Screen media exposure and behavioral adjustment in early childhood during and after COVID-19 home lockdown periods

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ABSTRACT

There is ample evidence that young children's screen media use has sharply increased since the outbreak of the novel 2019 coronavirus disease (COVID-19). However, the long-term impact of these changes on children's adjustment is currently unclear. The goals of the current study were to assess longitudinal trajectories of young children's screen media exposure through a series of national COVID-19 home lockdowns and to examine the predictive associations between different aspects of media exposure and post-lockdown behavioral adjustment. Data were collected at four timepoints during and after home lockdown periods in Israel. Longitudinal data measuring various aspects of media use, behavioral conduct and emotional problems were gathered from a sample of 313 Israeli children (54% females) between the ages two to five years (*M*age at T1 = 3.6), by surveying their mothers at 5 points in time. Child overall screen time use, exposure to background television, use of media to regulate child distress and maternal mobile device use all changed throughout the lockdown periods. Moreover, during lockdowns children's behavior problems were concurrently and positively correlated with screen time, use of media to regulate child distress, and exposure to background television. However, these were not longitudinally related to child behavior problems in the post-lockdown period. Possible implications for family media use during a public health crisis are discussed.

1. Introduction

The implementation of home lockdown and social distancing regulations due to the global outbreak of the novel 2019 coronavirus disease 2019 (COVID-19 pandemic) resulted in significant changes in family lifestyles, including children's media use patterns (Hartshorne et al., 2021; Pombo et al., 2021; Sultana et al., 2021; Wiederhold, 2020). Across multiple countries and reports, children's screen media use sharply increased during school and childcare center closures (Carroll et al., 2020; Eales et al., 2021; Hartshorne et al., 2021; Ozturk Eyimaya & Yalçin Irmak, 2021; Pombo et al., 2021; Ribner et al., 2021), raising questions about the possible effects of this increase on children's well-being. However, these changes in media use might be essential for educational purposes, social interactions, or as a form of entertainment to enable parents to work and cope with the multiple stressors that may arise during times of turmoil and uncertainty (Radesky, 2020; Ribner et al., 2021; Wiederhold, 2020). While extant research has explored

changes in media use among adolescents and adults during the COVID-19 pandemic (Drouin et al., 2020; Górnicka et al., 2020; Pišot et al., 2020), less is known about media use among families with young children (Carroll et al., 2020). Moreover, the impact of media use on children's subsequent adjustment is currently unknown (Radesky, 2020). A clear understanding of how these changes may affect children's behavior is necessary to inform guidelines that promote appropriate media use during the current and any future public health crisis. Accordingly, the goals of the current study were to assess trajectories of young children's media use through national COVID-19 home lockdown periods and examine the links between different aspects of media use and children's post-lockdown behavioral adjustment.

1.1. Theoretical and empirical background

1.1.1. Screen media use during the COVID-19 pandemic in young children

The social distancing regulations and periodic lockdowns that were

implemented in response to the COVID-19 outbreak have resulted in a worldwide increase in screen media use, as individuals have become strongly reliant on screens for remote working, social interaction, and entertainment (Carroll et al., 2020; Drouin et al., 2020; Górnicka et al., 2020; Keel et al., 2020; Ozturk Eyimaya & Yalçin Irmak, 2021; Pišot et al., 2020). Research on adult samples shows that between 49 and 70% of adults reported spending more time using screens during this period (Górnicka, 2020; Pišot et al., 2020). An emerging body of literature suggests a similar increase among young children (Bergmann et al., 2022; Carroll et al., 2020; Eales et al., 2021; Pedrotti et al., 2022; Ribner et al., 2021). For example, in a study focused on children under the age of 6 years living in Canada, parents reported that since the COVID-19 outbreak 87% of children increased recreational screen use (Carroll et al., 2020). Researchers in Brazil compared digital media use in a sample of children under 3 years measured before with a sample measured during the COVID-19 pandemic and found that media use duration was higher during the pandemic, but only among children over 12 months of age (Pedrotti et al., 2022). Finally, a study that examined young children's (8-to-36-month-olds) screen time in a large cohort sampled from 12 countries during the first COVID-19 lockdown reported an increase in children's screen time during lockdown relative to the period before lockdown (Bergmann et al., 2022). Furthermore, the increase in screen time was related to lockdown durations such that children from countries with longer lockdowns had larger increases in screen time compared to children from countries with shorter lockdowns.

Some researchers examined the types of direct media exposure. Ribner et al. (2021) collected data between April and July 2020 from families with 3 to 7-year-olds across six countries (Australia, China, Italy, Sweden, the United Kingdom, and the United States) and found that screen use increased on average by 50 min per day relative to pre-pandemic retrospective reports and the increase in usage was higher among low-income families. Increases were predominantly for entertainment purposes, but parents also reported a 20 min/day increase in the use of educational apps.

Researchers have begun examining how changes in screentime are associated with demographic characteristics and parent and child well-being. For example, a study conducted in Israel on 2-to-8-years-old children found that the strongest demographic predictor of child screen time in the Jewish population during the first COVID-19 lockdown was child age, with older children being exposed to longer screen time (Meoded Karabanov et al., 2021). Additionally, parents of older children were less involved in selecting and supervising the digital content that they were exposed to (Meoded Karabanov et al., 2021). In a cross-sectional survey study conducted in the US during the COVID-19 pandemic, more screen time was associated with higher total difficulties among younger (6–10 years) and older (11–17 years) children (Tandon et al., 2021). However, the authors caution that longitudinal studies are needed to better understand the direction of this association.

Although these studies provide evidence of an increase in children's overall screen time and in a few cases included the type of media content, the common use of global estimates of screen time are based on intentional direct exposure to media and disregards important aspects of media use, such as context (i.e., when and how media is used in the household), including incidental exposure to background media exposure that may have nuanced effects on children's social-emotional functioning (Barr, 2019; Barr et al., 2020; Danet et al., 2022).

1.1.2. Screen media use and behavioral adjustment in early childhood

The use of screen media devices became deeply embedded in the lives of young children long before the COVID-19 outbreak, motivating both scientific inquiry and a public debate about the potential effects of media use on children's development. Displacement theory posits that frequent use of screen media might replace time participating in activities that are crucial for children's social-emotional development, especially activities involving physical movement and interpersonal

communication, and may thus negatively affect children's mental health and well-being (Kraut et al., 1998; Zimmerman & Christakis, 2007). Hence, abundant research has focused on examining the links between children's recreational screen media use and behavior problems. Overall, whereas there is evidence for positive cross-sectional links between screen time and child behavior problems, such as emotional and conduct problems (Liu et al., 2021; Wu et al., 2017), findings from longitudinal studies that considered baseline levels of behavior problems as well as the bidirectional links between screen time and behavior problems suggest that these associations are complex (Hinkley et al., 2014; McDaniel & Radesky, 2020; Neville et al., 2021). For example, a large cohort study that collected data at two time points (child baseline age 2–6 years), and controlled for baseline levels of well-being outcomes, found that early childhood electronic media use was associated with children being at risk for poorer outcomes only for some indicators of well-being (e.g., emotional problems) and not others (e.g., peer problems; Hinkley et al., 2014). Findings from an additional cohort study (Neville et al., 2021) that collected data on screen time and behavior problems at four time points (ages 3, 5, 7, and 9 years) showed bidirectional associations between screen time and internalizing problems. However, children's initial levels of externalizing behaviors were associated with later increases in screen time, but not vice versa. McDaniel and Radesky (2020) reported a similar pattern of associations between screen time and externalizing behaviors using a sample 1- to 5-year-old children measured at two time points. These findings suggest that whereas excessive screen time can lead to behavioral problems, it also possible that children with behavioral problems are exposed to more screen time to manage their problematic behavior (Neville et al., 2021).

In addition to children's direct media use or screentime, attention has recently been drawn to contextual aspects of media use, such as how media is used in the household and children's daily routines (Barr, 2019; Gueron-Sela & Gordon-Hacker, 2020). In the current study, we will focus on three contextual aspects of media use that can be particularly relevant during home lockdown periods in which parents and children spend most of their time together at home, including household background television, use of media to regulate child emotions, and parental mobile device use while parenting, none of which are captured by typical global measures of children's screentime.

Household Background Television. Background television is defined as content not intended for children that occurs in the background while children are engaged in other activities (Anderson & Evans, 2001; Schmidt et al., 2008). Children pay little active attention (~5%) to background television (Schmidt et al., 2008) and therefore parents frequently do not report this form of media exposure in their estimates of direct screen time. Prolonged exposure to background television use may result in children's unsupervised exposure to violent or inappropriate content. In the United States, 42% of parents in the US report the television is on "always" or "most of the time" in their home, whether anyone is watching or not (Rideout, 2017). Although young children frequently orient to the screen for short periods prompted by television sound effects and then look away, exposure to background television interferes with experiences such as toy play and social interactions that are essential for children's development. For example, background television decreases play episode duration, play quality and complexity (Schmidt et al., 2008), and parent-child interactional quality (Kirkorian et al., 2009). Furthermore, elevated exposure to background television has been concurrently and longitudinally associated with lower self-regulation abilities and higher aggressive behavior and emotional problems in early childhood (Barr et al., 2010; Chonchaiya et al., 2015; Manganello & Taylor, 2009; Ribner et al., 2020).

Use of Media to Regulate Child Distress. The American Academy of Pediatrics (AAP) does not recommend use of screen media devices as a means to regulate children's distress, as excessive use of this strategy can interfere with the development of self-regulation abilities (Council on Communications and Media, 2016). The use of screen media to calm children's distress can establish passive and ineffective regulatory

strategies in young children, resulting in increased arousal and difficulties in regulating emotion in the face of environmental demands (Gordon-Hacker & Gueron-Sela, 2020; Gueron-Sela & Gordon-Hacker, 2020). Previous research has shown positive cross-sectional associations between parental use of media to regulate children's emotions and toddlers' negative affect and social-emotional difficulties (Coyne et al., 2021; Radesky et al., 2016). However, the authors caution that longitudinal studies are needed to understand the direction of this association, as children's behavior problems and the use of media to regulate may influence each other in a transactional manner. Parents may soothe fussier children using screen media, which decreases interpersonal communication and opportunities for social exchanges that promote children's self-regulatory abilities and contributes to continued behavioral difficulties (Coyne et al., 2021; Gueron-Sela & Gordon-Hacker, 2020; Radesky et al., 2014).

Parental Mobile Device Use. Due to their portability and accessibility, the use of modern mobile devices has increased during many family activities such as meals and playtime, creating opportunities for "technoference": interruptions in interpersonal interactions that occur due to digital and mobile technology devices (McDaniel & Coyne, 2016). Accumulating evidence suggests that when parents are occupied with mobile devices, their ability to respond to their children's cues is limited (see Kildare & Middlemiss, 2017; McDaniel, 2019, for reviews). In response, children may escalate expressions of negative affect to regain their caregivers' attention (McDaniel & Radesky, 2018). Experimental studies examining the immediate effect of parental mobile device use on children's behavior show that young children express less positive affect, more negative affect, and less toy engagement when their mothers are occupied with a mobile device compared to free-play with no mobile device (Konrad et al., 2021; Myruski et al., 2018; Rozenblatt-Perkal et al., 2022). Correlational studies further show that technoference in parent-child interactions was concurrently and longitudinally associated with elevated levels of both externalizing and internalizing behavior problems (McDaniel & Radesky, 2018; Sundqvist et al., 2020; Wong et al., 2020).

1.1.3. Moderators of screen media use effects

Although there is some evidence for direct links between screen media use and children's behavior problems in early childhood, there are also inconsistent findings across studies (Hinkley et al., 2014; McDaniel & Radesky, 2020; Wu et al., 2017), stressing the need to examine moderating factors. The differential susceptibility to media effects model (DSMM; Valkenburg & Peter, 2013) suggests that some individuals may be more strongly affected by media use than others depending on dispositional, developmental, and social contextual factors. *Dispositional* susceptibility refers to internal characteristics that predispose an individual's responsiveness to media exposure, such as gender and temperament (Piotrowski & Valkenburg, 2015). For example, a recent study found that initial levels of child negative affectivity moderated the link between maternal use of media to regulate child distress and negative affectivity eight months later (Gordon-Hacker & Gueron-Sela, 2020). *Developmental* susceptibility refers to responsiveness to media due to children's cognitive, emotional, and social developmental stage (Piotrowski & Valkenburg, 2015). Young children may be more susceptible to the effects of violent or arousing media content than older children as they are not fully able to differentiate reality from fantasy, focus less on perceptual characteristics and do not fully understand others' perspectives ((Piotrowski & Valkenburg, 2015). For example, the effect of exposure to violent media on aggressive behavior was found to be stronger for preschool-aged children than for older children and adolescents (Paik & Comstock, 1994). Finally, *social contextual* susceptibility is defined as all social-context factors that can impact children's responsiveness to media, including the home environment, institutional contexts, family demographics, and cultural norms and values. For example, there is evidence that the link between background media use and children's self-regulation is stronger among children exposed to heightened demographic risk (e.g., low income to needs ratio, low levels of maternal education) compared to children from low-risk families (Linebarger et al., 2014; Wright et al., 2001).

1.2. The current study

Accumulating evidence suggests that young children's screen media use has increased since the outbreak of the COVID-19 pandemic, often increasing feelings of guilt and concern among parents (Vanderloo et al., 2020). Because the use of screen media has become an integral part of family life during this ongoing public health crisis, it is imperative to understand whether children's media use during this time has implications for their behavioral adjustment.

In March 2020, the first national home lockdown regulations were implemented in Israel, including daycare and school closures, lockdown laws, and social-distancing recommendations. These regulations were gradually amended with the decrease in infection rates, and schools and childcare centers reopened in May 2020. However, a total of three national home lockdown periods were implemented between March 2020 and January 2021. These nationwide defined periods of home lockdown across Israel provided us a unique opportunity to examine changes in media use and exposure during and after the lockdown periods.

The current study addresses the following limitations of previous research on young children's media use during the COVID-19 pandemic. First, the literature currently lacks a systematic longitudinal investigation of changes in children's media use through different time points during the pandemic. Second, the extant COVID-19 media use literature focused exclusively on examining child screen time while disregarding contextual, indirect measures of media exposure. Third, the long-term effects of children's media use and exposure during the pandemic are currently unknown. Finally, the literature on the associations between screen media use and child outcomes has traditionally relied on frequentist approaches to statistical inference that often lead to misinterpretation of null findings (Held & Ott, 2018). This may partially explain the mixed findings regarding the associations between screen media use and children's behavior problems (e.g., Liu et al., 2021; McDaniel & Radesky, 2020; Neville et al., 2021; Wu et al., 2017). To address this limitation, in the current study we used both traditional hypothesis testing and Bayesian analysis that allows for a comparison between the evidence for the null and alternative hypotheses and the strength of evidence in either direction (Aczel et al., 2018). We proposed the following research questions:

RQ1. Did young children's use of screen media change before, during, and after the COVID-19-related home lockdown periods? Guided by a family media ecology perspective (Barr, 2019), we focused on direct measures of child screen time as well as contextual measures of media use such as exposure to household background television, maternal use of media to regulate child distress, and parental mobile device use while parenting.

RQ2. Are different aspects of screen media use during the home lockdown periods related to children's behavior problems post-lockdown? We specifically focused on children's conduct and emotional problems, two behavioral domains that were previously associated with different aspects of media use (e.g., (Liu et al., 2021; Wu et al., 2017).

RQ3. Are links between screen media use and children's behavior problems moderated by child dispositional characteristics (i.e., biological sex, baseline behavior problems), developmental stage (i.e., child age), and contextual factors (i.e., family income)?

2. Methods

2.1. Sampling and participants

The study protocol was reviewed and approved by the Human Subjects Research Committee at (retracted for review). Data were collected from March 2020 to March 2021 through The Midgam Project Web Panel (MIDGAM). This online Israeli research platform has access to a sample of approximately 100,000 panelists that participate in different online studies for a fee (http://www.midgampanel.com/research/en/index.asp). MIDGAM is a valuable alternative to other crowdsourcing platforms and recruitment through social media because of the ability to screen participants based on prescreening questions and the ability to conduct longitudinal studies by re-approaching participants from a specific study. Mothers of children between two and five years of age were initially approached via MIDGAM and invited to participate in the study. Mothers were asked to choose one specific child within the age range of 2–5 years and to complete questionnaires that assess household media use habits, child behavior problems, COVID-19 related emotional distress, and demographic information. Mothers were asked to complete the questionnaire using the same target child through all time points. To verify that mothers referred to the same target child at each time point, we asked mothers to state the child's initials and age at each time point.

For the current analysis, we used data that were collected at four time points (see Table 1 for design timeline). T1 was collected at the end of March 2020, during the first home lockdown (L1) in Israel. At T1, mothers were also asked to retrospectively answer questionnaires about the two months before the COVID-19 outbreak in Israel (T0; Pre-L). Data at T2 were collected during October 2020, the second lockdown period in Israel (L2). Data at T3 were collected during January 2021, the third lockdown period in Israel (L3). Finally, data at T4 was collected during March 2021, one month after the home lockdown regulations were amended, and childcare systems reopened (Post-L). Mothers completed all the study questionnaires.

We obtained 328 valid responses at T1. Response rates for the time points following T1 were 77% at T2, 76% at T3 and 65% at T4. Eight participants were excluded from the analysis due to child health and developmental problems (n = 5), severe maternal health problems (n = 2), incorrect answers to attention verifying items at all time points ("If you read this please mark 4"; n = 1). A total of thirty-six responses at specific time points were removed due to mothers completing the questionnaire for a different target child than the other time points, as indicated by different child initials and age. A total of seventeen responses at specific time points were removed due to incorrectly answering the attention verifying items. After removing these invalid responses, a total of seven participants were removed for having valid data at only one time point. The final sample size at each time point was 279 at T1, 202 at T2, 210 at T3 and 181 at T4. For the current study we included participants that contributed data for at least 2 timepoints (N = 313).

2.2. Measures

2.2.1. Child screen media use and exposure

Children's screen media use and exposure were assessed using selected questions from the media assessment questionnaire (MAQ), that was developed by The Comprehensive Assessment of Family Media Exposure (CAFE) consortium (Barr et al., 2020).

Overall Screen Time. We choose to focus on recreational screen time based on research showing that this type of screen time showed the sharpest increase during the COVID-19 pandemic (Ribner et al., 2021). At timepoints T1 to T4, mothers reported the total time (i.e., number of hours and number of minutes in 15-min intervals) the child spent on a typical day engaging in different types of media use, including 1) program viewing on any type of digital media device (i.e., television, tablet, computer, or mobile phone; 2) game playing on digital media devices (i.e., tablet, computer, or mobile phone). Mothers were also asked to report about these measures retrospectively, at the months before the COVID-19 outbreak (T0). The reported times in minutes for each type of media use were summed to create a measure of media use at each time point.

Household Background Television. At time points T1 to T4, mothers were asked to indicate the degree to which they agreed with the statement "There is usually a television turned on somewhere in our home" on a scale ranging between 1 ("Definitely untrue") to 5 ("Definitely true"). Mothers were also asked to report about these measures retrospectively, for the months before the COVID-19 outbreak (T0).

Use of Media to Regulate Child Distress. At timepoints T1, T3 and T4, mothers were asked to indicate how often they used media to calm their child down when she/he was upset in the past week on a scale ranging from 1 ("Never") to 7 ("Several times per day"). Use of media to regulate child distress was not collected at T2 due to a technical error.

Maternal Mobile Device Use While Parenting. At timepoints T1 to T4, mothers were asked to rate how likely they were to use their phone or other devices (e.g., to make calls, text, check email, watch a video, check social media) in the last week during the following activities with the child: meals, indoor play, bedtime, and outdoor play. Each activity was rated on a scale from 1 ("I never do this") to 5 ("Very likely").

2.2.2. Child behavior problems

The Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997) was used to assess children's conduct problems at all three time points. The SDQ contains 25 items, each of which was scored on a 3-point scale (0 = not true, 1 = somewhat true, 2 = certainly true). In the current study we used two subscales: conduct problems (5 items, e.g., "Often loses temper") and emotional problems (5 items, e.g., "Often unhappy, depressed or tearful"). Scale scores were generated by summing the items on each scale. Cronbach α coefficients ranged from 0.58 to 0.72 for both the emotional and conduct problems scales.

2.2.4. Covariates

Covariates included child biological sex and age, family income, and maternal COVID-related distress. Family income was reported on a six-point scale ranging from "no income" to "Significantly above average" based on the national monthly average income in Israel.

Maternal COVID-19 Related Distress. Mothers' COVID-19 related distress was assessed using a questionnaire that taps several aspects of emotional distress (e.g., restlessness, difficulty concentrating, excessive worry) in the context of the COVID-19 outbreak (e.g., "I feel like I am not able to protect myself and my family from the COVID-19"; "I am worried about the financial implications of the COVID-19 pandemic for me and my family"). This questionnaire contains 14 items, each of which was scored on a 5-point scale (0 = not true, 1 = slightly true, 2 = somewhat true, 3 = true, 4 = very true). Scale scores were generated by averaging the items on each scale. Cronbach α coefficients ranged from 0.88 to 0.90.

2.3. Missing data

Overall, 181 individuals (58%) provided data across all the different time points, and the average of missing data per timepoint was 26% (see

Table 1
Design timeline.

Time point	T0	T1	T2	T3	T4
Month	March 2020	March 2020	October 2020	January 2021	March 2021
Period	Pre-lockdown (Pre-L)	Lockdown 1 (L1)	Lockdown 2 (L2)	Lockdown 3 (L3)	Post-lockdown (Post-L)

the percent of missing data for each main variable in Table 2). Little's test was conducted using R package 'naniar' v0.6.1 (Tierney & Cook, 2018), yielding insignificant results ($p = 0.19$), suggesting that the missing data are missing completely at random. Missing data were imputed using the 'mice' package v3.13.0 (Van- Buuren & Groothuis-Oudshoorn, 2011). As the expected effect sizes are relatively small and the percentage of missing data is relatively high (26% on average), the number of imputations was set to 26 following the recommendation of White et al. (2011). Predictive mean matching was used as the imputation method for all variables except for child biological sex, which was imputed using logistic regression. All analyses were also re-analyzed using the raw data, showing overall consistent findings to those reported using the imputed datasets (see Appendix A).

2.4. Statistical analysis

All statistical analyses were conducted using R software version 4.1.0. (R Core Team, 2021).

2.4.1. Changes in media use

Repeated measures one-way ANOVAs were conducted to examine whether media use and exposure to media differed between timepoints. These analyses were conducted using the 'nlme' package v3.1 (Pinheiro et al., 2017) and the 'multcomp' package v1.4-17 (Hothorn et al., 2008). Results from the multiple imputed datasets were pooled using the 'mitml' package v0.4–1 (Grund et al., 2016).

As residuals of several models deviated from normality, some variables were transformed as follows: Child screen time use was transformed using $\sqrt{x + 1}$ transformation to correct for a mild positive skew. Household background television could not be transformed to a normal distribution by any conventional transformation, thereby we chose using the Friedman test, a non-parametric alternative for repeated-measures ANOVA. As the Friedman test statistic follows a χ^2 distribution, results were pooled using the micombine. chisquare function of the 'miceadds' package v3.11–6 (Robitzsch et al., 2017) which combines all statistics into an approximate F-distributed statistic (formulas can be found in Allison, 2001 and Enders, 2010). Planned comparisons for this analysis were carried out using paired Wilcoxon tests, and results were pooled calculating D2 statistics (as described by Li et al., 1991). The residuals of the models examining maternal use of media to regulate child distress and use of mobile devices were approximately normally distributed. To account for multiple comparisons, the p-values of the planned comparisons were adjusted for multiple comparisons using Bonferroni corrections ($p_{adj} = p$ x number of planned comparisons).

2.4.2. Prediction of Children's post-lockdown conduct and emotional problems

We conducted two regression analyses with child total screen time, household background television, use of media to regulate child distress, and maternal phone use during routines during home lockdowns as predictors of behavioral and emotional problems (separately) post-lockdown at T4. For this analysis, we used an average of children's reported media use between the three lockdown periods. Maternal COVID-related stress, socioeconomic status, child age, and child biological sex were used as covariates. After $\sqrt{x + 1}$ transformation of the dependent variables, residuals of each model were approximately normally distributed. Analyses were carried out using 'stats' package v3.6.2 (R Core Team, 2021). As the reliability of the conduct problems scale of the SDQ was below the acceptable level of $\alpha > 0.7$, a multivariate analysis of variance (MANOVA) was used to examine whether the regression coefficients differed across prediction of the five items of this scale (see Appendix B, Table B1). As no differences were found (Pillai's Trace < 0.07, $p > 0.05$), this scale was analyzed as a single dimension.

We then examined whether dispositional characteristics of the children (age, biological sex), and contextual factors (socioeconomic status) contributed to the model fitting as possible moderators. To do so, for each moderator we compared the models with and without the moderator. We aimed to examine only models with at least substantial evidence for the contribution of the moderating effect.

To gain further support for the robustness of the results, a complementary Bayesian approach was adopted. Unlike classical inference, Bayesian approaches directly assess the relative strength for one hypothesis over the other, thereby providing a better estimate for the null hypothesis (Aczel et al., 2018). Such complementary analyses were previously implemented in other studies (e.g. Yatziv et al., 2018; Zhang et al., 2021). Two Bayesian regression analyses were conducted using the 'brms' package v2.15.0 (Bürkner, 2017) which is based on *Stan* (Carpenter et al., 2017). All variables were standardized and mean centered. We set commonly used weakly informative priors for the model betas ($\beta \sim N(0, 1)$ and a positive half Cauchy distribution ($x_0 = 0$, $\gamma = 1$) for the standard deviation. Such priors are reasonable (as they assume that the estimates will most likely fall between -1 and 1 and revolve around 0), are preferred over the use of non-informative priors (Lemoine et al., 2019), and were previously used in other studies in the field (e.g.,Tunçgenç et al., 2021). The Bayesian models were fit in 4 Markov chains with 10,000 iterations (5000 warmups) and showed satisfactory convergence in both analyses (rhat = 1).

Additional hypothesis tests were conducted to provide Bayes Factors (BFs) for predictors with credible intervals including zero, quantifying the evidence supporting the null hypothesis (BF_{01}). We followed Jeffreys (1961) evidence categories interpretation of BFs, with $BF = 1$ indicates equal evidence for H0 and H1, while $BF_{01} > 3$ and $BF_{01} > 10$ indicate substantial and strong evidence in favor of H0 (respectively).

Complementary Bayesian analyses were also conducted to examine the moderation analyses estimating BF comparing between the model with and without interaction terms. We set weakly informative priors for these terms (see Supplementary Materials).

2.4.3. Power analysis

An a priori power analysis based on 5000 Monte Carlo simulations revealed that 300 participants should provide sufficient power ($\beta > 0.8$

Table 2
Sociodemographic characteristics of participants at baseline.

Variable		Statistic	N
Child biological sex		53.7% females	168 females
Child age		Mean = 3.61 years (0.95)	313
Number of children in the family		Median = 2 (1)	313
Family income (based on the national monthly average in Israel)	Much less than average	17.375%	55
	Less than average	29.16%	91
	Average	33.48%	105
	More than average	14.82%	46
	Much more than average	5.16%	16
Family status	Single	3.19%	10
	Married	95.85%	300
	Divorced	0.64%	2
	Widowed	0.32%	1
Maternal education	Less than high school diploma	3.51%	11
	High school diploma	8.63%	27
	BA degree/BA student	60.38%	189
	MA degree/MA student	25.56%	80
	PhD/PhD student	1.92%	6

Note. Standard deviations are in parenthesis.

with $\alpha = 0.05$) to detect effects of small sizes ($\eta_p^2 = 0.02$) for the repeated measures ANOVA analyses and effects of small-to-medium sizes ($\beta = 0.2$) in the regression analyses. Power analysis was conducted using the powerCurve function from the 'simr' v1.0.5 package (Green & MacLeod, 2016) and the 'simsem' package v0.5-16 (Pornprasertmanit et al., 2021).

3. Results

3.1. Descriptive statistics and bivariate correlations

Descriptive statistics of the demographic characteristics and variables across the three time points are shown in Tables 2 and 3, respectively. Children's conduct problems and emotional problems increased from pre-to post-lockdown t (312) = 2.82, $p = 0.005$, $\eta_p^2 = 0.02$ for conduct problems; t (312) = 3.60, $p = 0.0003$, $\eta_p^2 = 0.04$ for emotional problems.

Correlations between study variables are shown in Table 4. During lockdown periods, children's emotional problems were concurrently positively correlated with screen time use, use of media to regulate child distress, and background television. Conduct problems were positively correlated with screen time use and use of media to regulate child distress. None of the media use measures during lockdown periods were correlated with children's emotional problems in the post-lockdown period. Only use of media to regulate child distress during lockdown periods was positively correlated with children's post-lockdown conduct problems. COVID-19-related distress was perhaps not surprisingly associated with many of the measures during lockdown.

3.2. Changes in media use and exposure

Fig. 2 summarizes the results of the changes in media use and exposure pre-, during, and post-lockdowns.

Child screen time significantly changed between the five time points F (4, 1560) = 107.295, $p_{adj} < 0.0001$, $\eta_p^2 = 0.22$; See Fig. 2A. Post-hoc analyses revealed that screen time increased at L1 compared with pre-L t (312) = 13.06, $p_{adj} < 0.0001$, $\eta_p^2 = 0.35$. The increase in screen time use did not change from L1 to L2 t (312) = 1.417, $p_{adj} = 0.47$, $\eta_p^2 = 0.006$ or from L2 to L3 t (312) = −0.477, $p_{adj} = 0.99$, $\eta_p^2 = 0.0007$. Screen time increased even further post-L t (312) = 8.40, $p_{adj} < 0.0001$, $\eta_p^2 = 0.18$.

As the residuals for the household background television model were not normally distributed, a Friedman test was conducted revealing significant changes in household background television exposure F (4,542) = 12.17, $p_{adj} < 0.0001$, *Kendall's W* = 0.049 – interpreted like Cohen's d; see Fig. 2B). Planned Paired Wilcoxon tests revealed that household background television exposure at L1 increased compared with pre-L (Z = 7.89, $p_{adj} < 0.0001$, $r = 0.26$); these changes decreased at L2 (Z = −4.08, $p_{adj} = 0.002$, $r = 0.13$), and did not change from L2 to L3 (Z = −0.77, $p_{adj} = 0.99$, $r = −0.001$), or from L3 to post-L (Z = 1.65, p_{adj} = 0.99, $r = 0.05$).

Next, our analyses revealed that maternal use of media to regulate child distress differed across time, F (3,624) = 22.47, $p_{adj} < 0.0001$, $\eta_p^2 = 0.1$ (see Fig. 2C). Maternal use of media to regulate child distress

dropped from L1 to L3 t (312) = −4.21, $p_{adj} = 0.0001$, $\eta_p^2 = 0.05$ and from L3 to post-L t (312) = −2.31, $p_{adj} = 0.046$, $\eta_p^2 = 0.02$.

Lastly, we found differences in maternal use of mobile devices while parenting F (3,623) = 8.81, $p_{adj} < 0.0001$, $\eta_p^2 = 0.04$ (see Fig. 2D). Post-hoc analyses revealed that maternal mobile device use increased from L1 to L2 t (312) = 4.27, $p_{adj} = 0.0001$, $\eta_p^2 = 0.06$, and did not change from L2 to L3 t (312) = 0.18, $p_{adj} = 0.99$, $\eta_p^2 = 0.0001$, or post-L t (312) = −1.05, $p_{adj} = 0.76$, $\eta_p^2 = 0.003$.

3.3. Prediction of Children's post-lockdown conduct problems

The results of the regression model predicting child post-L conduct problems suggest that all predictors explained 9% of the variance ($R^2 = 0.09$, F (8,304) = 3.88, $p = 0.003$). Results are reported in Table 5. None of the media use and exposure variables significantly predicted the children's conduct problems post-lockdown. These findings converged with the Bayesian regression analysis (see *Appendix c*).

3.3.1. Moderation analysis

Socioeconomic status, child biological sex, and child age did not contribute to the model as moderators F (7, 234) = 1.23, $p = 0.26$, $\eta_p^2 = 0.04$; F (7, 234) = 1.02, $p = 0.43$, $\eta_p^2 = 0.03$, and F (7, 234) = 0.97, $p = 0.68$, $\eta_p^2 = 0.03$, respectively. These findings converged with the Bayesian examination (see *Appendix D*).

3.4. Prediction of Children's post-lockdown emotional problems

The regression model predicting emotional problems indicated that the predictors explained 18% of the variance ($R^2 = 0.18$, F (8,304) = 8.55, $p < 0.0001$). Results are reported in Table 6. It was found that only maternal COVID-related distress during lockdowns was positively associated with children's post-L emotional problems ($\beta = 0.27$, p = 0.0003). These findings converge with the Bayesian regression analysis (see *Appendix C*).

3.4.1. Moderation analysis

No significant contribution to the model were found for family income, child biological sex, and child age F (7, 209) = 1.74, $p = 0.051$, $\eta_p^2 = 0.06$; F (7, 209) = 1.69, $p = 0.06$, $\eta_p^2 = 0.05$; F (7, 209) = 1.69, $p = 0.06$, $\eta_p^2 = 0.05$, respectively. These findings converged with the Bayesian analyses (see *Appendix D*).

4. Discussion

The execution of home lockdown regulations throughout the COVID-19 pandemic has raised substantial concerns about consequential increases in children's screen media use and the possible long-term effects of this increase on children's well-being (Eales et al., 2021; Ribner et al., 2021). To address this topic, the goals of the current study were to assess longitudinal trajectories of young children's screen media exposure through the COVID-19 home lockdown periods in Israel and to examine the predictive associations between different aspects of media exposure and post-lockdown behavioral adjustment. The defined periods of national home lockdowns in Israel provided us a unique opportunity to

Table 3
Descriptive statistics for study variables.

|	Pre-L	L1	L2	L3	Post-L	% Missing
Child screen time (minutes)	35.4 (35.96)	74.21 (63.73)	75.8 (51.6)	75.74 (59.585)	101 (50.02)	29.33%
Household background television	2.41 (1.47)	2.89 (1.53)	2.68 (1.36)	2.57 (1.54)	2.5 (1.46)	26.84%
Media to regulate child distress	–	2.47 (1.42)	–	2.06 (1.16)	1.83 (0.96)	29.23%
Maternal use of mobile device	–	2.07 (0.65)	2.24 (0.63)	2.25 (0.62)	2.21 (0.66)	28.59%
Maternal COVID-19-related stress	–	1.91 (0.735)	1.58 (0.78)	1.41 (0.80)	1.12 (0.73)	28.11%
Child conduct problems	2.03 (1.65)	–	–	–	2.88 (1.82)	28.43%
Child emotional problems	1.62 (1.65)	–	–	–	2.12 (1.74)	28.43%

Note. Standard deviations are in parenthesis. Pre = pre-lockdown; L1-L3 = during lockdown. Post = post-lockdown.

Table 4
Correlations for study variables.

Period	Variable	Pre-lockdown				During lockdowns							Post-lockdowns						
		1	2	3	4	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Pre-lockdowns	1. Emotional problems	–																	
	2. Conduct problems	0.20***	–																
	3. Screen time use	0.09	0.16**	–															
	4. Background television	0.01	0.09	0.32***	–														
During lockdowns	1. Emotional problems	0.54***	0.17**	0.12	0.08	–													
	2. Conduct problems	0.10	0.57***	0.07	0.07	0.43***	–												
	3. Screen time use	0.05	0.13*	0.34***	0.56***	0.13*	0.13*	–											
	4. Background television	0.05	0.05	0.22***	0.74***	0.14*	0.12	0.61***	–										
	5. Media to regulate distress	0.13*	0.18**	0.25***	0.26***	0.23***	0.35***	0.41***	0.38***	–									
	6. Maternal phone use	0.12*	−0.02	−0.01	−0.06	0.01	0.05	0.16**	0.02	0.16*	–								
	7. Covid Stress	0.18**	0.08	0.10	0.15*	0.38***	0.24***	0.21***	0.25***	0.33***	0.24***	–							
Post-lockdowns	1. Emotional problems	0.35***	0.14	0.07	0.12	0.57***	0.29***	0.11	0.21**	0.26***	−0.02	0.32***	–						
	2. Conduct problems	0.01	0.35***	0.18*	0.11	0.24**	0.61***	0.10	0.12	0.23**	−0.01	0.13	0.43***	–					
	3. Screen time use	−0.06	0.06	0.35***	0.19*	−0.06	0.00	0.31***	0.20**	0.09	−0.03	0.05	0.03	0.05	–				
	4. Background television	0.04	0.01	0.28***	0.67***	0.10	0.05	0.55***	0.87***	0.28***	0.01	0.20**	0.12	0.08	0.20*	–			
	5. Media to regulate distress	0.06	0.05	0.16	0.17	0.12	0.17*	0.22**	0.27**	0.52***	0.09	0.18*	0.20*	0.14	0.10	0.27***	–		
	6. Maternal phone use	0.11	−0.04	−0.13	0.00	−0.07	0.01	0.13	0.08	0.05	0.77***	0.18**	0.02	−0.03	−0.05	0.05	0.09	–	
	7. Covid Stress	0.13	0.01	0.10	0.12	0.29***	0.09	0.15*	0.25***	0.14*	0.21**	0.74***	0.27***	0.10	0.07	0.19*	0.17*	0.14	–

Note. Estimates of media use were averaged during lockdown periods to ease interpretation and reduce the number of variables.

*p < 0.05, **p < 0.01, ***p < 0.001.
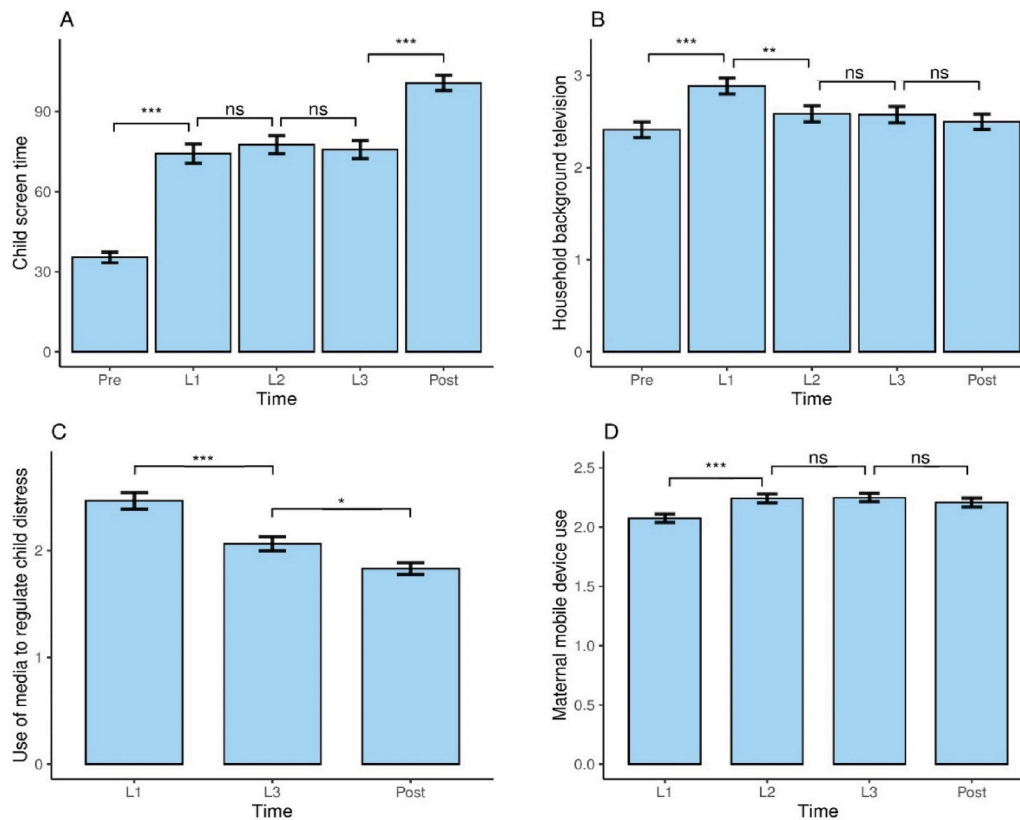
Note. Pre = pre-lockdown; L1–L3 = during lockdown. Post = post-lockdown; Significant results are indicated in asterisks. Error bars represent standard errors. * $p_{adj} < 0.05$, ** $p_{adj} < 0.005$, *** $p_{adj} < 0.0005$.

Fig. 2. Changes in Media Use and Exposure.
Note. Pre = pre-lockdown; L1–L3 = during lockdown. Post = post-lockdown; Significant results are indicated in asterisks. Error bars represent standard errors. * $p_{adj} < 0.05$, ** $p_{adj} < 0.005$, *** $p_{adj} < 0.0005$.

Table 5
Regression analysis predicting child post-lockdown conduct problems.

Predictor	Estimate (SE)	β	p-value
Screen time	0.0003 (0.001)	0.03	0.80
Background television	0.004 (0.04)	0.01	0.91
Use of media to regulate child distress	0.07 (0.04)	0.15	0.09
Maternal mobile device use	−0.04 (0.08)	−0.04	0.59
Maternal COVID-related distress	0.08 (0.07)	0.09	0.30
Child age	−0.006 (0.004)	−0.13	0.08
Child biological sex	−0.09 (0.07)	−0.09	0.20
Socioeconomic status	−0.01 (0.04)	−0.03	0.70

Note. Predictors were averaged across the three lockdown periods. Results were also replicated when the average conduct problems throughout the lockdown was included as a covariate.

Table 6
Regression analysis predicting child post-lockdown emotional problems.

Predictor	Estimate (SE)	β	p-value
Screen time	−0.0004 (0.001)	−0.04	0.70
Background television	0.04 (0.04)	0.12	0.19
Use of media to regulate child distress	0.07 (0.04)	0.14	0.11
Maternal mobile device use	−0.08 (0.07)	−0.08	0.26
Maternal COVID-related distress***	0.22 (0.06)	0.27	0.0003
Child age	−0.003 (0.004)	−0.06	0.43
Child sex	0.005 (0.07)	0.005	0.94
Socioeconomic status	−0.06 (0.03)	−0.12	0.10

Note. Predictors were averaged across the three lockdown periods. Results were also replicated when the average emotional problems throughout the lockdown was included as a covariate. ***$p < 0.0005$.

examine time-locked changes in young children's screen media exposure through the pandemic. To our knowledge, this study is the first to examine media exposure at multiple time points during the pandemic and examine whether media use patterns measured during lockdown periods have long-term implications for children's behavior. Overall, we found that child screen time, exposure to background television, maternal use of media to regulate child distress and maternal mobile device use while parenting all changed during the lockdown periods but

showed different trajectories of change. Despite changes in media use during the lockdowns, these changes in media use patterns did not seem to be related to child conduct and emotional problems in the post-lockdown period.

4.1. Family media ecology during lockdowns

Our first goal was to characterize the patterns of children's media use

and exposure through different time points during the pandemic. First, we found that child screen time significantly changed between the pre-lockdown period, the three lockdowns and the post-lockdown period. Replicating findings from recent studies (Bergmann et al., 2022; Carroll et al., 2020; Eales et al., 2021; Pedrotti et al., 2022; Ribner et al., 2021), screen time increased and remained stable during lockdowns compared with the pre-lockdown period. Unexpectedly, screen time further increased in the post-lockdown period, suggesting that the disruption caused by lockdown routines may have changed habitual child viewing habits. It is also possible that parental media restriction practices toned down in the post-lockdown period as parents felt more confident that their children were being exposed to developmentally appropriate activities such as formal schooling and peer interactions that can compensate for the potential effects of prolonged screen time.

Moving beyond the exclusive focus on measures of direct media use (Barr et al., 2020), we also examined contextual factors of children's indirect exposure to media. First, household background television exposure showed an initial increase during the first lockdown compared to the pre-lockdown period, followed by a decrease in the second lockdown which remained stable until the post-lockdown period. The initial increase can be explained by families' need to be constantly updated regarding the development of the pandemic in its initial stages, and the news serving as a central conduit of this information (Stainback et al., 2020). It is estimated that COVID-19-related news consumption markedly increased during March 2020 (Newman et al., 2020). However, while people depended on news for pandemic-related information, they were simultaneously overwhelmed and emotionally drained by the extent of pandemic news (Ytre-Arne & Moe, 2021). Greater COVID-19 media consumption was associated with increased perceptions of COVID-19 threats which, in turn, was associated with greater psychological distress (Stainback et al., 2020). Research conducted after the initial stages of the pandemic demonstrated changes in news consumption patterns. Specifically, there was a shift between news abundance to news avoidance as a mechanism to reduce the emotional distress people experienced when consuming the news (de Bruin et al., 2021). Although we did not measure the type of background television exposure in our study, these news consumption patterns may explain the initial increase and consecutive decrease in background television exposure in our study.

Next, our results show that maternal use of media to regulate child distress to reduce children's distress decreased between lockdowns and further declined in the post-lockdown period. Excessive use of media to regulate children's distress can be considered as *problematic media use* (i. e., media use that interferes with daily functioning; Holmgren et al., 2022), as it can establish passive and ineffective regulatory strategies in young children, resulting in increased arousal and difficulties in regulating behavior in the face of external demands (Coyne et al., 2021; Gordon-Hacker & Gueron-Sela, 2020). The Interactional Theory of Childhood Problematic Media Use (IT-CPU; Domoff et al., 2020) suggests that both proximal and distal factors can shape the development and maintenance of problematic media use. For example, maternal postpartum depression symptoms predicted elevated maternal and child problematic media use two years later (Holmgren et al., 2022). In the context of the COVID-19 pandemic, recent studies show that child problematic media use increased from before the pandemic onset to the initial stages of the pandemic (Eales et al., 2021). This increase can be attributed to multiple factors, including parental stress and the use of inconsistent or inefficient parenting practices that characterized family life during the pandemic (Eales et al., 2021). In the current study, mothers may have often used media to regulate children's distress in the initial stages of the pandemic to alleviate their own negative feelings caused by the exhaustion and burnout associated with the changes in their parental roles. However, by the third lockdown mothers may have been less distressed (Gordon-Hacker et al., 2022) and were able to employ more adaptive strategies to regulate children's distress.

Finally, while exposure to background television and maternal use of media to regulate child distress seemed to decrease between lockdowns, maternal use of mobile devices while parenting slightly increased between the first and second lockdown and then remained stable. In general, mothers in our sample reported low use of mobile devices while spending time with their children, with the average score in all time points being approximately 2 ("Not very likely"). It is possible that this measure is particularly sensitive to report bias and underreporting due to social desirability and recall distortion (Gramm et al., 2020). Indeed, a study that used mobile passive sensing to measure parent smartphone usage and compare it to parental self-reported use demonstrated that only few parents accurately self-reported their daily smartphone use, with most underreporting (Yuan et al., 2019). Thus, our results may not be an accurate reflection of mothers' actual mobile device use. The direction of the findings showing a sustained increase during lockdowns and post-lockdown, however, suggest that parental media use during routines may have shifted during the pandemic.

4.2. Prediction of Children's post-lockdown adjustment

Our second goal was to examine whether different aspects of media exposure were longitudinally associated with children's post-lockdown behavioral adjustment. Overall, we found that while measures of media exposure were cross-sectionally related to children's behavior problems during lockdowns, media use and exposure did not predict children's behavior in the post-lockdown period. Results from the correlational analysis show that during lockdown periods, child screen time, maternal use of media to regulate child distress, and background television exposure were all positively related to children's emotional problems. A similar pattern emerged for conduct problems, except for background television which was not associated with conduct problems. These findings replicate findings from pre-COVID research that showed positive concurrent associations between these direct and indirect measures of media exposure and children's behavior (Coyne et al., 2021; Liu et al., 2021; Manganello & Taylor, 2009; Radesky et al., 2016; Wu et al., 2017), as well as recent findings from a study conducted during the pandemic (Tandon et al., 2021). These cross-sectional associations can reflect the bi-directional nature of the associations between media use and children's adjustment. It is plausible that frequent direct and indirect exposure to screen media increases emotional and conduct problems through different mechanisms such as exposure to violent content, displacement from developmentally appropriate activities and lack of experience in practicing adaptive emotion regulation strategies (Gordon-Hacker & Gueron-Sela, 2020; Kraut et al., 1998; Zimmerman & Christakis, 2007). Alternatively, children with elevated behavior problems who are harder to soothe may also elicit parents' higher use of digital media as a regulatory strategy (Neville et al., 2021). Therefore, these correlational findings cannot establish causal relations between screen media use and children's behavior. Our longitudinal examination of these associations, which also controlled for demographic factors, showed that although children's conduct and emotional problems increased between the pre and post-lockdown periods, the different measures of screen media exposure during lockdown did not predict children's behavior problems. In fact, the only significant predictor of children's post-lockdown emotional problems was maternal COVID-related distress. The lack of longitudinal associations between media exposure and child behavior problems is consistent with previous literature, particularly for overall child screen time (Hinkley et al., 2014; McDaniel & Radesky, 2020). Our moderation analysis further suggested that these findings did not differ as a function of family income, child biological sex, and child age. This suggests that the changes to patterns of media consumption during this global crisis did not have long-term effects on children's behavior problems, and that other factors that were not measured in the current study (e.g., household chaos, negative parenting behaviors; Dubois-Comtois et al., 2021; Hails et al., 2022) may account for the observed rise in children's behavior problems. In the context of the COVID-19 pandemic, it is possible that screen media

use served as an effective tool to occupy young children and provide parents an opportunity to attend to their multiple additional roles in their workplace and in the house, reduce parental stress, and maintain a sense of normality. Although our findings should be interpreted with caution due to multiple limitations listed below, they may reduce feelings of guilt and concern that parents have been experiencing about their children using screens more frequently during the pandemic period.

4.3. Limitations and conclusions

Findings from this study should be considered in light of several limitations. First, our investigation focused only on two child outcomes, namely emotional and conduct problems. Previous research has shown that screen media exposure was associated with additional aspects of children's functioning such as language abilities, executive function, and social skills (Aishworiya et al., 2022; Barr et al., 2010; Linebarger et al., 2014; Wright et al., 2001). Further research is needed to determine whether exposure to screen media during the pandemic has differential effects on other domains of child functioning. Second, an online-recruited sample might not be representative of the general population. Mothers using the MIDGAM platform may have different media use practices and attitudes compared with mothers who do not use this platform. Also, although our sample was representative and diverse in terms of family income, most of the participating mothers were highly educated, limiting generalizability of the findings. A third main limitation is the exclusive use of maternal report measures, and retrospective measures of pre-lockdown media use which may introduce single reporter and recall bias. Given that the use of direct, more objective measures of child functioning was not possible during the pandemic, future research should focus on following samples that were assessed during the pandemic to examine long-term effects of functioning using a multi-method approach, including passive sensing methods that can measure of media use more accurately.

Despite these limitations, findings from this study contribute to the understanding of media use during an unprecedented time of social distancing and home lockdowns. Although media use and exposure overall increased during home lockdowns, the lack of longitudinal associations between media use and children's post-lockdown behavior suggests that media use may be meeting very important instrumental needs for parents and children in the short-term, and children's behavior changes may return to more typical patterns after the crisis. Future research should continue to monitor potential effects of media use using a comprehensive multi-domain measurement approach.

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Credit author statement

Noa Gueron Sela: Conceptualization; Data curation; Funding acquisition; Methodology; Resources; Supervision; Writing – original draft. **Ido Shalev**: Conceptualization; Formal analysis; Writing – review & editing. **Avigail Gordon-Hacker**: Conceptualization; Data curation; Methodology; Project administration; Investigation. **Alisa Egutobov**: Conceptualization; Data curation; Methodology; Project administration; Investigation. **Rachel Barr**: Conceptualization; Methodology; Writing – review & editing.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.chb.2022.107572.

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