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Impact of the COVID-19 era on preventative primary care for children 0–5 years old: a scoping review

Helen Valkanas[1], Kimberley McFadden[2], Isabella Mignacca[3], Xin Qi[4], Mackenzie Jordan[5], Imaan Bayoumi[6] and Patricia Li[7*]

Abstract

Background Restrictions to routine preventative primary care well child visits (WCV) during COVID-19 may have affected a variety of outcomes for young children including growth, development, and the identification and management of developmental delays. To better understand the effect of the pandemic on these outcomes, we conducted a scoping review of studies published between March 2020 and April 2024. The objectives of this scoping review were to determine the impact of the COVID-19 era on WCV attendance and developmental outcomes in children 0–5 years old.

Results 23 articles met inclusion criteria. Most studies were conducted in the U.S. The overall COVID-19 era WCV rate was lower compared to pre-COVID visit rates. Higher rates of missed WCVs and reduced access were reported for racialized children and those from families with lower socioeconomic status. Studies measuring developmental outcomes found associations between children born during the pandemic and increased rates of expressive language delays, decreased personal-social skills, increased delays in achieving verbal, motor, and overall cognitive performance milestones, increased externalizing behaviours, and decreased prosocial behaviour. No study examined the impact of WCV attendance rates on developmental outcomes.

Conclusions During the COVID-19 pandemic, infants, toddlers, and young children attended fewer preventative primary care visits and pandemic-born children were more likely to show signs of developmental delay. This review highlights the need for further research to better understand the longitudinal impact of reduced access to preventative primary care and child health outcomes, including the early detection of, and referral for, developmental delays.

Keywords Primary care, Pandemic, Child development, Preventative care

*Correspondence:
Patricia Li
patricia.li@mcgill.ca
[1]McGill University Health Centre Research Institute, Montreal, QC, Canada
[2]Kimberley McFadden, PhD, Queen's University, Kingston, ON, Canada
[3]Department of Family Medicine, McGill University, Montréal, QC, Canada
[4]School of Medicine, Xin Qi, Queen's University, Kingston, MD, ON, Canada
[5]School of Medicine, Mackenzie Jordan, Queen's University, Kingston, MD, ON, Canada
[6]Department of Family Medicine, School of Medicine, Queen's University, Kingston, ON, Canada
[7]Department of Pediatrics, Faculty of Medicine and Health Sciences, McGill University, McGill University Health Centre Research Institute, Montréal, QC, Canada

Background

The COVID-19 pandemic and its accompanying restrictions interrupted many aspects of health care, including routine preventative care visits [1–7]. For children 5 years old and under, these well-child visits (WCV) are paramount to monitoring their growth and development and allowing primary care providers to address concerns in a timely manner [8]. To curb infection transmission during the pandemic, restrictions such as clinic closures, limited clinic hours, reduced patient capacity, and mandatory COVID-19 testing were put in place across primary care clinics, which may have affected WCV attendance rates. In addition, pandemic restrictions on socialization may have impacted the social and emotional development of children, the full effects of which are still emerging [9, 10]. Finally, there is evidence that certain groups of children (e.g., those from lower income families) were disproportionately affected by these restrictions, which may have increased existing health inequities [11]. It remains uncertain if exposure to the pandemic and the accompanying restrictions have had long-term effects on young children's development [5].

The current scoping review aimed to determine the impact of the COVID-19 era (March 2020-May 2023) on WCV attendance and on developmental outcomes for healthy children aged 0–5 years old. Specific objectives were to identify Changes in attendance for in-person and virtual WCV, The impact of the COVID-19 era on child development, The impact of primary care service disruptions on diagnosis and management of developmental delays in children 0–5 years old, and Whether specific groups of children experienced more challenges accessing primary preventative care and receiving diagnoses of developmental delays.

Methods/design

A scoping review method was chosen to evaluate the extent and range of knowledge contributed to the field thus far and to identify gaps in literature published between March 2020 and April 2024 to prompt further research. Detailed methods can be found in the published protocol paper [12]. This review used the methodological framework proposed by Arksey and O'Malley and updated by the Joanna Briggs Institute [13, 14]. Study inclusion criteria were healthy children 0–5 years old, set during the COVID era (March 11, 2020, to May 11, 2023), conducted in high income countries, and reporting on WCV rates or developmental outcomes. Studies were excluded if they involved: premature children or children living with complex chronic conditions whose developmental trajectories or use of health services may differ from the general population; case reports and series, commentaries, editorials, abstracts, conference proceedings, grey literature, and non-English studies [12]. Using the PRISMA checklist (Supplementary file) [15] two authors performed title and abstract screening, and reviewed conflicts. An additional two authors performed full-text review and resolved any remaining conflicts.

Results

A total of 14,260 titles and abstracts were screened, and 664 full text articles were assessed. This process identified 22 articles, and one article was identified through a manual search for inclusion (PRISMA flow diagram, Fig. 1). Among the 23 included studies (Table 1), six articles reported on the association between the pandemic and WCV attendance, and 17 articles discussed the association between the pandemic and child development. Most studies were conducted in the U.S. (five of the WCV attendance studies and 9 of the child development studies). Most articles collected baseline demographic data on the social determinants of health (SDH) such as race, income, parental education, and/or food insecurity [2–7, 11, 16–28].

Association between COVID-19 and visit attendance rates

All six studies examining changes in WCV attendance rates reported decreased attendance throughout the pandemic period [2–7] (Table 2). A Canadian study reported that children experienced a significant decrease in WCV attendance during the pandemic when compared to the pre-pandemic period (8.2% and 15.1% decrease for < 12 months old and 8.2% and 15.1% decrease for 12–24 months old in the provinces of Ontario and Manitoba, respectively) [3]. A study in the United States examined the proportion of missed WCV in children aged 6 weeks to 6 years old and found that over 50% of children missed one scheduled WCV and 27% had missed at least two consecutive appointments [4]. Among American military families, the median monthly WCV rate per 1000 children under 24 months old initially dropped during the first phase of the pandemic (March to April 2020), but was followed by a rebounding in WCV rates in May to June 2020 [5]. A similar trend was found by Thakkar and authors who reported that monthly WCV rates were lower from March 2020 to February 2021, but that rates returned to pre-pandemic levels by March 2021 [6].

Association between COVID-19 era and child development

Association between pandemic and child behaviour, communication skills, motor skills, problem-solving and socio-emotional development

Among the 17 studies that reported developmental outcomes, almost all reported a negative associations between the pandemic and developmental domains screened (Table 3). Fifteen out of 17 studies showed negative associations in several domains (behaviour,

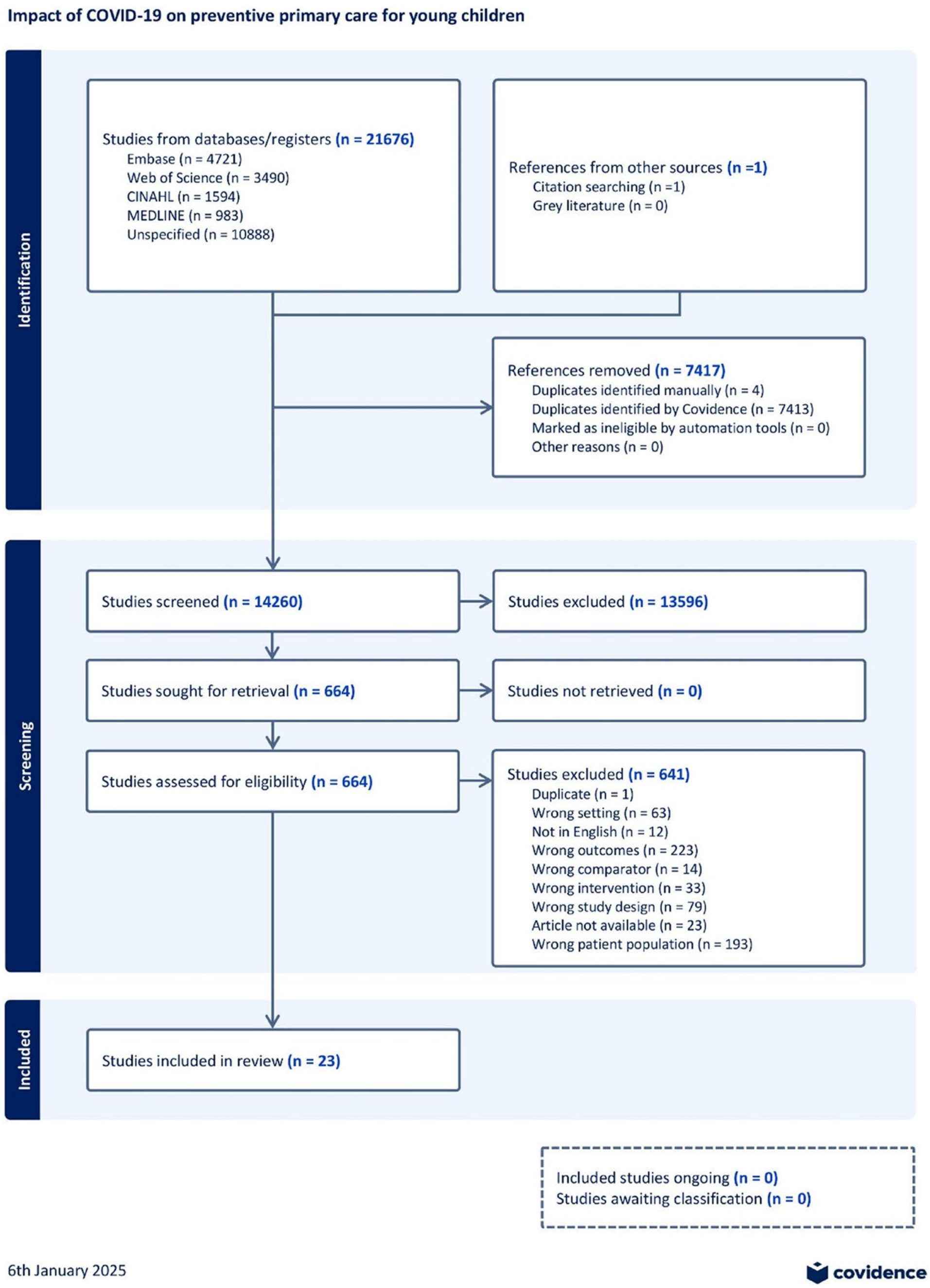

Fig. 1 Prisma flow diagram

communication, language, gross motor, fine motor, problem solving, emotional, and personal-social skills), measured with ASQ-3 and ASQ SE-2 (7 = studies) [16, 17, 22, 23, 26, 27, 29], adapted Griffiths questionnaire (*n* = 1 study) [21], KIDS (*n* = 1 study) [19], K-DST (*n* = 1 study) [20], adapted public health questionnaire (*n* = 1 study) [18], SYWC (*n* = 1 study) [11], SDQ (*n* = 1 study) [24], BITSEA and LDS (*n* = 1 study) [30], and diagnosis of speech language delay (*n* = 1 study) [31].

Although all studies that used the ASQ-3 and ASQ SE-2 found at least one deficit in developmental domains when comparing pandemic cohorts to pre-pandemic cohorts [16, 17, 22, 23, 26, 27, 29], three of these studies also reported improved scores in select domains. Johnson et al.'s domain specific interpretations showed that 6-month-olds and 24-month-olds in the pandemic cohort scored slightly higher in the problem-solving domain, when compared to the pre-pandemic

Table 1 Description of study population, study design, and data source

Study ID and Location (country)	Study Dates	Population Age	Population Description	Study Design and Data source
Effect of COVID-19 on visit rate attendance (*n*=6)				
Eliason 2024 [2] United States	April 2020-Dec. 2020	2 months to 6 months	• Mothers with infants taking part in the Pregnancy Risk Assessment Monitoring System	• Cross sectional study • Clinic patients
Evans 2023 [3] Canada	Sept. 2016-Sept. 2022	Birth to 24 months	• Post-pandemic cohort: infants in Ontario and Manitoba born between September 1, 2018, and September 30, 2020 • Pre-pandemic cohort: infants in Ontario and Manitoba born between September 1, 2016, and September 30, 2018	• Cohort study • Health administrative and demographic databases
Onimoe 2022 [4] United States	March 2020-Oct. 2020	6 weeks to 6 years	• Children aged 6 weeks to 6 years receiving medical care at MH hospital before COVID-19, and newborns who initiated care at MH facilities	• Retrospective review • Clinic patients
Sexton 2022 [5] United States	Feb. 2018-July 2021	Birth to 23 months	• U.S. military members' children < 2 years who had data entered in the Military Health System database from February 2019-February 2020 and/or March 2020-July 2021 • U.S. uniformed services' beneficiaries aged 0 to < 24 months who were enrolled in TRICARE insurance in any given month from February 2019 to July 2021	• Cross sectional study • EHR data
Thakkar 2023 [6]** United States	March 2019-March 2021	≤ 14 months	• Children from North Carolina with continuous Medicaid enrollment from birth through the start of the follow-up period	• Cohort study • Administrative claims
Weston 2021 [7] United States	Nov. 2020-Dec. 2020	0 to 5 years	• Mothers of children < 6 years old	• Cross sectional study • Social media
Effect of COVID-19 on developmental outcomes (*n* = 17)				
Byrne 2023 [22] United Kingdom	March 2020-May 2022	Birth to 24 months	• CORAL cohort: infants born in the two participating major maternity hospitals in Dublin between March 2020 and May 2020 • BASELINE cohort: healthy, term babies born in Ireland between 2008 and 2009	• Cohort study • Medical record data and recruitment postnatally in hospital
Cartwright 2023 [31]* United States	Jan. 1, 2018- Feb. 28, 2023	< 5 years old	• Children with health care encounters during the study period	• Retrospective review • Electronic health records
CORAL Study 2023 [21] Ireland	March 2020-May 2021	Birth to 12 months	• CORAL cohort: babies born in Dublin, Ireland in the first 3 months of the COVID-19 pandemic • BASELINE cohort: babies born in Ireland between 2008 and 2011	• Cohort study • Clinic patients, mail, and accessing previously acquired data
Deoni 2021 [25]* United States	2011–2021	3 months to 3 years	• Healthy and neurotypically developing children from 3 months to 3 years old in Providence, Rhode Island	• Cross sectional study • Data source not specified
Finegold 2023 [16] Canada	Feb. 2018-June 2022	24 months to 54 months	• Women receiving prenatal care at Mount Sinai Hospital in Toronto, Ontario recruited before 17 weeks' gestation	• Cross sectional study • Clinic patients
Giesbrecht 2023 [17] Canada	2015–2022	11 months to 14.9 months	• Women from every province and territory in Canada, except for Nunavut • Pre-pandemic cohort: women up to 3 weeks postpartum who had a singleton live birth at > 33 weeks' gestational age • Pandemic cohort: women 17 years or older pregnant at the time of study enrollment	• Cohort study • Social media advertisements, postpartum outreach in 3 childbirth units in Toronto
Imboden 2022 [23] United States	Oct. 2018-Jan. 2021	5 months to 38 months	• Patients from two private (rural & urban) pediatric practices in Southern Illinois who attended a WCV during the study period and whose caregiver completed an ASQ-3 in the age categories of 6, 12, 18, 24, or 36 months	• Correlational study • EMR data
Johnson 2024 [29] United States	March 1, 2018-May 30, 2022	0 to 5 years	• Parents or caregivers of children aged 0–5 years with reports in the Comprehensive Health and Decision Information System	• Cohort study • EHR data

Table 1 (continued)

Study ID and Location (country)	Study Dates	Population Age	Population Description	Study Design and Data source
Kuehn 2024 [26] United States	July 2022- Oct. 2023	10 months to 18 months	• Pregnant women living within a NFP service area who were 28 weeks or less gestational age at enrollment • Women who gave birth between January 2015 and December 2021 and completed at least 1 ASQ-3 and/or 1 ASQ: SE-2 screening	• Cohort study • Home nursing program
Lee 2024 [20] South Korea	April 2018-Dec. 2021	30 months to 36 months	• Children aged 30–36 months old living in South Korea	• Cross sectional study • National Health Screening Program for Infants and Children
Matsuo 2024 [18] Japan	Jan. 2017-Dec. 2022	18 months	• Children who attended the 18-month health check-up provided by the Okayama City Public Health Center	• Cross sectional study • Daycares
Nozadi 2023 [27] United States	Aug. 2018-Aug. 2021	0 to 4 years	• Children ages 1–48 months with ASQ data within 18-month window before and after March 11, 2020 • Parent-reported data on COVID-19 survey	• Cohort study • Clinic patients
Perry 2023 [28] United States	Fall 2019-Winter 2021	3 to 4 years	• A subsample of participants who had EF data from a larger study of preschoolers recruited from high-quality early childhood education centers in a large city in the northeastern United States	• Cross sectional study • Early childhood education centres
Romem 2024 [11] United States	Sept. 2018-Feb. 2022	3 months to 58 months	• Minnesota parents who consented to a review of their child's medical records for general research studies • Toddlers aged 3 to 58 months old who received their primary care at Mayo Clinic or a Mayo Clinic affiliated site in Minnesota who completed a SWYC during a well WCV	• Cohort study • EMR data
Sato 2023 [19] Japan	2017–2021	1 to 5 years	• Japanese children from nursery centres in a single municipality	• Cohort study • Nurseries
Specht 2021 [30] Denmark	Jan. 2020-April 2020	3.5 to 6.8 years	• Parents from three rotation kindergartens in Copenhagen who completed both the baseline SDQ between January and February 2020 and the follow-up SDQ in April 2020	• Cross sectional study • Kindergarten classes
Sperber 2023 [24] United States	June 2018-April 2021	Mothers 18 years and older	• Mothers recruited from the NYC metropolitan area before the onset of the pandemic who were 18 + years old, 35 + weeks pregnant, and carrying a singleton fetus with no known neurological or developmental issues	• Cross sectional study • Local prenatal clinics, parenting/birthing classes, community events, social media

EHR Electronic health record, *EMR* Electronic medical record, *CORAL* Impact of Corona Virus Pandemic on Allergic and Autoimmune Dysregulation in Infants Born During Lockdown, *ASQ* Ages and Stages Questionnaire

**Not peer-reviewed, ** Financial conflict of interests declared*

cohort [29], while Finegold and authors found the COVID cohort demonstrated better problem-solving and fine motor skills [16]. Another study using the KIDS reported differences in outcomes among age groups, with better scores for pandemic exposed participants aged 1–3 years old and worse scores among 3–5 year olds in the domains of physical motor manipulation, language concepts, and social relationships [19]. The remaining 2 studies reporting on developmental outcomes showed no differences between pre-pandemic and pandemic cohorts [11, 24].

Association between pandemic and executive functioning and neurocognition

Overall, the two studies that looked at the association between the pandemic and cognition and executive functioning (EF) found mixed results. One study assessed the EF of 3–4 year old children transitioning to kindergarten before, during, or after the pandemic, using the Heads–Toes–Knees–Shoulders Task (HTKS) and the Childhood Executive Functioning Inventory (CHEXI) [28]. The authors hypothesized that over time, EF should be increasing for children in all cohorts (prepandemic, transition,

Table 2 Association between pandemic and visit attendance ($n = 6$)

Article ID	WCV Attendance pre-COVID 19	WCV Attendance during COVID-19	Missed or delayed WCV during COVID-19
Eliason 2024 [2]	N/A	N/A	• WCV cancellations/delays highest among non-Hispanic Black infants (10.21%) and birthing parents who were uninsured (15.25%) • Prevalence of all disruptions highest among lowest income group • Non-Hispanic Black infants had higher odds of WCV cancellations/delays compared to non-Hispanic White infants: 1.50 (95% CI: 1.07–2.10)* • Parents with Medicaid had higher odds of WCV cancellations/delays compared to parents with private health insurance: 1.61 (95% CI: 1.19–2.16)* • Uninsured parents had higher odds of WCV cancellations/delays compared to parents with private health insurance: 3.16 (95% CI: 1.94–5.15)**
Evans 2023 [3]	Ontario: • infants < 12 mos 48.8% ($N = 65{,}810$) attended 4 + WCV • children 12–24 mos 38.4% ($N = 52{,}157$) attended 3 + WCV Manitoba: • infants < 12 mos 70.7% ($N = 12{,}168$) attended 4 + WCV • children 12–24 mos 70.1% ($N = 11{,}416$) attended 2 + WCV	Ontario • infants < 12 mos 33.0% ($N = 41{,}247$) attended 4 + WCV • children 12–24 mos 30.2% ($N = 39{,}758$) attended 3 + WCV Manitoba: • infants < 12 mos 55.0% ($N = 9{,}235$) attended 4 + WCV • children 12–24 mos 55.0% ($N = 9{,}143$) attended 2 + WCV	Ontario: • 15.8% decrease in WCV attendance for infants < 12 months old during the pandemic aRR = 0.67 (95% CI: 0.66–0.68) • 8.2% decrease in WCV attendance for children 12–24 months old during the pandemic aRR = 0.78 (95% CI: 0.77–0.79) Manitoba: • 15.7% decrease in WCV attendance for infants < 12 months old during the pandemic aRR = 0.78 (95% CI: 0.77–0.80) • 15.1% decrease in WCV attendance for children 12–24 months old during the pandemic aRR = 0.79 (95% CI: 0.77–0.80)
Onimoe 2022 [4]	N/A	N/A	• > 50% missed a scheduled WCV • 27% had missed at least two consecutive WCV
Sexton 2022 [5]	291 (IQR: 282–305) median monthly WCV rate per 1000 children < 24 mos	275 (IQR: 264–283) median monthly WCV rate per 1000 children < 24 mos	• Median monthly WCV rates declined from pre-COVID to during COVID for all demographic groups***
Thakkar 2023 [6]	405,295 WCV for children ≤ 14 months	287,285 WCV for children ≤ 14 months	• WCV rate was lower during COVID compared to pre-COVID across all demographic sub-groups RR = 0.64 (95% CI: 0.64–0.64) • Monthly rate of WCV was lower during the pandemic from March 2020 to February 2021 • WCV rate returned to pre-pandemic levels by March 2021
Weston 2021 [7]	N/A	1,284 (69%) parents of children ≤ 5 years reported attending WCV	• 588 (31%) parents of children ≤ 5 years missed WCV • Statistically significant ($p < 0.5$) characteristics of parents who attended WCV include: higher education level, have private health insurance, employed, have only one child, identify as non-Hispanic, and have an income higher than 1.5 times the federal poverty line

WCV Well child visit, *aRR* Adjusted Relative Risk, *IQR* Intraquartile range, *CI* Confidence interval

**p < 0.05, **p <0.01, and ***p<0.001*

and post pandemic). However, the authors reported contrasting findings between teacher-reported scores and objective scores for children in the transition cohorts. Although objective measures of EF found that children in all cohorts were in line with their increasing EF hypothesis, subjective teacher ratings found that children in the transition cohort showed decreased EF scores. This was theorized to be related to changes in classroom settings, and teacher related stress, rather than children's EF skills [28].

Neurocognitive assessment using the Mullen Scales of Early Learning (MSEL) found that children born during the pandemic had significantly reduced verbal, motor, and overall cognitive performance compared to children born before the pandemic and that these skills continued to decline incrementally across the population level as the pandemic progressed [25]. The authors found that children born in the pandemic period showed significantly lower performance on the neurocognitive assessments compared to infants born prior to the pandemic [25].

Implications of increased risk of developmental delays on health services utilization

In a study using electronic medical records and diagnostic codes to determine the rates of speech delay

Table 3 Association between pandemic and child development ($n = 17$)

Study ID	Assessment Instrument(s)	Pre-COVID Cohort Development Scores	COVID Cohort Development Scores	Cohort Differences in Development
Byrne 2023 [22]	ASQ24 (version 3) CBCL	Communication: M = 53.7, SD = 11.6	Communication: M = 49.5, SD = 15.1	• COVID cohort scored worse on Communication: aOR = 2.1 (SD = 1.1–4.2)*
Cartwright 2023 [31]	Diagnosis of speech language delay	First-time speech delay diagnosis Overall: 1.58 (95% CI: 1.53–1.63) 1-yr-olds: 2.71 (95% CI: 2.62–2.8) 2-yr-olds: 3.31 (95% CI: 3.19–3.43)	First-time speech delay diagnosis Overall: 2.45 (95% CI: 2.4–2.51) 1-yr-olds: 4.58 (95% CI: 4.47–4.69) 2-yr-olds: 5.39 (95% CI: 5.23–5.56)	• Increase of 1.55x the rate of first-time speech delay diagnosis from 2018/2019 to 2021/2022*** • Rate increase of 1.69 for one-year-olds*** • Rate increase of 1.63 for two-year-olds***
CORAL Study 2023 [21]	Questions adapted from Griffiths Scales of Mental Development Version 2, 0–2 years	One meaningful word: 89.3% Finger point: 92.8% Wave bye-bye: 94.4% Crawl: 91.0%	One meaningful word: 76.6% Finger point: 83.8% Wave bye-bye: 87.7% Crawl: 97.4%	• Fewer babies in COVID cohort had one definite meaningful word: aRR = 0.86 (95% CI: 0.80–0.92)** • Fewer babies in COVID cohort could finger point: aRR = 0.91 (95% CI: 0.86–0.96)** • Fewer babies in COVID cohort could wave bye-bye: aRR = 0.94 (95% CI: 0.90–0.99)* • More babies in COVID cohort could crawl: aRR = 1.06 (95% CI: 1.03–1.09)**
Finegold 2023 [16]	ASQ-3 MCHAT-R NIH Toolbox Early Childhood Cognitive Battery	Problem-solving: M = 54.5, SD = 7.8 Personal-social: M = 49.9, SD = 8.8 Fine motor: M = 51.9, SD = 10.8 Picture sequence memory: M = 118.3, SD = 21.6 Vocabulary: M = 111.3, SD = 16.7 Cognitive composite: M = 116.7, SD = 16.1	Problem-solving: M = 50.6, SD = 10.0 Personal-social: M = 51.5, SD = 8.8 Fine motor: M = 49.7, SD = 10.2 Picture sequence memory: M = 112.2, SD = 23.9 Vocabulary: M = 108.0, SD = 14.6 Cognitive composite: M = 112.7, SD = 14.9	• COVID group had higher problem-solving skills: B = 3.93 (95% CI: 2.48 to 5.38) β = 0.21** • COVID group had lower personal-social skills: B = –1.7 (95% CI: –3.21 to –0.2) β = –0.09* • COVID group had higher fine motor skills: B = 2.18 (95% CI: 0.41 to 3.95) β = 0.10* • COVID group had higher picture sequence memory: B = 5.95 (95% CI: 1.11 to 10.79) β = 0.11* • COVID group had higher vocabulary: B = 3.16 (95% CI: 0.13 to 6.19) β = 0.09* • COVID group had higher cognitive composite scores: B = 3.89 (95% CI: 0.73 to 7.04) β = 0.11*
Giesbrecht 2023 [17]	ASQ-3	Communication: 6.7% below 1 SD Gross motor: 12.0% below 1 SD Personal-social: 7.9% below 1 SD	Communication: 9.4% below 1 SD Gross motor: 13.9% below 1 SD Personal-social: 11.3% below 1 SD	• COVID group scored worse on Communication: aOR = 1.39 (95% CI: 1.14–1.71)*** • COVID group scored worse on Gross Motor: aOR = 1.19 (95% CI: 1.01–1.39)* • COVID group scored worse on Personal-Social: aOR = 1.54 (95% CI: 1.27–2.86)***
Imboden 2022 [23]	ASQ-3	6-month-old Problem-Solving: median = 60 24-month-old Problem-Solving: median = 55 6-month-old Communication: *N* = 0 scored below cutoff 12-month-old Communication: *N* = 1 scored below cutoff	6-month-old Problem-Solving: median = 55 24-month-old Problem-Solving: median = 60 6-month-old Communication: *N* = 5 scored below cutoff 12-month-old Communication: *N* = 6 scored below cutoff	• 6-month-old COVID group scored worse on problem-solving: U = 4881.5* • 24-month-old COVID group scored better on problem-solving: U = 5678* • 6-month-old COVID group scored worse on communication: H (2) = 4.64* • 12-month-old COVID group scored worse on communication: H(2) = 4.24*
Johnson 2024 [29]	ASQ-3	Communication: 0.091 (95% CI: 0.08 to 0.101) Personal-social: –0.00 (95% CI: –0.01 to 0.011) Problem-solving : 0.034 (95% CI : 0.024 to 0.044)	Communication: 0.062 (95% CI: 0.052 to 0.073) Personal-social: –0.016 (95% CI: –0.026 to –0.006) Problem-solving: 0.016 (95% CI: 0.005 to 0.026	• COVID group scored worse on Communication: –0.029 (95% CI: –0.041 to –0.017)* • COVID group scored worse on Personal-Social: –0.016 (95% CI: –0.028 to –0.004)* • COVID group scored worse on Problem-solving: –0.018 (–0.03 to –0.006)*

Table 3 (continued)

Study ID	Assessment Instrument(s)	Pre-COVID Cohort Development Scores	COVID Cohort Development Scores	Cohort Differences in Development
Kuehn 2024 [26]	ASQ: SE-2 ASQ-3	ASQ-3 at 10mos Communication: 0.7% positive screening Gross Motor: 6.6% positive screening Fine Motor: 2.2% positive screening Problem-solving: 1.6% positive screening ASQ-SE at 12mos: 1.3% positive screening ASQ-3 at 18mos Communication: 3.4% positive screening ASQ-SE at 18mos: 1.4% positive screening	ASQ-3 at 10mos Communication: 0.9% positive screening Gross Motor: 6.5% positive screening Fine Motor: 2.6% positive screening Problem-solving: 1.8% positive screening ASQ-SE at 12mos: 2.4% positive screening ASQ-3 at 18mos Communication: 4.3% positive screening ASQ-SE at 18mos: 2.7% positive screening	• COVID group had increased odds of positive screening on Communication: 1.44 (95% CI: 1.05–1.98)* • COVID group had decreased odds of positive screening on Gross Motor: 0.94 (95% CI: 0.84–1.06)* • COVID group had increased odds of positive screening on Fine Motor: 1.28 (95% CI: 1.06–1.56)* • COVID group had increased odds of positive screening on Problem Solving: 1.27 (95% CI: 1.02–1.58)* • COVID group had increased odds of positive screening on ASQ-SE at 12 mos: 1.94 (95% CI: 1.61–2.33)* • COVID group had increased odds of positive screening on Communication:1.26 (95% CI: 1.03–1.53)* • COVID group had increased odds of positive screening for ASQ-SE at 18 mos: 1.87 (95% CI: 1.5–2.32)*
Nozadi 2023 [27]	ASQ-3	N/A	N/A	• Male children more than twice as likely to lose developmental functioning in Communication: OR = 2.4 (95% CI: 1.61–4.0)*** • Male children more than twice as likely to lose developmental functioning in Personal-Social; OR = 2.4 (95% CI: 1.46–4.0)***
Deoni 2021 [25]	MSEL	Mean values from 2011–2019 ranged from 98.5 to 107.3 with SD of 15.2 to 19.7	Means and SD for March-December 2020: 86.3 +/- 17.9 Means and SD for January-August 2021: 78.9 +/- 21.6	• Children born since July 2020 have significantly reduced verbal, motor, and overall cognitive performance compared to children born pre-pandemic • Children from lower SES families have been most affected. • Across all measures, there were significant ($p < 0.01$) reductions between the 2011–2019 period and 2021
Lee 2024 [20]	K-DST	N/A	N/A	• COVID group at higher risk for delay in Fine Motor skills: aOR: 1.08 (95% CI: 1.06–1.09)*** • COVID group at higher risk for delay in Cognition: aOR: 1.10 (95% CI: 1.08–1.11)*** • COVID group at higher risk of delay in Communication: aOR: 1.21 (95% CI: 1.19–1.22)*** • COVID group at higher risk of delay in Social Interaction: aOR: 1.15 (95% CI: 1.13–1.17)*** • COVID group at higher risk of delay in Self- care; aOR: 1.14 (95% CI: 1.12–1.16)***
Matsuo 2024 [18]	Public health nurse assessment	N/A	N/A	• COVID group had non-significant increased relative risk of language delay: 1.11 (95% CI: 1.08–1.15) • COVID group had non-significant increased relative risk of inability to say 3 + meaningful words: 1.14 (95% CI: 1.08–1.2)
Perry 2023 [28]	HTKS CHEXI	Pre-K Fall: M = 44.67 Pre-K Spring: M = 44.26	Pre-K Fall: M = 48.72 Pre-K Spring: M = 48.72	• In Fall of pre-K, COVID group had higher EF scores than the pre-COVID group: β = 0.15* • In Spring of pre-K, COVID group had higher EF scores than the pre-COVID group: β = 0.07* • COVID group had an increase in EF scores over time: M = 18.7***, σ^2 = 84.57***
Romem 2024 [11]	SWYC	N/A	N/A	• Overall, there was no difference in the odds of "meeting expectations" between pre-COVID and COVID groups: OR 0.99 (95% CI: 0.94–1.04) • Certain characteristics contributed to lower odds of "meeting expectations", such as male sex at birth, race identified as Other, Hispanic ethnicity, families in lowest two SES quartiles, having Medicaid insurance, maternal age ≤ 20 years at time of delivery, single parent household, maternal substance use during pregnancy

Table 3 (continued)

Study ID	Assessment Instrument(s)	Pre-COVID Cohort Development Scores	COVID Cohort Development Scores	Cohort Differences in Development
Sato 2023 [19]	KIDS	N/A	N/A	• For the 1-to-3 age group, COVID cohort showed positive associations between the pandemic and development in physical motor, manipulation, language concepts, and social relationships • For the 3-to-5 age group, COVID cohorts were 4.39 months behind in overall development at age 5: −4.39 (95% CI: −7.66 to −1.27)
Specht 2021 [30]	SDQ	SDQ-TD score: M = 6.0, SD = 3.8 Hyperactivity score: M = 2.5, SD = 2.4 Peer problem score: M = 0.4, SD = 0.7 PSB score: M = 8.5, SD = 1.4 Externalizing: M = 4.1, SD = 3.1	SDQ-TD score: M = 7.9, SD = 5.2 Hyperactivity score: M = 3.6, SD = 2.9 Peer problem score: M = 0.7, SD = 1.2 PSB score: M = 7.9, SD = 1.5 Externalizing: M = 5.6, SD = 4.0	• COVID group scored worse on Total Difficulties* • COVID group scored worse on Hyperactivity* • COVID group scored worse on Peer Relationship Problems* • COVID group scored better on Prosocial behavior* • COVID group showed more externalizing behavior*
Sperber 2022 [24]	BITSEA LDS	N/A	Socioemotional: 12 mos: M = 7.54, SD = 6.00 24 mos: M = 8.14, SD = 7.07 Language: 12 mos: M = 106.68, SD = 14.79 24 mos: M = 101.23, SD = 17.29	• Duration of pandemic exposure did not predict infant socioemotional problems at 12 months or 24 months • No significant effect of pandemic exposure on infant language development at 12 months or 24 months

ASQ Ages and Stages Questionnaire, *ASQ SE* Ages and Stages Questionnaire Social Emotional, *CBCL* Child Behaviour Checklist, *MSEL* Mullen Scales of Early Learning, *MCHAT-R* The Modified Checklist for Autism in Toddlers, Revised, *K-DST* The Korean Developmental Screening Test, *HTKS, CHEXI* Childhood Executive Functioning Inventory, *SWYC* Survey of Well-Being of Young Children, *KIDS* Kinder Infant Development Scale, *BITSEA* Brief Infant-Toddler Social Emotional Assessment, *LDS* LENA Developmental Snapshot, *M* Mean, *SD* Standard deviation, *aOR* Adjusted odds ratio, *aRR* Adjusted relative risk, *CI* Confidence interval

**p < 0.05, **p <0.01, and ***p<0.001*

diagnosis, there was a significant increase in the rate of first-time speech delay diagnosis for all age groups (0–5 years old).[21] Similarly, in another study, authors modelled the impact of increased risk for communication and personal-social skill deficits across the US population and estimated that the poorer scores in these domains would translate to 1541 more recommended referrals per month across the US over baseline [29]. Kuehn and Giesbrecht also estimated increased need for referral services in the pandemic cohorts [17, 26]. While these studies inferred the potential impact of increased risk of developmental delays on health services utilization, there was no direct measure of the correlation between these two factors.

Populations at risk for missed WCV and risk of developmental delay

A study from the US examined structural barriers that may have contributed to difficulties for parents following the recommended schedule for pediatric care visits during the pandemic [7]. They found that higher parental education, having private health insurance for their children, being employed, having only one child, identifying as non-Hispanic and having an income greater than 1.5 times the federal poverty level were all associated with higher attendance for WCV [7]. Two other studies reported that publicly insured children were more likely to miss appointments compared to their privately insured counterparts [2, 6]. Missed appointments appeared to be the highest in areas with reduced median incomes [4].

Three studies examining developmental effects also identified disparities. Children from lower SES backgrounds demonstrated a larger decrease in language, motor, and perceptual abilities during the pandemic than their higher SES counterparts [32]. Romem and authors found an unequal distribution of suboptimal developmental outcomes for children who identified as American Indian/Native Alaskan, Native Hawaiian/Pacific Islander, Hispanic/Latino/Spanish, or who came from rural areas, highlighting that the pandemic may have exacerbated existing inequities in child development [11]. Similarly, children identified as having lower SES and living in rural areas had a greater risk for neurodevelopmental delay [20]. However, one study did not find any disparities when measuring sociodemographic effects. In a study assessing language development in a sample of infants born during the first wave of the pandemic in spring 2020 in New York City, the authors found no differences between various SDH measures (maternal educational attainment, annual income, and household size data) or age at onset of pandemic and the measured outcomes (expressive vocabularies and word combinations and risk factors for language delay). [24].

Discussion

Overall, our review demonstrated a decrease in WCV attendance rates during the pandemic era, when compared to the pre-pandemic era. However, since studies limited their reporting periods to 15 months or less, all but two studies [5, 6] were not able to report on whether WCV rates rebounded consistently to pre-pandemic levels. No studies examined the relationship between primary care attendance and child development, which remains an important research gap. Despite some studies showing that efforts to prioritize WCV may have occurred, evidence suggests that some groups of children were disproportionately affected by pandemic restrictions compared to others [2–7]. Persistent challenges accessing health care services within existing societal structures, such as language barriers and lack of social support for parents were further highlighted during the pandemic [11]. The structure of health services may have contributed to access barriers, such as when parents were required to pay for health services and the economic impacts on parents of their country's emergency restrictions on workers. Ensuring that existing health inequities are addressed should be a priority within pediatric preventative primary care.

All but two studies [11, 24] looking at the association of the pandemic and developmental domains found a negative association of the pandemic period on at least one domain of child development, particularly in the language and social domains. The studies included in this review used a wide range of assessment tools, measured a variety of between-group differences, recruited different age groups, and had different reporting periods; therefore, the results warrant further exploration. It is still not well understood why and how the pandemic may have been associated with changes in certain domains of development for children. Though not directly examined, it is possible that reduced attendance may have contributed to the observed changes in child development. For example, pandemic related service restrictions and associated parental concerns may have resulted in selective reluctance of parents without developmental concerns to attend well child visits. Furthermore, the association of sociodemographic factors with both attendance and child development, may also be an important factor. More information on the relationship between age at the time of exposure to the pandemic restrictions and risk for developmental delay is needed and may elucidate why some children were at higher risk compared to others [19, 28].

The pandemic presented changes to the environment that might have impaired early development [32]. According to the socio-ecological framework [33], the environment plays a crucial role for children's health outcomes. Restrictions put in place during the pandemic, which may have resulted in family isolation, financial stress, worry about infection, may have also exacerbated existing inequities and resulted in increased risk for adverse health outcomes. The larger community, familial factors, and individual child factors also potentially play a role in either protecting or worsening delays in young children's socio-emotional development [26, 28]. For example, having increased time at home with parents and other family members may have been beneficial for infants' language development, in some cases, while greater isolation from the larger community may have been detrimental. As such, addressing these inequities would require:1) identifying/recognizing them; and 2) targeted interventions [19, 24].

There were some successful targeted approaches during the pandemic. Garg and authors were able to successfully implement strategies to ensure WCV adherence, such as minimizing the number of times patients travelled for their appointments and providing families with transportation support; as well as providing staff with resources to address language barriers using technological aids [34]. Persaud and authors recommended several ways to address inequities exacerbated by the pandemic in Canada, including advocating for the expansion of publicly funded childcare for children, as well as universal basic income [35].

The role that SDH might have on the ability to seek or access care and their effect on children's growth and development were not always explored. In articles that did consider their role, the findings aligned with existing evidence on the barriers to seeking health care and contribution to overall health and development related to education, income, and health literacy [11, 27]. It is important to consider how the pandemic may have widened these existing inequities and may have impacted the diagnosis and management of developmental delays in specific groups of children.

Results from this scoping review support the need for ongoing monitoring, further supports for children and their families during emergencies such as the pandemic, as well as the need for further research into the association between WCV and child development. Specifically, evidence showed the need for supports and tools for children who may have sequelae from decreased WCVs, increased risk of developmental delays. Ongoing monitoring of children at higher risk, especially those with intersecting health disparities is needed to understand the clinical implications that increased risk for developmental delays and the long-term effects of the pandemic may have on child health and well-being.

Limitations

It is important to note that many of the tools used in the studies of this scoping review are screening tools and not diagnostic tools. Studies that used diagnostic code for language delay in EMRs or administrative data did not verify clinical data to confirm diagnoses. Timelines of studies did not necessarily account for different phases of the pandemic, or identify the specific restrictions present during the COVID period during which the study took place, and most were conducted in the first year of the pandemic, limiting the available data from longer follow up. Understanding what role different time periods had on the measured outcomes would be beneficial. Finally, though our search was thorough, we may have missed relevant studies in our review, including research from low and middle income countries.

Conclusion

This scoping review used a well-established framework to provide an overview of available evidence to identify gaps in the literature related to preventative primary care for young children during the COVID-19 pandemic. Further research is needed to better understand the longitudinal effects of the pandemic on young children. Specifically, the role that missed preventative primary care appointments may have had on health outcomes, as well as the relationship between the risk for developmental delays on children's long-term health and well-being. Several studies hypothesize that the increased delay of achieving certain milestones may result in an increased need for the utilization of health services; [17, 25, 29] it is thus particularly important to further understand the role that preventative primary care may have on the management and diagnosis of developmental delays in young children.

Abbreviations

ASQ-3/ASQ:SE-2	Ages and Stages Questionnaire
BITSEA	Brief Infant-Toddler Social Emotional Assessment
CORAL	Impact of Corona Virus Pandemic on Allergic and Autoimmune Dysregulation in Infants Born During Lockdown
CHEXI	Childhood Executive Functioning Inventory
CBCL	Child Behaviour Checklist
EF	Executive Functioning
ELC	Early Learning Composite
GRIFFITHS	Griffiths Scale of Mental Development
HTKS	Heads–Toes–Knees–Shoulders Task
K-DST	The Korean Developmental Screening Test
KIDS	Kinder Infant Development Scale
LDS	LENA Developmental Snapshot
MCHAT-R	The Modified Checklist for Autism in Toddlers, Revised (MCHAT–R)
MSEL	Mullen Scales of Early Learning
NIH	National Institute of Health
NVDQ	Non-Verbal Development Quotient
SDH	Social Determinants of Health
SDQ	Strengths and Difficulties Questionnaire
SWYC	Survey of Well-Being of Young Children
VDQ	Verbal Development Quotient
WCV	Well Child Visit

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

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Authors' contributions

IB and PL conceptualised the study and generated the inclusion and exclusion criteria. XQ developed the search strategy in conjunction with MJ and IM. KM and HV conducted the literature review, wrote, edited, and revised the manuscript. All authors critically revised and approved the manuscript for publication.

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Data availability

All data generated or analysed during this study are included in this published article.

Declarations

Ethics approval and consent to participate

Ethics approval was not required by the research ethics board as this scoping review does not consist of any primary data collection.

Consent for publication

Not required.

Competing interests

The authors declare no competing interests.

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