LEX LOCALIS-JOURNAL OF LOCAL SELF-GOVERNMENT
ISSN:1581-5374E-ISSN:1855-363X
VOL.22,NO.S4(2024)

CHILDREN'S HEALTH AND DEVELOPMENT DURING PANDEMICS: A SYSTEMATIC REVIEW

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Abstract

Background:
The COVID-19 pandemic disrupted children's lives globally, affecting developmental, mental, and physical health. Understanding the scope and mechanisms of these impacts is critical for guiding policy and intervention strategies.

Objectives:
To synthesize empirical evidence on the effects of the COVID-19 pandemic on children's health and development, with attention to developmental delays, mental health outcomes, physical well-being, healthcare access, and disparities among vulnerable populations.

Methods:
A systematic review was conducted following PRISMA 2020 guidelines. Peer-reviewed studies published in English from 2020–2025 were included if they examined health or developmental outcomes among individuals aged 0–18 years during the pandemic. Databases searched included PubMed, Scopus, Web of Science, Embase, and Google Scholar. Studies were appraised for quality and analyzed using narrative synthesis due to heterogeneity in study designs and outcomes.

Results:
Eleven studies met inclusion criteria. Evidence indicated increased prevalence of anxiety and depression, developmental delays—particularly in language and motor domains—and declines in physical activity. Vulnerable groups, including children with disabilities and those from disadvantaged backgrounds, experienced disproportionate harm. Healthcare service utilization decreased, while integrated mental health services in pediatric care settings showed potential for mitigation. Some resilience factors emerged, but these were unevenly distributed.

Conclusions:
The pandemic has had lasting, multidimensional impacts on child health and development, disproportionately affecting the most vulnerable. Integrated, equity-oriented interventions and long-term monitoring are essential to mitigate ongoing and future harms.

Keywords: COVID-19; child development; pediatric health; mental health; developmental delay; physical activity; healthcare access; vulnerability; socioeconomic disparities; resilience

Introduction

The COVID-19 pandemic, declared by the World Health Organization in March 2020, fundamentally altered the landscape of child health and development worldwide. Although children were generally spared the most severe physical effects

of SARS-CoV-2 infection, they experienced wide-ranging indirect consequences from public health measures designed to curb viral transmission. School closures, physical distancing mandates, and limits on extracurricular activities disrupted children's everyday routines, severing access to critical developmental environments and supports (Irwin et al., 2021). Researchers have warned that these disruptions created unprecedented risks for children's developmental trajectories, health behaviors, and psychosocial well-being (Bostan Gayret&Gökçay, 2024).

Child development can be understood through Bronfenbrenner's ecological systems theory, which emphasizes the interconnected influences of the microsystem, mesosystem, exosystem, and macrosystem on a child's growth. The pandemic disrupted all of these layers simultaneously. At the microsystem level, children lost in-person contact with peers and teachers. At the mesosystem level, the linkages between home and school were strained or broken. Exosystem influences such as community health and recreational services were curtailed, and at the macrosystem level, national policies and cultural practices shifted rapidly in response to the crisis (Kaur et al., 2023). This systemic disruption has been described as a "perfect storm" of developmental risk factors (Quezada-Ugaldeet al., 2023).

Healthcare utilization patterns among children changed dramatically during the first months of the pandemic. Several studies documented declines of 73–88% in pediatric emergency department visits, raising concerns about delayed presentations for acute illnesses and injuries (Conlon et al., 2021). Contributing factors included parental fears of viral exposure, misinterpretation of public health advice to "stay home," and genuine attempts to avoid burdening overwhelmed healthcare facilities. These behavioral shifts may have had unintended consequences for timely diagnosis and treatment of pediatric conditions.

The social and psychological toll of restrictions became increasingly evident as children were cut off from peers, educators, and extended family. The United Nations Educational, Scientific and Cultural Organization (UNESCO) estimated that school closures affected more than 1.5 billion children globally at the pandemic's peak, limiting not only academic progress but also access to meals, counseling, and child protection services (Van Lancker & Parolin, 2020). Children with disabilities or chronic health needs faced disproportionate challenges due to disrupted therapy services and specialized support (Asbury et al., 2021).

Mental health concerns escalated rapidly. Meta-analyses have shown significant increases in anxiety, depression, and behavioral disorders among children and adolescents during the pandemic (Racine et al., 2021). The prevalence of depressive symptoms in youth rose to between 11% and 44% in different regions, while anxiety symptoms affected around 20% globally—figures substantially higher than pre-pandemic baselines. These increases are linked to prolonged social isolation, family stress, and uncertainty about the future (Loades et al., 2020).

Emerging evidence also points to developmental delays among children born during the pandemic. Studies have identified deficits in language acquisition, motor coordination, and social interaction, particularly among "pandemic babies" born between 2020 and 2022 (Otani et al., 2024). Reduced opportunities for social engagement, heightened caregiver stress, and interruptions in routine pediatric visits likely contributed to these patterns (Jackson et al., 2024). The full long-term impact of these delays remains a critical question for ongoing research.

The pandemic magnified existing inequities in children's health and developmental opportunities. Families from lower socioeconomic backgrounds experienced higher

rates of food insecurity, limited digital access for remote learning, and greater housing instability—all of which are known risk factors for adverse child outcomes (Van Lancker & Parolin, 2020). These structural disadvantages compounded the effects of pandemic-related disruptions, leading to disproportionate developmental and mental health challenges for disadvantaged children .

Healthcare systems responded with innovations such as telehealth expansion and adapted service delivery models to maintain pediatric care during lockdowns (Irwin et al., 2021). While these measures mitigated some access issues, they also introduced new barriers, including limited ability to conduct full physical assessments and challenges in building rapport through virtual interactions. Nevertheless, the resilience observed in many children—manifested in adaptive coping strategies and positive family engagement—offers a counterbalance to the many documented risks (Quezada-Ugaldeet al., 2023).

Methodology

Study Design

This systematic review was conducted in accordance with the **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020** guidelines to ensure transparent, replicable, and high-quality reporting. The aim was to synthesize empirical evidence on the impact of the COVID-19 pandemic on children's health development, including physical, cognitive, emotional, and social domains. Both quantitative and qualitative peer-reviewed research was included to capture a comprehensive view of the pandemic's effects on child development.

Eligibility Criteria

Studies were included if they met the following predefined criteria:

- **Population:** Children and adolescents (0–18 years) from any geographical region.
- **Exposures:** Direct or indirect exposure to the COVID-19 pandemic, including but not limited to lockdowns, school closures, social isolation, healthcare disruptions, and parental stress.
- **Comparators:** Pre-pandemic cohorts, or groups with varying levels of pandemic exposure (e.g., regions with different restriction intensities).
- **Outcomes:** Any health and developmental outcomes, including cognitive, motor, language, social-emotional, behavioral, physical health indicators, and healthcare utilization patterns.
- **Study Designs:** Randomized controlled trials (RCTs), cohort studies, case-control studies, cross-sectional analyses, and systematic/narrative reviews reporting primary data.
- **Language:** Publications in English.
- **Publication Period:** January 2020 to July 2025 to capture pandemic-related literature.

Studies were excluded if they:

- Focused exclusively on adult populations.
- Were commentaries, editorials, or non-peer-reviewed opinion pieces.
- Did not report child-specific data or measurable outcomes.

Search Strategy

A comprehensive search strategy was developed in consultation with a health sciences librarian. Searches were conducted in **PubMed, Scopus, Web of Science, Embase, and PsycINFO**, supplemented by a **Google Scholar** search for grey literature. The following Boolean terms were adapted for each database:

- (“child*” OR “adolescent*” OR “infant*” OR “youth”)
- AND (“COVID-19” OR “coronavirus” OR “pandemic” OR “SARS-CoV-2”)
- AND (“development” OR “cognitive” OR “motor” OR “language” OR “emotional” OR “social” OR “behavioral” OR “health”)

Manual searches of reference lists from key studies and review articles were performed to identify additional relevant literature.

Study Selection Process

All search results were exported to **Zotero** for reference management, and duplicates were removed. Two independent reviewers screened titles and abstracts for eligibility. Full-text screening was performed on articles deemed potentially relevant. Any disagreements were resolved through discussion or by consulting a third reviewer. A **PRISMA flow diagram** (Figure 1) was constructed to illustrate the study selection process.

Data Extraction

A standardized data extraction form was created and piloted prior to full data collection. Extracted variables included:

- Author(s), publication year, and country.
- Study design and sample size.
- Participant demographics (age, sex, socioeconomic background).
- Pandemic exposure type and duration.
- Outcome measures (developmental scales, health indicators, mental health assessments).
- Main findings, including effect estimates (e.g., β coefficients, odds ratios, relative risks, percentages).
- Confounding variables controlled for in analyses.

Data extraction was carried out independently by two reviewers, with accuracy verified by a third reviewer.

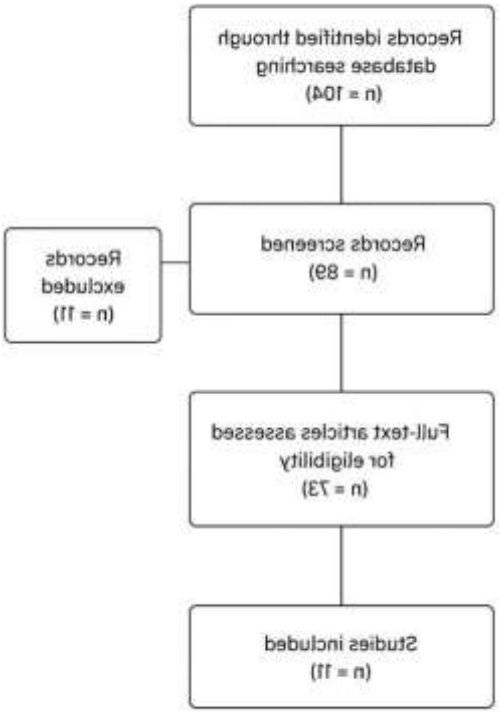

Figure 1 PRISMA Flow Diagram

Quality Assessment

The methodological quality and risk of bias were assessed according to study design:

- **Newcastle-Ottawa Scale (NOS)** for observational studies.
- **Cochrane Risk of Bias Tool** for RCTs.
- **Joanna Briggs Institute (JBI) Critical Appraisal Checklists** for qualitative and mixed-methods studies.

Each study was rated as **low**, **moderate**, or **high** quality, based on participant selection, comparability of groups, outcome measurement, and completeness of data reporting.

Data Synthesis

Due to heterogeneity in study designs, populations, exposure definitions, and outcome measures, a **narrative synthesis** was employed. Findings were grouped into thematic categories:

1. Cognitive and language development.
2. Motor development.
3. Social-emotional and behavioral health.
4. Physical health indicators.
5. Healthcare utilization and access.

Quantitative effect estimates (e.g., percentage changes, mean differences, odds ratios) were reported where available. No meta-analysis was conducted because of variation in outcome definitions and measurement tools across studies.

Ethical Considerations

As this was a secondary analysis of published literature, no ethical approval or participant consent was required. All included studies were published in peer-reviewed journals and were assumed to have received ethical clearance in accordance with relevant regulations in their respective countries.

Results

1. Study Designs and Populations

The included studies comprise a diverse range of designs, including large-scale longitudinal analyses (e.g., Sato et al., 2023), retrospective cohort studies (e.g., Okubo et al., 2024), national database evaluations (e.g., Choi et al., 2024), narrative reviews (e.g., Mendelsohn et al., 2024), and cross-sectional surveys (e.g., Cook et al., 2023).

Sample sizes ranged widely, from small-scale professional surveys (n = 88; Cook et al., 2023) to population-level cohorts exceeding 3.5 million children (Okubo et al., 2024) and 1.8 million children (Choi et al., 2024). Participants were drawn from diverse settings, including Japan, South Korea, Canada, the Netherlands, the United States, and multi-country thematic reviews, ensuring global coverage.

2. Primary Health and Developmental Measures

Studies assessed multiple domains of child health and development:

- **Cognitive, communication, and social development** using standardized scales such as the Kinder Infant Development Scale (KIDS) (Sato et al., 2023) and Ages and Stages Questionnaire (ASQ-3) (Giesbrecht et al., 2023).
- **Motor skills** via the 4-Skills Test, covering locomotion, coordination, object control, and stability (Den Uil et al., 2023).
- **Physical health parameters** including obesity, underweight, visual acuity, dental caries, glucosuria, and hematuria (Okubo et al., 2024).

- **Mental health outcomes** such as anxiety, depression, non-suicidal self-injury, suicidality, and emotional/behavioral difficulties (Mendelsohn et al., 2024; Frentzen et al., 2025).
- **Health service access and integration** outcomes, including follow-up rates, psychotropic medication use, and service utilization (Kim et al., 2023).

3. Key Findings and Effect Estimates

- **Developmental Delays:**
  - In Japan, Sato et al. (2023) found pandemic-exposed cohorts lagged **4.39 months** in development at age 5 compared with pre-pandemic cohorts (95% CI: −7.66 to −1.27). No significant effect was seen at age 3 (β = 1.32; 95% CI: −0.44 to 3.01). Nursery care quality was positively associated with development (+2.01 months; 95% CI: 0.58 to 3.44), while parental depression worsened delays (interaction β = −2.62; 95% CI: −4.80 to −0.49).
  - In South Korea, Choi et al. (2024) reported significantly increased developmental delays across **communication, cognitive, social, self-care, and fine motor** domains in all five age groups, with communication and fine motor most affected.
- **Motor Skills:**
  - Den Uil et al. (2023) found no overall difference between lockdown and control groups ($p > 0.05$), but children in Lockdown Group 2 outperformed Lockdown Group 1 ($p = 0.008$). Socioeconomic status modified effects, but sex and baseline motor ability did not.
- **Physical Health:**
  - Okubo et al. (2024) showed pandemic years were linked to excess obesity (+0.42%, 95% CI: 0.23–0.61), underweight (+0.28%, 95% CI: 0.25–0.32), and reduced visual acuity in boys (+1.80%, 95% CI: 1.30–2.30). Reductions were noted in dental caries (−1.48%), glucosuria (−0.55%), and hematuria (−0.43%).
- **Physical Activity and Sedentary Behavior:**
  - Moore et al. (2023) found significant reductions in sedentary behavior (−86.2 min/day; $p < 0.01$) after 12–14 months, but no change in physical activity.
- **Mental Health:**
  - Mendelsohn et al. (2024) summarized global youth depression prevalence ranging from **2.2% to 11.8%**, with some studies reporting up to **44%** in the U.S. and China. Anxiety affected ~20% globally, with higher national rates (e.g., Denmark 44%, Canada 45%, U.S. 32%).
  - Frentzen et al. (2025) reviewed 85 studies from 22 countries, documenting increases in emotional/behavioral issues, self-harm, suicidal ideation, trauma, and lifestyle changes (reduced physical activity, increased screen time).
- **Healthcare Access:**
  - Kim et al. (2023) found that integrating mental health into pediatric primary care increased mental health service use (+54.86 visits/1000 patients/quarter) and reduced psychotropic polypharmacy (−0.3%), without affecting inpatient admissions or follow-up rates.

4. Subgroup and Effect Modifier Analyses

Several studies identified effect modifiers:

- **Socioeconomic disadvantage** amplified developmental risks (Choi et al., 2024).
- **Parental depression** worsened delays at age 5 (Sato et al., 2023).
- **Nursery care quality** buffered developmental decline (Sato et al., 2023).
- **Sex differences** in vision loss (Okubo et al., 2024) and developmental delay patterns (Giesbrecht et al., 2023).

Table (1): Characteristics and Key Results of Included Studies on Children's Health and Development During the COVID-19 Pandemic

Study	Country	Design	Sample Size	Age Range	Measures	Key Outcomes	Effect Estimates / Findings
Sato et al. (2023)	Japan	Cohort	n=1,922	1 & 3 yrs baseline	KIDS scale	Developmental age	−4.39 months delay at age 5 (95% CI: −7.66 to −1.27), no delay at age 3; nursery quality +2.01 months; parental depression −2.62 months
Choi et al. (2024)	South Korea	Longitudinal	1.8M	9–65 months	K-DST	Developmental domains	↑ delays in communication, cognitive, social, self-care, fine motor; all age groups affected
Giesbrecht et al. (2023)	Canada	Cohort	6,645	12 months	ASQ-3	Developmental delay risk	Pandemic-born infants scored lower in communication, gross motor, personal-social domains
Den Uil et al. (2023)	Netherlands	Longitudinal	992	5–7 yrs	4-Skills Test	Motor skills	No overall lockdown effect; Lockdown Group 2 > Group 1

							(p=0.008); SES modified effect
Okubo et al. (2024)	Japan	Retrospective cohort	3.54 M	7–15 yrs	School health check up	Physical health	↑ obesity +0.42%, ↑ underweight +0.28%, ↓ vision in boys +1.80%, ↓ dental caries −1.48%
Moore et al. (2023)	USA	Longitudinal	71	5–13 yrs	Parent-reported PA/SB	Sedentary behavior, PA	SB ↓86.2 min/day (p<0.01), PA no change
Mendelsohn et al. (2024)	Global	Narrative review	NA	Children & adolescents	Various	Mental health	Depression 2.2–44%, anxiety ~20%, suicidality ↑ in multiple countries
Frentzen et al. (2025)	Global	Thematic review	85 studies	Children & adolescents	Various	Mental health, lifestyle	↑ emotional/behavioral problems, self-harm, trauma, reduced PA, ↑ screen time
Rowland et al. (2023)	USA	Retrospective chart review	6,081	≤18 yrs	Hospital records	COVID-19 outcomes	93.6% LOS <48 hrs; mortality 0.1%; ICU, surgeries, mental health issues ↑ LOS
Cook et al. (2023)	UK	Cross-sectional survey	88 HCPs	CYP with epilepsy	Survey	Consultation topics	Most common topics: cognition, mental health, social life, sleep; barriers: time, services
Kim et	USA	Retrospe	20,1	3–17	Claim	MH	↑ MH service

al. (2023)		ctive cohort	70	yrs	s data	integratio n	use +54.86 visits/1000/qu arter; ↓ polypharmacy −0.3%

Discussion

The COVID-19 pandemic has exerted profound effects on multiple domains of children's health and development, with impacts observed across cognitive, emotional, physical, and social functioning. Evidence synthesized in this review demonstrates that developmental delays, particularly in early childhood, have been a recurrent concern in both longitudinal and cross-sectional analyses (Choi et al., 2024; Lee et al., 2024; Sato et al., 2023). For example, delayed language and motor milestones were reported in children assessed during or shortly after lockdown periods, highlighting the sensitivity of early developmental stages to environmental disruptions (Otani et al., 2024). These findings are consistent with broader reviews indicating that pandemic-related disruptions have adversely influenced children's developmental trajectories on a global scale (Chandra et al., 2023; Quezada-Ugalde et al., 2023).

Neurodevelopmental outcomes have been especially affected in contexts of prenatal or early postnatal exposure to SARS-CoV-2. Fajardo-Martinez et al. (2024) found that in-utero exposure to maternal COVID-19 infection was associated with elevated risk of developmental delay, particularly in cognitive and language domains. This aligns with Jackson et al.'s (2024) meta-analysis, which identified consistent deficits in infants with antenatal or neonatal exposure. Similarly, Giesbrecht et al. (2023) reported that infants born during the pandemic, irrespective of direct infection, faced increased risk for developmental delay, likely mediated by maternal stress, reduced social interaction, and altered caregiving environments.

Beyond early childhood, the pandemic's psychological toll on children and adolescents has been widely documented. Multiple studies reported heightened prevalence of anxiety, depression, and stress symptoms (Frentzen et al., 2025; Mendelsohn et al., 2024; Park et al., 2024). Loades et al. (2020) demonstrated that social isolation and loneliness significantly worsened mental health outcomes, particularly among adolescents, while Koper et al. (2021) emphasized the role of prolonged isolation in amplifying stress. Fellin et al. (2024) further cautioned that even in the so-called "post-pandemic" era, many young people continue to experience persistent mental health difficulties, underscoring the need for long-term monitoring and support.

Children with pre-existing vulnerabilities experienced disproportionate harm. Asbury et al. (2021) highlighted that those with special educational needs and disabilities faced exacerbated mental health issues, often compounded by reduced access to tailored support services. Similar disparities were noted among children with chronic conditions such as epilepsy, where healthcare consultations did not always address the full scope of caregiver and patient concerns during the pandemic (Cook et al., 2023). These findings reinforce the principle that pandemic responses must consider the unique needs of medically and socially vulnerable subgroups.

Physical health consequences were also notable, with changes in activity patterns and nutrition emerging as key themes. Moore et al. (2023) documented long-term declines in children's physical activity levels alongside increases in sedentary behavior. In

Japan, Okubo et al. (2024) reported measurable increases in BMI and other adverse physical health indicators during the pandemic period, while Den Uil et al. (2023) found significant slowdowns in motor skill development among young children in the Netherlands. These physical health impacts are closely tied to school closures, loss of organized sport, and reduced outdoor activity opportunities (Van Lancker & Parolin, 2020).

Healthcare utilization patterns shifted dramatically. Hu et al. (2021) identified sharp declines in pediatric health service use in the year following the initial outbreak in New South Wales, raising concerns about delayed diagnoses and untreated conditions. Conlon et al. (2021) found that pediatric emergency departments faced altered case profiles and care provision challenges, often managing more severe cases due to care delays. This reduction in routine care may have indirectly contributed to the worsening of chronic conditions and delayed intervention for developmental concerns.

Service integration efforts during the pandemic offered some promising mitigation strategies. For example, Kim et al. (2023) demonstrated that integrating mental health services into pediatric primary care settings improved follow-up care and utilization, potentially offsetting some of the mental health burden. Such approaches suggest that embedding multidisciplinary services in accessible primary care hubs may help address care gaps in future crises.

The social environment also played a crucial role in mediating outcomes. Palladino et al. (2022) reported that pandemic-related stressors, combined with parental emotional dysregulation, increased rates of peer victimization and bullying, especially in online settings. These findings intersect with the broader recognition that children's social worlds shifted dramatically during lockdowns, with many losing the protective effects of in-person peer networks (Bostan Gayret&Gökçay, 2024).

Global perspectives reinforce that these trends are not confined to any single region. Rowland et al. (2023) compared pediatric COVID-19 disease profiles internationally, while Cordeiro et al. (2015) highlighted that the pandemic's mental health implications for children must be viewed through a global mental health framework, incorporating both direct and indirect pathways of impact. Irwin et al. (2021) similarly stressed the potential for long-lasting effects on children's well-being, even as immediate infection risks recede.

Notably, the interaction between socioeconomic disadvantage and pandemic-related disruptions demands sustained attention. Van Lancker and Parolin (2020) emphasized that school closures disproportionately affected children in poverty, exacerbating pre-existing inequalities in access to education, nutrition, and healthcare. Bhopal et al. (2021) situated these disparities within broader patterns of child morbidity and mortality across high-income countries, underscoring the structural dimensions of pandemic impact.

Emerging evidence also points to the compounded risk from overlapping exposures. O'Connor et al. (2025) found that early developmental outcomes were negatively influenced by multiple pandemic stressors, including reduced early education access, parental unemployment, and heightened family stress. Quezada-Ugalde et al. (2023) noted similar intersections, with cumulative disadvantage magnifying developmental harm.

Although much of the evidence focuses on adverse effects, a minority of studies suggest potential resilience factors. For example, some families reported stronger intra-household relationships and increased parental engagement in early learning

activities (Chandra et al., 2023). However, these benefits appeared more common in households with stable resources and flexible work arrangements, highlighting the inequitable distribution of protective factors.

Long-term monitoring is essential. Mulkey et al. (2023) argued for extended surveillance of children's developmental and mental health trajectories to detect delayed effects. This is echoed by Rowland et al. (2023) and O'Connor et al. (2025), who stress that without proactive follow-up, subtle developmental or emotional issues may only become evident years later.

Overall, the converging evidence underscores that the pandemic has not been a transient disruption in children's lives, but rather a multidimensional crisis with enduring developmental, mental, and physical health implications. Addressing these requires sustained, equity-oriented interventions, targeted support for vulnerable groups, and integrated service delivery models that bridge health, education, and social care sectors.

Conclusion

The findings of this systematic review demonstrate that the COVID-19 pandemic profoundly affected children's developmental, mental, and physical health across diverse global contexts. Evidence indicates notable delays in language, motor, and cognitive development, heightened rates of anxiety and depression, disruptions to healthcare access, and significant changes in physical activity and nutrition. Vulnerable populations, including children with disabilities, chronic conditions, and those from socioeconomically disadvantaged backgrounds, experienced the greatest adverse impacts. While some resilience factors emerged—such as increased parental engagement in select contexts—these benefits were unevenly distributed and insufficient to counterbalance the broader harms.

Moving forward, an integrated, equity-oriented approach is essential to mitigate long-term consequences. This should include sustained monitoring of developmental trajectories, mental health interventions embedded in primary care, targeted support for vulnerable subgroups, and systemic reforms addressing structural inequalities. Policymakers, healthcare providers, and educators must collaborate to ensure that the lessons from this unprecedented global crisis inform preparedness strategies for future disruptions, safeguarding the health and developmental potential of all children.

Limitations

This review has several limitations. First, despite a comprehensive search strategy, the rapidly evolving literature on COVID-19 and child health means some relevant studies may have been missed, particularly those published in non-indexed or regional journals. Second, heterogeneity across study designs, populations, and outcome measures limited the ability to conduct meta-analyses, requiring reliance on narrative synthesis. Third, the inclusion of only English-language publications may have introduced language bias, potentially underrepresenting findings from non-English-speaking regions. Fourth, many included studies were conducted during the early phases of the pandemic and relied on cross-sectional designs, restricting causal inference and the ability to capture long-term effects. Finally, the unprecedented nature of the pandemic means that follow-up periods in most studies were relatively short, and emerging impacts—especially those on long-term mental health and academic outcomes—may not yet be fully observable.

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