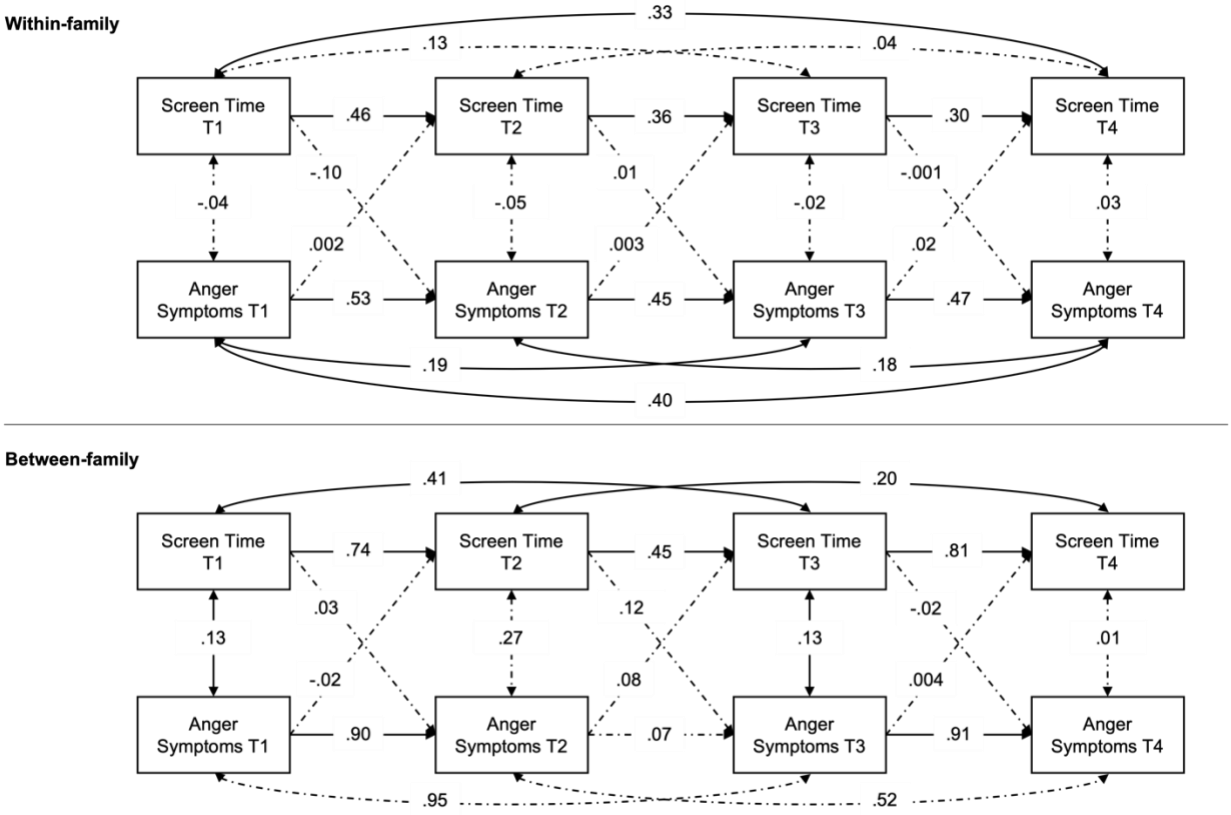
Model 1c: Associations Between Screen Time and Anger Symptoms

The original model depicting the associations between anger and screen time showed good fit to the data, with slight room for improvement: $\chi^2(56) = 2104.20$, $p < .001$; CFI = .95; RMSEA = 0.09 [$CI_{.90}$ = 0.08, 0.11]; $SRMR_{within}$ = .08, $SRMR_{between}$ = .04. Modification indices suggested the addition of autocovariances between the first final time points for both screen time and anger measures at the within-family level. This resulted in improved fit: $\chi^2(56) = 2104.20$, $p < .001$; CFI = .99; RMSEA = 0.05 [$CI_{.90}$ = 0.03, 0.07]; $SRMR_{within}$ = .04, $SRMR_{between}$ = .03. The full model (Model 1c) is depicted in Figure 3.

All autoregressions in screen time at the within-family level were significant. The sibling who used screens at higher amounts in May continued to do this in July ($\beta = .46$, $p < .001$). This was also the case between July and September ($\beta = .36$, $p < .001$), as well as between September and November ($\beta = .30$, $p = .001$). Screen time in May and November were also significantly correlated ($r = .33$, $p < .001$). With regards to anger ratings, all autoregressive parameters between adjacent time points were significant. The sibling who showed higher levels of anger in May also did so in July ($\beta = .53$, $p < .001$). Anger levels in July also predicted levels in September ($\beta = .45$, $p < .001$), and a significant predictive effect emerged between September and November ($\beta = .47$, $p < .001$). Stable trajectories were further supported by significant autocovariances in anger between May and September ($r = .19$, $p = .002$), and between July and November ($r = .18$, $p = .002$). Differences in anger levels between siblings in May and November were also positively correlated ($r = .40$, $p < .001$). Model 1c found little support for associations between screen use and anger at the within-family level; screen time and anger ratings were not significantly associated within each time point, and no significant cross-lagged relations emerged.

Figure 3

Multilevel Cross-Lagged Panel Model of Associations Between Screen Time and Anger Symptoms Over Time (Model 1c)



Note. T1 = May; T2 = July; T3 = September; T4 = November. Solid lines indicate statistically significant paths at the $p < .05$ level. Standardized path estimates are shown.

At the between-family level, screen time (averaged across sibling pairs) showed rank-order stability throughout the study timeline (May–July: $\beta = .74$, $p < .001$; July–September: $\beta = .45$, $p < .001$; September–November: $\beta = .81$, $p < .001$). Furthermore, screen time between families in May was correlated with screen time in September ($r = .41$, $p < .001$). A significant T-2 covariance also emerged between July and November ($r = .20$, $p = .048$). Similarly, siblings who showed higher levels of anger in May were also rated to show more symptoms in July (β

= .90, $p < .001$). Between-family differences in anger in July did not predict differences in September, but anger in September predicted ratings in November ($\beta = .91$, $p < .001$). No significant autocorrelations emerged between anger measures that were two time points apart. Although anger and screen time were correlated in May ($r = .13$, $p = .022$) and September ($r = .13$, $p = .048$), Model 1c suggested little evidence for directional relations due to a lack of significant cross-lagged regression parameters.

Covariates in Cross-Lagged Panel Models

Cross-lagged panel models were tested with child- and family-level covariates. However, this significantly reduced model fit, which could not be rectified through the addition of modification indices. A wide variety of covariates were assessed in subsequent multilevel models.

Multilevel Growth Curve Models

Model 1: Null Model

To examine the most salient child- and family-level predictors of screen use, three-level growth curve models were constructed with screen time as the outcome variable (Table 8). ICCs from the null model (Model 1) revealed that 55% of the variability in screen time was at the between-family level (Level 3 variance), only 2% was at the within-family level (Level 2 variance), and 43% was related to time (Level 1 variance, including error). Thus, children across different families were much more likely to exhibit different amounts of screen use compared to siblings from the same home. Accounting for family and child differences, there is also significant variability in screen time within children over time, including measurement error.

Model 2: Conditional Growth Model

Next, a conditional growth model was estimated by adding the predictors of time (study time point), child age, and child gender. A linear effect of time was observed, revealing that on average, parents reported children to engage in decreasing amounts of screen use throughout the study. Specifically, screen time decreased by 0.20 points ($p < .001$) at each successive time point. Child age also emerged as a significant predictor, such that older children engaged in higher amounts of screen use ($B = 0.10$, $p < .001$). Male children were also likely to engage in slightly higher amounts of screen time compared to females ($B = 0.09$, $p = .012$). The predictors included in this model accounted for a notable portion of variance at the family (55%; Level 3) and residual levels (44%; Level 1) and retained statistical significance in all further models. Notably, there was little variability in screen use at the within-family level (Level 2).

Model 3: Conditional Growth Model with Mental Health Predictors

Model 3 included mental health symptoms in the domains of depression, anxiety, and anger as predictors of screen time. Symptoms of depression ($B = 0.02$, $p < .001$) and anger ($B = 0.01$, $p = .031$) both reached statistical significance, but estimates of their independent effect sizes were very small.

Model 4: Conditional Growth Model with All Child-Level Predictors

Model 4 included various child-level variables (i.e., measures that differ between two children from within the same family) as predictors, providing insight into the extent to which lifestyle factors and other child-specific attributes may relate to screen time. Although depressive symptoms retained significance in this model, its effect size remained very small ($B = 0.02$, $p = .005$). Children's technology use for maintaining social connections emerged as a strong predictor of increased screen use ($B = 0.19$, $p < .001$). Moreover, physical activity showed an

inverse association with screen time, such that children exhibited less screen use when they engaged in more exercise (B = -0.11, p < .001). These child-level predictors retained statistical significance in the subsequent model. Ratings of sleep disturbances were not associated with screen time, nor were levels of caregiver-reported parenting stress for each child.

Model 5: Conditional Growth Model with Child- and Family-Level Predictors

In the final model, family-level predictors of children's screen time were added (Model 5). These included COVID-19 disruptions to the family, past-year household income, parental screen time, and parental psychological distress. Most variability remained at the between-family level (47%) in Model 5, suggesting that differences were more likely to be driven by factors from the shared home environment. In line with this, parental screen time emerged as a significant predictor of children's screen time (B = 0.22, p < .001). These findings collectively illustrate that children's screen use during the COVID-19 pandemic was related to a range of both child- and family-level factors.

Table 8

Multilevel Growth Curve Models Assessing Predictors of Screen Time

	Model 1 Null Model			Model 2 Conditional Growth Model			Model 3 Conditional growth model with child mental health predictors			Model 4 Conditional growth model with child mental health and child-level predictors			Model 5 Conditional growth model with child mental health, child-level, and family-level predictors		
Fixed Effects	*B*	(*SE*)	$CI_{.95}$	*B*	(*SE*)	$CI_{.95}$	*B*	(*SE*)	$CI_{.95}$	*B*	(*SE*)	$CI_{.95}$	*B*	(*SE*)	$CI_{.95}$
Intercept	4.01**	(.04)	[3.93, 4.09]	3.38**	(0.08)	[3.21, 3.54]	3.09**	(0.10)	[2.88, 3.29]	2.93**	(0.17)	[2.59, 3.27]	1.86**	(0.20)	[1.40, 2.33]
Time				-0.20**	(0.01)	[-0.22, -0.17]	-0.18**	(0.01)	[-0.21, -0.16]	-0.18**	(0.01)	[-0.20, -0.15]	-0.17**	(0.01)	[-0.19, -0.15]
Child Age				0.10**	(0.01)	[0.09, 0.11]	0.10**	(0.01)	[0.08, 0.11]	0.07**	(0.01)	[0.06, 0.08]	0.07**	(0.01)	[0.06, 0.08]
Child Gender				0.09*	(0.03)	[0.02, 0.16]	0.10**	(0.03)	[0.03, 0.17]	0.15**	(0.03)	[0.08, 0.21]	0.15**	(0.03)	[0.08, 0.21]
Emotional Problems															
Dep Symp							0.02**	(0.01)	[0.01, 0.03]	0.02*	(0.01)	[0.01, 0.03]	0.02*	(0.01)	[0.01, 0.03]
Anxiety							0.01	(0.004)	[-0.01, 0.00]	0.003	(0.00)	[-0.01, 0.01]	-.004	(0.00)	[-0.01, 0.00]
Anger							0.01*	(0.01)	[0.01, 0.03]	0.07	(0.01)	[-0.01, 0.02]	0.01	(0.01)	[-0.01, 0.02]
Child-Level Predictors															
Tech Social										0.19**	(0.01)	[0.16, 0.22]	0.18**	(0.01)	[0.16, 0.21]
Phys Act										-0.11**	(0.01)	[-0.14, -0.08]	-0.11**	(0.01)	[-0.14, -0.08]
Sleep Dist										0.01	(0.01)	[0.00, 0.02]	0.01	(0.00)	[-0.02, 0.02]
Parent Stress										0.03	(0.01)	[0.00, 0.05]	0.02	(0.01)	[-0.01, 0.05]
Family-Level Predictors															
Income													0.01	(0.01)	[-0.01, 0.03]
CG Screen Time													0.22**	(0.02)	[0.19, 0.26]
CG Distress													.02	(0.00)	[-0.01, 0.00]
COVID Disrupt													.003	(0.01)	[-0.01, 0.01]

Table 8 (continued).

	Model 1			Model 2			Model 3			Model 4			Model 5		
	Null Model			Conditional Growth Model			Conditional growth model with child mental health predictors			Conditional growth model with child mental health and child-level predictors			Conditional growth model with child mental health, child-level, and family-level predictors		
Random Effects	Var	*SD*	$CI_{.95}$	Var	*SD*	$CI_{.95}$	Var	*SD*	$CI_{.95}$	Var	*SD*	$CI_{.95}$	Var	*SD*	$CI_{.95}$
RI (Child Level)	0.03	0.19	[0.10, 0.25]	0.01	0.10	[0.00, 0.18]	0.01	0.12	[0.00, 0.19]	0.00	0.00	[0.00, 0.10]	0.00	0.00	[0.00, 0.10]
RI (Family Level)	0.83	0.91	[0.85, 0.98]	0.71	0.84	[0.79, 0.90]	0.68	0.83	[0.77, 0.88]	0.58	0.76	[0.72, 0.82]	0.48	0.69	[0.64, 0.74]
RI (Residual)	0.64	0.80	[0.78, 0.82]	0.57	0.76	[0.74, 0.78]	0.57	0.75	[0.73, 0.77]	0.55	0.74	[0.72, 0.76]	0.54	0.73	[0.71, 0.75]
ICCs															
Child Level		.02			.01			.01			.00			.00	
Family Level		.55			.55			.54			.52			.47	

Note. Dep Symp = Depressive Symptoms; Tech Social = Technology Use for Social Purposes; Phys Act = Physical Activity; Sleep Dist = Sleep Disturbances; Parent Stress = Parenting Stress; Income = Past-Year Household Income; CG Screen Time = Caregiver Screen Time; CG Distress = Caregiver Psychological Distress

Discussion

This project aimed to examine the longitudinal associations between children's screen use and emotional well-being during the COVID-19 pandemic at between-and within-family levels of analysis. Key child- and family-level predictors of screen use were also evaluated. Using rigorous, longitudinal sibling comparison methodology, the results revealed limited support for directional (putatively causal) relations between screen time and mental health symptoms. These findings hold important methodological implications for the screen time literature, and offer considerations for caregivers, pediatric clinicians, and policymakers in their ongoing efforts to promote children's emotional well-being.

Trends in Children's Screen Use and Emotional Difficulties Throughout the Pandemic

Reports from the early months of the COVID-19 pandemic suggest that children's screen use reached an all-time high as their lives became largely confined to virtual platforms (ParentsTogether Foundation, 2020; Seguin et al., 2021). Situated within these findings, children in the present study engaged in relatively lower amounts of screen use (3–4 hours) as reported by their parents. Moreover, a slight downward trajectory of screen use was observed. These patterns may reflect a significant role of screen-based activities in children's initial transition to pandemic-related closures, particularly as a result of drastically reduced opportunities for in-person learning, entertainment, and socialization. Thereafter, screen time may have decreased slightly as children adjusted to a more balanced lifestyle comprising fewer digital activities, especially with most of the sample entering summer holidays by early- or mid-July 2020 and transitioning to in-person education services in subsequent months.

At the same time, the onset of the pandemic saw steep declines in children's mental well-being, documented through high rates of both internalizing and externalizing symptoms (Ma et

al., 2021; Racine et al., 2021; Sun et al., 2022). In contrast with these reports, participants in the present study generally showed sub-clinical average levels of symptoms in the domains of depression, anxiety, and anger, with downward trajectories over time. These patterns may signify that children experienced greater psychological distress during the earliest stages of COVID-19 shutdowns. Specific mechanisms responsible for this may include school and education service closures, as well as the loss of social support, both of which are significant risk factors for poor mental health outcomes (Browne, Wade, et al., 2021; Gallagher-Mackay et al., 2021; Grooms & Childs, 2021; McCoy et al., 2021). As symptoms declined, it is possible that children in this study already had some opportunity to adjust to COVID-19-related disruptions, since data collection began several weeks after the World Health Organization's initial pandemic announcement in March 2020 (Cucinotta & Vanelli, 2020). Emotional adjustments may have further coincided with some shifts to in-person operations in the countries included in the present study, which likely buffered against the pandemic's adverse impacts on children's mental well-being.

Trajectories in Screen Use and Emotional Problems Across Multiple Levels of Analysis

Despite a wealth of research documenting associations between screen exposure and indicators of poorer mental well-being, there remains an overemphasis on sample-level mean effects in this area of work (Browne et al., 2020). This is a key issue to address given growing indications of family-wide contextual effects in influencing screen time (Cillero & Jago, 2010; Coyne et al., 2014; Jago et al., 2012; Padilla-Walker et al., 2012). In the present study, temporally stable autoregressive components of cross-lagged panel models revealed both child-specific and family-wide differences in emotional problems and daily screen use. Among siblings from the same family, the child who engaged in higher screen use at previous time

points did so consistently over subsequent months. However, larger autoregressive parameters at the between-family level suggested that household-level differences were even more stable. Moreover, all but one of the significant cross-sectional links between screen time and emotional difficulties emerged at the between-family level; for instance, sibling pairs who averaged higher screen time simultaneously showed more symptoms of depression, anxiety, and anger at the first study time point. These results collectively affirm previous studies demonstrating that between-family contextual effects influence children's levels of daily screen time (Cillero & Jago, 2010; Tooth et al., 2021). Hence, family-wide factors related to media use (e.g., parental screen use, co-use of media) and beyond (e.g., COVID-19 disruption, socioeconomic status) likely also contribute to the co-occurrence of screen time and emotional difficulties (Browne, Wade, et al., 2021; Coyne et al., 2014).

Few Directional Associations Between Screen Use and Emotional Problems

The tendency for screen time to be consistently correlated with all three domains of emotional symptoms at study baseline (May 2020) aligns with much cross-sectional work from the early months of the pandemic. In China, studies identified associations between screen use and various indicators of worsened mental health, such as anxiety and depressive symptoms, in children and adolescents (Cao et al., 2021; Xiao et al., 2021). Similar effects were reported in Canada (X. Li et al., 2021), the United States (Nagata et al., 2022), Italy (Nicolì et al., 2022), and many other countries (Kovacs et al., 2021). Yet, the inability of these findings to inform directional conclusions represents a major shortcoming. A more rigorous examination of longitudinal associations in the present study revealed some inconsistent signals for directional relations between screen time and emotional difficulties.

At the between-family level, children with higher levels of depressive symptoms in July engaged in more screen use in September. Given that the obverse association was not significant, this finding may lend support to the possibility that digital media use was a form of coping. As COVID-19 upended the social lives of most children and youth, reports of loneliness skyrocketed (Loades et al., 2020), and participants in the present sample may have relied on device use to seek interpersonal support from friends and family outside of the home (Cauberghe et al., 2021). Entertainment and social media may also have acted as a digital distraction, offering a temporary escape from negative feelings (Eden et al., 2020). Finally, as COVID-19 mandated shifts to virtual mental health service delivery (Saunders et al., 2022), children and youth who showed higher depressive symptoms may have been more likely to seek professional support via devices.

Bidirectional relations also emerged between anxiety and screen use from July to September, indicating a potential positive feedback loop. During periods of lockdown and quarantine, screen use may be a helpful method of managing anxiety (Cauberghe et al., 2021). For instance, Drouin et al. (2020) observed stronger increases in media use—including for maintaining social connections—among children with higher levels of anxiety during the pandemic. On the other hand, turning to digital media to cope may limit one's ability to manage anxiety (Neville et al., 2021). Within the context of COVID-19, mutually reinforcing associations between anxiety and screen time could further reflect doomscrolling, a perpetual cycle of consuming distressing media that inflicts negative affect, leading to perpetual monitoring behaviour and distress (Blades, 2021; Price et al., 2022). As with depressive symptoms, children who experienced more anxiety may have also been inclined to seek support from friends, family, and mental health professionals. It is important to further consider the

potential presence of comorbidity between anxiety and depressive symptoms (Garber & Weersing, 2010). Although these two aspects of emotional problems were assessed in separate models, they may have followed similar patterns in the same participants to reflect higher levels of general internalizing symptoms, which would thereby result in significant associations in both models. Given these possibilities, future work may consider incorporating qualitative measures to explore the mechanisms underlying the predictive associations between internalizing symptoms and screen use.

It is important to note that signals for directional associations only emerged across two time points. Additionally, anger and screen use were not related over time. This stands in contrast with previous work suggesting that externalizing problems may result from some forms of media consumption (Riehm et al., 2019) or vice-versa (Neville et al., 2021). Discrepancies may, to some extent, be attributed to measurement differences, in that some studies extend over a longer time frame while others took place prior to COVID-19. These contextual variations are important to consider, as the role of digital media during the pandemic was very different than at any other point in history. Furthermore, some work incorporated a wider range of externalizing symptoms (e.g., aggression and hyperactivity), whereas the present study included a relatively brief assessment of anger. Significant effects, if present, may therefore have been too small to be detected, particularly as the present sample of caregivers generally reported lower levels of anger symptoms in children compared to internalizing challenges. However, it is also possible that externalizing behaviours such as anger are not associated with screen use (Ferguson, 2017; Stiglic & Viner, 2019).

Overall, the inconsistent and generally insignificant nature of directional relations in the present study precludes definitive conclusions regarding causality. In addition, the lack of child-

specific associations (that is, associations at the within-family level) indicates that screen use in individual children may not be inherently detrimental. As Przybylski and Weinstein (2017) assert, "moderate use of digital technology is not intrinsically harmful and may be advantageous in a connected world" (p. 207). This statement is particularly applicable within the context of virtual operations during the pandemic. Several other large-scale studies further assert that screen use has little effect on youth's mental well-being (Vuorre et al., 2021). Following this trend, the present study did not substantiate claims of putative causal effects. Rather, family-wide confounding factors and rapid fluctuations in COVID-19 public health restrictions may have led to oscillations in both screen use and emotional problems, thereby resulting in associations at the between-family level.

It is important to interpret the results of cross-lagged panel models in the context of the variance partitioning of study outcome variables. The lack of significant associations at the within-family level of analysis converges with the results of multilevel growth models, which revealed that sibling pairs generally showed very similar amounts of screen use throughout the study. Additionally, symptoms of emotional challenges were comparable within sibling pairs. Hence, while overall patterns indicate that there were no directional associations between screen time and emotional difficulties based on sibling differences, it is possible that effects were occluded by homogeneity within families. Further research that adopts sibling comparison designs may consider focusing on sibling pairs who show greater variability in outcomes. It is also possible that the unique context of the pandemic may have attenuated the associations between emotional challenges and screen time. Given that digital media use became a necessity rather than a choice for many children and youth under COVID-19 restrictions (Anitha & Narasimhan, 2020), screen-based devices adopted a new role as the facilitator of academic,

social, and recreational activities that may promote well-being. As such, the benefits of screen use during the pandemic may have outweighed the negative consequences, and additional work should explore this balance by incorporating a wide range of psychological outcomes. Nonetheless, the results from the present study broadly illustrate that screen time may not be inherently detrimental to well-being, especially as a wide range of factors, many of which reside at the family-wide level, impact mental health status.

Predictors of Screen Use Throughout the COVID-19 Pandemic

Child Demographic Characteristics and Screen Time

Digital media played a defining role in children's lifestyles during the pandemic, and there is a need to better understand the relative importance of individual and family factors associated with screen time. Several notable child-level demographic predictors emerged in growth models from the present study. In line with well-documented age differences in the literature (Rideout, 2015; Rideout & Robb, 2020; Twenge & Farley, 2021), older child age predicted higher screen time. This increase is typical of the transition from childhood through adolescence and young adulthood, reflecting natural progressions toward more media consumption as a wider range of on-screen activities becomes available (Rideout & Robb, 2019). This finding supports the application of a developmental lens to interpret and understand children's media use both during and beyond the pandemic (McArthur, Madigan, et al., 2021). Gender also had a slight predictive effect on screen time, such that parents consistently rated male children to exhibit higher use than females. Some previous studies corroborate this finding (Twenge & Farley, 2021), while others suggest that gender differences lie in the type of content consumed rather than the amount (Rideout et al., 2022). Further research must continue to explore the role of child demographic characteristics in relation to screen time. Explorations of

gender differences in media use and their associations with mental health outcomes are also warranted.

Life Style Factors as Predictors of Screen Time

Although the present study found some support for the notion that psychological distress (anxiety and depressive symptoms) prompts youth to engage in higher screen time, the relative influence of these associations must be qualified by a wider collection of lifestyle factors. In growth models, depressive symptoms and anger emerged as significant predictors of screen use, but with near-zero effect sizes. Hence, these predictors may be negligible in the context of additional factors that inform a comprehensive assessment of children's activities during the pandemic. In subsequent models that included screen use for socializing, physical activity, and sleep, the effect of depressive symptoms remained very small, and anger did not retain statistical significance. In comparison, technology use for social purposes emerged as a strong predictor of increased screen use. This finding provides empirical support for the essential role of screen-based devices in promoting interpersonal connections for children and youth during the pandemic. Activities such as video chatting or contacting others on social media may offer protection against the toll of stress and loneliness induced by COVID-19 restrictions (Imran et al., 2020; Orben et al., 2020). This perspective supports the notion that not all media use confers negative effects on well-being. The present study also found physical activity to be inversely related to screen time. A wealth of literature, often on the topic of media displacement, suggests that screen-based activities may overtake exercise. This effect is highly possible during pandemic shutdowns (Brown, Cairney, et al., 2021; Kovacs et al., 2021; Lizandra et al., 2019). However, this must be qualified by considerations of COVID-19 restrictions, which inevitably

led to both more screen time and less physical activity. As such, future work must explore the extent to which this association persists beyond the pandemic.

Promoting an active lifestyle may therefore buffer against any potential harms of excessive screen time. Although sleep disturbances did not predict higher screen use, this association requires further exploration as screen time may moderate links between children's sleep and mental well-being during the pandemic (Guerrero et al., 2020). Finally, caregivers' levels of parenting stress for each sibling did not predict children's screen time. Despite previous work suggesting that screens can act as a tool for managing parenting stress (L. Tang et al., 2018), this did not emerge as a contributing factor to children's screen use above and beyond other child-level predictors. Overall, these findings highlight that child demographic characteristics, the social aspects of media use, and physical activity ranked among the most salient within-family contributors to children's screen time during the COVID-19 pandemic.

Screen Time as a Family-Wide Activity

Recent studies suggest that media use is best conceptualized as a shared family activity (Coyne et al., 2017; Jennings, 2017; Villegas, 2013). In support of this perspective, between-family contextual differences accounted for over half (55%) of variability in screen time, thus warranting a thorough examination of family factors that may relate to children's screen use. The predictive effects of COVID-19-related disruption, past-year household income, caregivers' psychological distress, and caregivers' screen time were examined. Of these, parental screen use emerged as the strongest predictor of children's screen time. This may depict the role of modelling behaviours rooted in Social Learning Theory (Bandura, 1977), whereby children imitate the screen use habits of the adults around them (Lauricella et al., 2015). However, the predictive role of parental screen time could also suggest the presence of joint media

engagement, an activity that has become routine for families in recent years (Connell et al., 2015; Musick et al., 2021). Co-viewing TV programs and movies provides opportunities to build parent-child connections (Coyne et al., 2017). Video games also played a unique role in facilitating families' pandemic coping strategies (Pearce et al., 2021). In line with these findings, the present study further sustains that parental media use is closely related to children's screen time, although more research is required to understand the mechanisms that underlie this association. Nonetheless, for those children who may be spending excessive time on screens, considering their parents' media use behaviours may present an important point of intervention (Browne et al., 2020; Xu et al., 2015). This must be taken into account when providing parents with guidance regarding managing children's digital media use.

In summary, these findings support employing a family-wide lens to understanding the effects of screen use on children's psychological well-being. In considering the longitudinal associations between screen time and emotional problems across multiple levels of organization within the family, only a few directional relations emerged at the between-family level. This illustrates the role of shared contextual factors in the family on children's screen use. Hence, the various findings from this study converge to demonstrate that media use is best conceptualized as a family-wide activity. Implementing this perspective will enable more effective examinations of technology's impacts on psychological outcomes in developmental populations. Helping caregivers understand digital media use as a whole-family activity, as opposed to enforcing specific screen time rules for individual children, will promote positive development in a technology-saturated world.

Limitations and Future Directions

The present study has several strengths. The use of a longitudinal design, in conjunction with incorporating data from two siblings per family to achieve a quasi-experimental design, enabled the exploration of directional associations. Furthermore, investigating a range of child-specific and family-wide predictors of screen time added to the present understanding of factors that are most closely intertwined with media use in young people. Nonetheless, several limitations must be noted. First, the data available for the present study were limited to the period following the onset of the COVID-19 pandemic and therefore did not include information on the sample's screen time and mental health status before May 2020. Information regarding both short- and long-term trajectories on these measures would better situate the findings within the context of pandemic-related changes. That is, drawing longer-term comparisons that include measurements taken prior to the COVID-19 disruption would clarify whether associations emerged only under the circumstances of pandemic restrictions, or if pre-existing associations were exacerbated by the sudden addition of novel stressors. Given this limitation, there may be value in comparing the findings of the present study with others that have followed children before and during the pandemic, despite the potential for sample-specific attributes (McArthur, Racine, et al., 2021; ParentsTogether Foundation, 2020).

Several limitations lie in the study's measurement of screen use. First and foremost, past studies suggest that some caregivers tend to overestimate children's screen time, while others report underestimates (Nagata et al., 2021; Radesky et al., 2020). This results in flaws surrounding face validity (Browne, May et al., 2021). With many advocating for stronger measurement tools, alternative approaches to assessing screen use should be adopted in future work. This includes the use of multi-informant reports, ecological momentary assessment

methods (e.g., time-use diaries), and tracking applications. A combination of different approaches, such as the Comprehensive Assessment of Family Media Exposure tools developed by Barr et al. (2020), is most preferable.

The present study also did not account for the different types of media content that children engaged in. The concept of screen time condenses all media use into a single, unitary construct, which overlooks the wide range of activities that children engage in via device use (Browne, May et al., 2021; Ponti et al., 2017). Further, during the pandemic, children relied more on screens for attaining educational progress than ever before. As Odgers and Jensen (2020) suggest, "the next generation of digital mental health research for youth needs to ask when, under what conditions, and for whom does engagement with digital technology create opportunities, amplify risk, or neither" (p. 343). Methodology that accounts for the contents of digital media use will provide much more nuanced insight into the psychological outcomes related to children's screen use. This approach will further promote the adoption of conceptual frameworks that better account for technology's differential impacts on child development (McArthur et al., 2022; Navarro & Tudge, 2022).

Finally, the generalizability of the findings from this study is limited. Given that a sibling requirement was implemented, the results may not apply to other family constellations, such as those with one child or those with multiple children under 5 years of age. Additionally, the sample lacked a strong representation of ethnic and cultural minorities, as well as low-socioeconomic status households. Previous literature indicates that disadvantaged groups may hold divergent viewpoints on technology use, experience varying levels of access to devices, or rely on digital media for different purposes (Leung, 2014; Rivera & Valdivia, 2013). Moreover, research has highlighted that the COVID-19 pandemic disproportionally impacted the well-being

of racialized populations and low-income families (N. Singer, 2020; Tai et al., 2021). To this extent, future studies must include a more diverse sample of participants to achieve widely applicable accounts of the interactions between digital media use and mental health.

Clinical Applications

The findings across multiple components of the present study bear important implications for the current understanding of how screen time affects child and youth mental health. The results are also closely relevant to digital media use guidelines.

Moving Beyond Screen Time Guidelines

Although the AAP's original screen time recommendations first emerged over two decades ago and have since undergone revisions, this outdated advice continues to permeate parenting advice in the media (Blum-Ross & Livingstone, 2018; World Health Organization, 2019). Helping youth meet the 2x2 rule has become increasingly impractical in the face of rapid digitization and the COVID-19 pandemic, but parents continue to experience guilt and apprehension in the area of regulating children's screen use (Blum-Ross & Livingstone, 2016). Given a lack of robust causal evidence, it is important to leave blanket screen time guidelines behind and communicate to caregivers that moderate levels of screen use are unlikely to be inherently harmful to children's well-being. Instead, pediatric health providers should dedicate stronger efforts to helping parents understand and monitor the content and contexts of their children's digital media use (Blum-Ross & Livingstone, 2016; Cheng & Wilkinson, 2020). This will encourage youth to engage with technology in ways that promote opportunities for social, cognitive, and academic growth, and thereby foster constructive ways to incorporate screen-based devices into young people's lives.

Examining Digital Media Use as a Family-Wide Activity

The ubiquity of devices in the home also holds important implications for the integration of digital media into family life. The present study upholds the perspective that children's screen use and relevant psychological outcomes must be situated within the broader family environment. Therefore, media use guidelines must bring attention to the role of devices in the overall family ecology, rather than frame children's screen use as a separate, isolated activity. Researchers, clinicians, and policymakers should encourage parents to implement media plans that adopt a whole-family approach to managing multiple components of technology use (American Academy of Child and Adolescent Psychiatry, 2020b; American Academy of Pediatrics, n.d.; Chassiakos et al., 2016). This includes emphasizing not only specific facets of children's media use but also increasing caregivers' awareness of their own device use habits. Another important step involves encouraging shared media activities in the home. Creating and disseminating guidelines that capture these principles will effectively help families establish healthy relationships with technology, and thereby foster positive well-being for children in the digital age.

Conclusion

Throughout the pandemic, researchers and clinicians have depicted the harmful effects of screen time on children's mental health difficulties as an issue of ongoing public health concern (Sultana et al., 2020; Wiederhold, 2020). While this perspective rightfully emphasizes the importance of attending to children's screen use and monitoring for psychological consequences, a balanced approach is critical. This study addresses longstanding issues of directional and contextual ambiguity in the screen time literature. Findings highlight that screen use is one of many interactive factors related to mental health, embedded in both individual and family contexts (Browne et al., 2020). As such, researchers, clinicians, and policymakers must move beyond a "one-size-fits-all" approach that focuses on time-based guidelines. A shift to tailored recommendations that encapsulate multiple dimensions of media use and cater to the unique needs of every child and family will best serve efforts to promote healthy development in the 21st century.

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