



EDITORIAL

Indirect effects of the COVID-19 pandemic on children relate to the child's age and experience

© The Author(s), under exclusive licence to the International Pediatric Research Foundation, Inc 2023

Pediatric Research (2023) 94:1586–1587; <https://doi.org/10.1038/s41390-023-02681-4>

The COVID-19 pandemic has had immeasurable effects on individuals and families that go well beyond the actual viral infection. Now in 2023, we are entering the fourth year of the global COVID-19 pandemic! Babies born in 2020 are preparing to celebrate their third birthdays. Children who started kindergarten virtually in 2020 are now in the third grade, and adolescents who were starting high school at the onset of the pandemic may be near graduation and determining their future employment or making their post-graduation educational plans. The COVID-19 pandemic has had significant indirect effects on multiple areas of child development, school readiness, educational attainment, socialization skills, mental health, in addition to risks based on social determinants of health. The childhood experience of the COVID-19 pandemic relates to the child's age at the time of this experience, their family support structure, overall health, opportunities for e-learning and learning at home, and their community environment. In different parts of the world, the evolution of the child's experience was different, with some areas having a much longer quarantine period and closure of schools than in other areas. All of these factors impact the child of 2023 and beyond. Pediatricians and primary care physicians, teachers, and other healthcare professionals need to consider the child's "COVID-19 pandemic experience" as a part of important factors that can affect their neurodevelopment, academic performance, physical, and mental health. With the pandemic experience in mind, we must support children's development as their needs may be different than that of prior generations.

Pre-pandemic, pediatricians advocated for limits on screen time for young and school-age children based on multiple studies showing effects across the span of childhood. With the onset of the COVID-19 pandemic and the need for virtual learning, with reduced opportunities for in-person activities and sports, screen time use saw a major rise for children of all ages, from toddlers to adolescents. Children under the age of 2 years do not learn well from screen watching and benefit most from in-person interactions.¹ Early language and social development really require in-person experiences and peer-play time.² In a cohort study of 1994 mother-child pairs, children with two or more hours of screen time a day were more likely to have behavioral problems, delayed developmental milestones, and lower vocabulary knowledge compared to children with lower amounts of daily screen time.³ In another study of preschoolers, screen time at age three years was predictive of anger, temperament, and frustration at age four years.⁴ Excessive screen time is also not good for the eyes; it may cause eye fatigue and blue light exposure can affect circadian rhythms and sleep.⁵ The pandemic thus created a difficult situation with young children at home, preschools closed, and parents needing to telework, all of which lead to increased screen usage even among young children.

During this time, many school learning materials made a move to digital formats including storybooks and textbooks. Children learned to use digital platforms for completing assignments and had fewer opportunities for reading and writing on paper. Handwriting was a fine motor skill that certainly suffered during the pandemic for many children. There has been an increase in children with developmental delays, learning disabilities, and behavioral disorders that may be a sequela of multiple changed experiences during the early years of the COVID-19 pandemic for a child who may have already had some underlying risk. As pediatric care providers, we need to thoroughly assess the multiple domains of development at well-child checks or when a child presents that hasn't been seen in a while, screen for autism spectrum disorder, and ask about screen use, home environment, and behavior.

For adolescents, the pandemic and excessive screen time may have other important long-term physical and mental health implications at a time of life in which they are shaping themselves into the young adults that they will be regarding friend groups, healthful behaviors, habits, and hobbies. In a pre-pandemic cross-sectional study of US high school youth, the use of screen devices for five or more hours a day was associated with obesity, poor sleep, and lower physical activity.⁶ In a prospective cohort study from the Adolescent Brain Cognitive Development (ABCD) Study of 11,633 children aged 9–11 years, higher screen time was associated with higher odds of reporting suicidal behaviors in follow-up. This finding pointed out concerns about excessive screen time, which was amplified during the pandemic, and risks to mental health.⁷ In another study of children of similar age in the ABCD cohort, screen time including video games and watching videos was associated with the development of obsessive-compulsive disorder.⁸ Clearly, children of different ages, especially with heightened screen device use during the pandemic, are at risk for, or may already be experiencing the effects of excessive screen time on their mental and physical health. It is important for pediatricians, adolescent specialists, and other healthcare providers to ask about total screen time, physical activity opportunities, and nutrition, and to provide counseling on healthful behaviors. Hopefully, with the return to in-person school, social opportunities, athletics, and student interest clubs, children and adolescents will go back to their lower pre-pandemic screen usage. However, excessive screen use may be a new "habit" of youth during the pandemic that may be hard to break.

Babies, just born into the world during the pandemic, had their early life experiences altered. For some, babies were immediately quarantined away from their birthing mother due to maternal SARS-CoV-2 infection, until practices changed, and we learned more about the risks of infection in babies. For a number of mother-infant pairs, this likely affected breast-feeding success and duration, and other important elements of maternal infant bonding.⁹ Many babies had reduced exposure to family members and family friends outside of their immediate households, and a

Received: 10 May 2023 Accepted: 12 May 2023
 Published online: 6 June 2023

lack of exposure to older generations of their family. Human faces may have been observed half-masked, instead of learning from full-face smiles to which babies are naturally drawn.¹⁰ Maternal depression and family stress may have also altered the home environment during early critical years.⁹ Studies have shown that birth during the pandemic and with exposure to a mother with SARS-CoV-2 in pregnancy may increase the risk for lower developmental milestone achievement in infancy.^{11–13} Some families, however, report some benefits of the pandemic, such as a feeling of more togetherness, so there may be positive experiences that occurred for families too.¹⁴ With daycares and preschools closed, many families had more time together than they may not have had due to workplace obligations and children at school. Some hidden benefits to families of the pandemic may thus be present underneath the surface.

While the potential indirect effects of the COVID-19 pandemic are too many to name and fully discuss in the confines of this editorial, the indirect effects point to an important future direction and necessary support for ongoing pediatric research. The generation of children with their age-specific experience of the COVID-19 pandemic needs to be followed and assessed for effects on their neurodevelopment, educational attainment, social development, physical and mental health, and for the impact on their future employment, terminal educational achievements, and life-long mental and physical health. Investigators of child development of any pediatric condition and of controls need to include the potential impact of the COVID-19 pandemic on their cohorts and how that may be a factor affecting different elements of child outcome. Now more than ever, pediatricians and other healthcare professionals need to be vigilant in providing developmental, behavioral, and mental health screening at any opportunity when in contact with a child or adolescent.¹⁵ Expansion of rehabilitative therapies for children with language and other developmental delays and for children/adolescents with mental health issues are needed to support the increased needs of this generation of children.

Sarah B. Mulkey^{1,2}✉, Cynthia F. Bearer³ and Eleanor J. Molloy^{4,5,6}
¹Prenatal Pediatrics Institute, Children's National Hospital, Washington, DC, USA. ²Departments of Neurology and Pediatrics, The George Washington University School of Medicine and Health Sciences, Washington, DC, USA. ³Department of Pediatrics, Rainbow Babies & Children's Hospital, UH CMC, Cleveland, OH, USA. ⁴Paediatrics, Trinity College, Dublin, Ireland. ⁵Children's Hospital Ireland at Tallaght, Dublin, Ireland. ⁶Neonatology, Coombe Women's and Infants University Hospital, Dublin, Ireland.
 ✉email: SBMULKEY@childrensnational.org

REFERENCES

1. Council on Communications and Media. Media and young minds. *Pediatrics* **138**, e20162591 (2016).

2. Putnick, D. L. et al. Displacement of peer play by screen time: associations with toddler development. *Pediatr. Res.* **93**, 1425–1431 (2023).
3. McArthur, B. A., Tough, S. & Madigan, S. Screen time and developmental and behavioral outcomes for preschool children. *Pediatr. Res.* **91**, 1616–1621 (2022).
4. Fitzpatrick, C. et al. Preschooler screen time and temperamental anger/frustration during the COVID-19 pandemic. *Pediatr. Res.* 1–6 (2023).
5. Hisler, G. C., Hasler, B. P., Franzen, P. L., Clark, D. B. & Twenge, J. M. Screen media use and sleep disturbance symptom severity in children. *Sleep. Health* **6**, 731–742 (2020).
6. Kenney, E. L. & Gortmaker, S. L. United States adolescents' television, computer, videogame, smartphone, and tablet use: associations with sugary drinks, sleep, physical activity, and obesity. *J. Pediatr.* **182**, 144–149 (2017).
7. Chu, J. et al. Screen time and suicidal behaviors among U.S. children 9–11 years old: a prospective cohort study. *Prev. Med.* **169**, 107452 (2023).
8. Nagata, J. M. et al. Screen time and obsessive-compulsive disorder among children 9–10 years old: a prospective cohort study. *J. Adolesc. Health* **72**, 390–396 (2023).
9. Liu, C. H., Hyun, S., Mittal, L. & Erdei, C. Psychological risks to mother-infant bonding during the COVID-19 pandemic. *Pediatr. Res.* **91**, 853–861 (2022).
10. Carnevali, L., Gui, A., Jones, E. J. H. & Farroni, T. Face processing in early development: a systematic review of behavioral studies and considerations in times of COVID-19 pandemic. *Front. Psychol.* **13**, 778247 (2022).
11. Edlow, A. G., Castro, V. M., Shook, L. L., Kaimal, A. J. & Perlis, R. H. Neurodevelopmental outcomes at 1 year in infants of mothers who tested positive for SARS-CoV-2 during pregnancy. *JAMA Netw. Open* **5**, e2215787 (2022).
12. Mulkey, S. B. et al. Neurodevelopment in infants with antenatal or early neonatal exposure to SARS-CoV-2. *Early Hum. Dev.* **175**, 105694 (2022).
13. Shuffrey, L. C. et al. Association of birth during the COVID-19 pandemic with neurodevelopmental status at 6 months in infants with and without in utero exposure to maternal SARS-CoV-2 infection. *JAMA Pediatr.* **176**, e215563 (2022).
14. Williams, M. E. et al. Positive and negative effects of the COVID-19 pandemic on families of young children in rural Colombia and implications for child outcome research. *Child Care Health Dev.* <https://doi.org/10.1111/cch.13120> (2023).
15. Dalabih, A., Bennett, E. & Javier, J. R., Pediatric Policy Council. The COVID-19 pandemic and pediatric mental health: advocating for improved access and recognition. *Pediatr. Res.* **91**, 1018–1020 (2022).

AUTHOR CONTRIBUTIONS

S.B.M. wrote the first draft of the editorial. The editorial was reviewed and edited by all authors. The final version was approved by all authors.

COMPETING INTERESTS

The authors declare no competing interests.

ADDITIONAL INFORMATION

Correspondence and requests for materials should be addressed to Sarah B. Mulkey.

Reprints and permission information is available at <http://www.nature.com/reprints>

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.