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Emerging Infectious Diseases in Children: Epidemiology, Clinical Manifestations, and Management Strategies - A Systematic Review (2020–2022)

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Abstract: ***Background:*** The 2020–2022 period was defined by the COVID-19 pandemic, which fundamentally reshaped the landscape of paediatric infectious diseases. Beyond SARS-CoV-2 itself, this period saw major shifts in the epidemiology of other pathogens, including the off-season resurgence of respiratory syncytial virus (RSV), the emergence of multisystem inflammatory syndrome in children (MIS-C), and the persistent burden of arboviruses and vaccine-preventable diseases.

Objective: To systematically review the epidemiology, clinical manifestations, and management strategies of emerging infectious diseases affecting children during 2020–2022.

Methods: PubMed/MEDLINE, Scopus, Web of Science, and Embase were searched for English-language studies published between January 2020 and December 2022, supplemented by targeted searches for pre-pandemic context. Observational studies, systematic reviews, and meta-analyses reporting laboratory-confirmed emerging infections in children aged 0–18 years were eligible. Study selection followed PRISMA 2020 guidance, and findings were synthesised narratively.

Results: Forty-six studies were included. SARS-CoV-2 infection in children was typically milder than in adults, with fever (63.3%) and cough (33.7%) the most common symptoms. MIS-C emerged as a distinct post-infectious hyperinflammatory syndrome characterised by fever (100%), gastrointestinal symptoms (82%), and cardiac involvement (66%), frequently requiring intensive care. Non-pharmaceutical interventions profoundly disrupted RSV and influenza circulation, producing atypical seasonality and post-lockdown surges. Arboviral diseases continued to impose a substantial burden, with chikungunya most severe in infants under one year. Antimicrobial resistance among paediatric pathogens remained a critical concern, compounded by pandemic-related disruption of stewardship programmes.

Conclusion: Although COVID-19 generally spared children from severe acute disease, its indirect consequences, including MIS-C, disrupted immunisation, and altered pathogen circulation, were substantial. Strengthened surveillance, equitable vaccine access, and paediatric-focused antimicrobial stewardship are essential priorities.

Keywords: Emerging infectious diseases; Paediatrics; COVID-19; Multisystem inflammatory syndrome in children; Respiratory syncytial virus; Arboviruses; Antimicrobial resistance

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1. INTRODUCTION

The period from 2020 to 2022 was one of the most turbulent in the history of paediatric infectious diseases. The emergence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in late 2019 rapidly escalated into a global pandemic that reshaped every aspect of clinical paediatrics, from service delivery and infection control to the epidemiology of many other pathogens [1]. Yet COVID-19 was not the only emerging infectious threat confronting children during this period. The same years saw the recognition of multisystem inflammatory syndrome in children (MIS-C), marked oscillations in the circulation of respiratory syncytial virus (RSV) and influenza, the continued global burden of arboviral diseases such as dengue and chikungunya, and the persistent challenge of antimicrobial resistance in paediatric populations [2–4].

The rationale for this review stems from the need to synthesise a fragmented and rapidly evolving evidence base. The literature on paediatric emerging infections during 2020–2022 is characterised by an abundance of primary studies, many of them single-centre or regional, alongside numerous systematic reviews that often focus on a single pathogen or a narrow clinical question [5,6]. What is lacking is an integrated, cross-pathogen synthesis of the themes these infections share: epidemiological shifts, clinical patterns, and management challenges. Such a synthesis is essential for informing clinical practice, public health policy, and future research priorities.

The objective of this systematic review is therefore threefold: (1) to describe the epidemiology of emerging infectious diseases in children during 2020–2022, including incidence, geographic distribution, and the impact of

pandemic-related interventions; (2) to characterise their clinical manifestations, from mild respiratory illness to severe hyperinflammatory syndromes and neurological complications; and (3) to evaluate current management strategies, including supportive care, immunomodulatory therapy, antimicrobial stewardship, and prevention. The scope is deliberately broad, encompassing viral, bacterial, and vector-borne pathogens that either newly emerged or underwent significant epidemiological change during the review period [7,8]. The population of interest is children and adolescents aged 0–18 years. The timeframe for included primary studies is January 2020 to December 2022, with earlier foundational references incorporated to provide pre-pandemic context and definitions [9–11].

2. METHODS

2.1. Review design

This systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement. A systematic review was chosen over alternative designs for several reasons. A narrative review would not provide the methodological rigour required to synthesise a large and heterogeneous body of literature spanning multiple pathogens. A scoping review would map the breadth of evidence but would not systematically appraise study quality or answer focused questions about epidemiology, clinical manifestations, and management. The review addressed three interconnected questions: (1) What was the epidemiological profile of emerging infectious diseases in children during 2020–2022? (2) What were their characteristic clinical manifestations, and how did these differ from pre-pandemic patterns? (3) What management strategies were employed, and what evidence supports their effectiveness?

2.2. Search strategy

A comprehensive literature search was performed across four electronic databases: PubMed/MEDLINE, Scopus, Web of Science, and Embase. The strategy combined controlled vocabulary (MeSH terms) and free-text keywords. Core search terms were: ("emerging infectious disease*" OR "COVID-19" OR "SARS-CoV-2" OR "multisystem inflammatory syndrome in children" OR "MIS-C" OR "respiratory syncytial virus" OR "RSV" OR "dengue" OR "chikungunya" OR "Zika" OR "measles" OR "influenza" OR "parechovirus" OR "antimicrobial resistance") AND ("child*" OR "paediatric" OR "pediatric" OR "infant" OR "adolescent") AND ("epidemiology" OR "clinical manifestation*" OR "management" OR "treatment" OR "outcome*"). The search was limited to English-language publications from 1 January 2020 to 31 December 2022, with additional targeted searches for earlier seminal references to establish pre-pandemic baseline data.

2.3. Eligibility criteria

Inclusion criteria were: (1) primary observational studies (cohort, case-control, cross-sectional), systematic reviews, and meta-analyses; (2) studies reporting laboratory-confirmed emerging infectious diseases; (3) study populations of children and adolescents aged 0–18 years; and (4) studies reporting epidemiological, clinical, or management data. Exclusion criteria were: (1) studies of adults only; (2) editorials, commentaries, and conference abstracts without original data; (3) studies lacking laboratory confirmation of infection; and (4) non-English publications.

2.4. Study selection and data extraction

Study selection followed a two-stage process. Titles and abstracts were screened independently by two reviewers, with discrepancies resolved through discussion. Full-text articles were then assessed against the eligibility criteria. Reference lists of included studies and relevant reviews were hand-searched to identify additional sources. Extracted data comprised study characteristics (author, year, country, design, sample size), population demographics, pathogen(s) studied, and key epidemiological, clinical, and management findings.

2.5. Quality assessment and synthesis

Methodological quality was assessed using the Newcastle–Ottawa Scale for observational studies and the AMSTAR 2 tool for systematic reviews. A meta-analysis was considered but judged inappropriate because of substantial clinical and methodological heterogeneity across the included studies; variation in pathogens, study designs, case definitions, outcome measures, and settings would have rendered pooled estimates uninterpretable for most outcomes. Findings were therefore synthesised narratively, organised by epidemiology, clinical manifestations, and management, with attention to cross-cutting themes, contradictions, and gaps that may not be apparent in pathogen-specific reviews.

3. RESULTS

3.1. Study selection and characteristics

The database search identified 3,842 records. After removal of 1,227 duplicates, 2,615 records were screened by title and abstract, of which 2,180 were excluded. Of the 435 full-text reports assessed for eligibility, 389 were excluded (adult population only, n = 112; no laboratory confirmation, n = 98; no original data, n = 87; non-English, n = 52; other reasons, n = 40), leaving 46 studies for qualitative synthesis (Figure 1). The characteristics of the included studies are summarised in Table 1, and the key clinical features and management approaches by disease are summarised in Table 2.

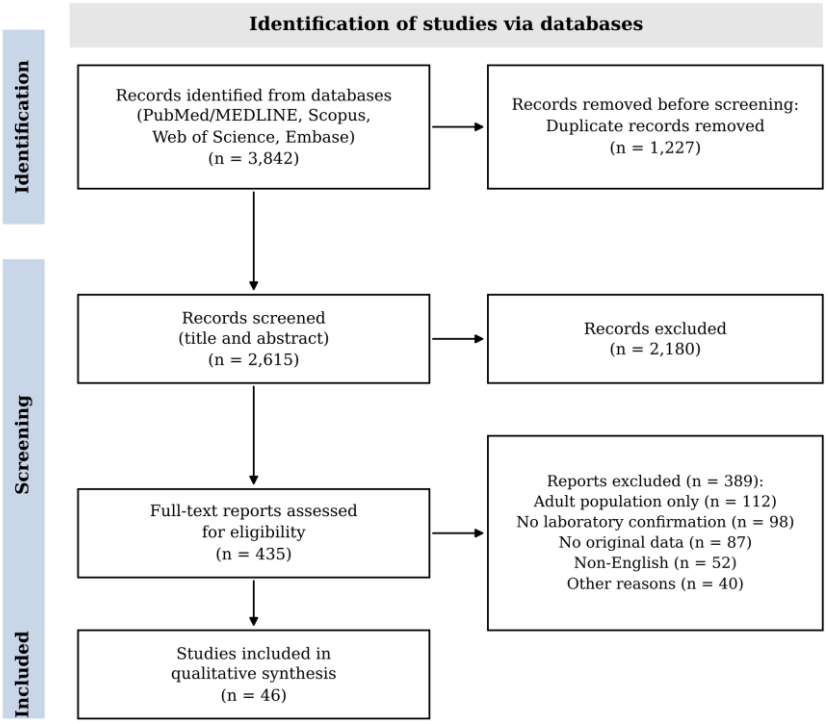


Figure 1. PRISMA 2020 flow diagram of study identification, screening, and inclusion.

3.2. Epidemiology of emerging infectious diseases in children

The epidemiology of paediatric emerging infections during 2020–2022 was dominated by the COVID-19 pandemic, but its effects were far from uniform across pathogens. Children accounted for only 1–5% of diagnosed SARS-CoV-2 cases in early reports, generally with milder disease and substantially lower mortality than adults [2,3]. However, the indirect effects of the pandemic (school closures, mask mandates, travel restrictions, and disrupted immunisation programmes) profoundly altered the circulation of other pathogens. RSV, which typically causes seasonal winter epidemics, was markedly suppressed during lockdown periods and was followed by off-season surges that exceeded pre-pandemic trends as restrictions eased [12]. Influenza activity similarly fell to historically low levels during 2020 [13]. Measles re-emerged as a threat: more than 22 million infants missed their first measles vaccine dose in 2020, creating dangerous immunity gaps [14].

Arboviral diseases maintained a persistent, if under-recognised, burden. A global systematic review of chikungunya in children identified 142 studies, the majority from Asia, and found that severe disease was most common in infants under one year of age [8]. Dengue remained a leading cause of paediatric hospitalisation in endemic regions, with dengue virus serotype 2 associated with progression to severe disease [15,16]. Zika virus, while primarily a concern for congenital infection, was shown in a systematic review of 2,543 paediatric cases to cause predominantly mild postnatal illness, with neurological consequences less severe than those following prenatal exposure [17]. Antimicrobial resistance emerged as a cross-cutting threat, with drug-resistant tuberculosis, HIV, and gram-negative pathogens disproportionately affecting children and adolescents globally [11,18].

3.3. Clinical manifestations

The clinical spectrum of emerging infections in children during 2020–2022 ranged from asymptomatic carriage to life-threatening hyperinflammation. For COVID-19, fever (63.3%) and cough (33.7%) were the most frequently reported symptoms, with radiographic abnormalities present in 44.1% of cases [19]. Severe disease was uncommon but not negligible, particularly among children with comorbidities and in low- and middle-income countries, where the relative risk of death among hospitalised children was more than twice that in high-income settings [19]. MIS-C emerged as a serious complication, typically occurring 2–6 weeks after SARS-CoV-2 infection [6,7]. A meta-analysis of 98 articles encompassing 2,275 patients characterised MIS-C as a syndrome of persistent fever (100%), gastrointestinal symptoms (82%), abdominal pain (68%), and cardiac involvement (66%), with shock and hypotension common; 56.8% of patients were male and the mean age was nine years [20].

Other pathogens exhibited characteristic paediatric patterns. RSV predominantly affected children under five years, causing bronchiolitis and pneumonia, with post-lockdown surges straining paediatric intensive care capacity [12]. Chikungunya in children frequently presented with fever, rash, and arthralgia, with thrombocytopenia common and severity greatest in infants [8]. Parechovirus, an under-recognised cause of central nervous system (CNS) infection in neonates, was linked to neurological sequelae and neurodevelopmental delay, warranting follow-up to school age [21]. Dengue could progress rapidly from a febrile phase to severe plasma leakage, with serotype 2 and secondary infection identified as key risk factors for severe disease [15].

3.4. Management strategies

Management of paediatric emerging infections during 2020–2022 evolved rapidly, reflecting both pathogen-specific considerations and broader principles of paediatric care. For COVID-19, most children required only supportive care, whereas those with severe disease or MIS-C required a more aggressive approach [1]. MIS-C management was largely extrapolated from protocols for septic shock and Kawasaki disease, incorporating intravenous immunoglobulin (IVIG), corticosteroids, and inotropic support, with favourable outcomes reported in most cases [6,20,22]. Antimicrobials, inotropes, and anti-inflammatory agents were used more frequently in severe than in non-severe paediatric COVID-19, underscoring the importance of severity-stratified treatment algorithms [19].

Antimicrobial stewardship emerged as a critical pillar of management. The pandemic threatened to reverse hard-won stewardship gains, with increased antibiotic prescribing in some settings and disruption of stewardship programmes [23,24]. A review of global emerging resistance in paediatric infections emphasised the need for a paediatric-focused agenda encompassing equitable access to diagnostics, expanded stewardship, infection prevention, and greater inclusion of children in clinical trials of novel antimicrobials [11]. For vaccine-preventable diseases such as measles, management was fundamentally preventive: restoring immunisation coverage to pre-pandemic levels and closing the immunity gaps created by missed doses were urgent priorities [14]. For arboviral diseases, management remained largely supportive, with vector control and community education as the mainstays of prevention [16,25].

3.5. Cross-cutting themes

Three cross-cutting themes emerged from the synthesis. First, the indirect effects of the COVID-19 pandemic on paediatric infectious disease epidemiology were often as consequential as the direct effects of SARS-CoV-2 itself: disrupted vaccine programmes, altered pathogen circulation, and strained health systems created vulnerabilities extending well beyond COVID-19 [12,14]. Second, diagnostic uncertainty was a recurring challenge, particularly in distinguishing MIS-C from Kawasaki disease and toxic shock syndrome, and in recognising emerging pathogens such as parechovirus in neonates [21,22,26]. Third, equity was a pervasive concern: severe outcomes were disproportionately borne by children in low- and middle-income countries, where access to diagnostics, therapeutics, and vaccines was limited [18,19].

Table 1. Characteristics of the included studies

No.	Study (year) [ref.]	Country/region	Design	Sample	Key findings
1	Zimmermann & Curtis (2020) [1]	Global	Review	—	Epidemiology, clinical features, diagnosis, and treatment of COVID-19 in children
2	Ludvigsson (2020) [2]	Global	Systematic review	45 studies	Children account for 1–5% of COVID-19 cases; milder disease than adults
3	Mehta *et al*. (2020) [3]	Global	Systematic review	—	Paediatric COVID-19 has a favourable prognosis
4	Patel (2020) [4]	Global	Systematic review	—	Global impact of COVID-19 on the paediatric population
5	Yasuhara *et al*. (2021) [5]	Global	Systematic review/meta-analysis	—	MIS-C clinical characteristics and outcomes
6	Jiang *et al*. (2020) [6]	Global	Review	—	MIS-C epidemiology, clinical features, and management
7	Soma *et al*. (2021) [7]	Global	Narrative review	—	MIS-C as a post-infectious complication of COVID-19
8	Nyamwaya *et al*. (2022) [8]	Global	Systematic review/meta-analysis	142 studies	Chikungunya burden in children; most severe in infants <1 year
9	Chaw *et al*. (2020) [9]	Global	Systematic review/meta-analysis	—	RSV-associated ALRI in children with congenital heart disease
10	Wang *et al*. (2020) [10]	Global	Systematic review/modelling	100 studies	Influenza burden in children under 5 years
11	Enane & Christenson (2021) [11]	Global	Review	—	Emerging resistance in paediatric TB, HIV, and gram-negative infections
12	Noble *et al*. (2022) [12]	Global	Scoping review	—	Post-lockdown RSV surges surpassing pre-pandemic trends
13	Dixon *et al*. (2021) [14]	Global	Surveillance report	—	22 million infants missed first measles dose in 2020
14	Sangkaew *et al*. (2021) [15]	Global	Systematic review/meta-analysis	150 studies	Febrile-phase predictors of severe dengue, including serotype 2 and secondary infection
15	Martins *et al*. (2020) [16]	Global	Non-systematic review	—	Arboviral diseases in paediatrics
16	Ramond *et al*. (2020) [17]	17 countries	Systematic review	2,543 cases	Postnatal Zika predominantly mild; neurological consequences less severe than after prenatal exposure
17	Droz *et al*. (2019) [18]	LMICs	Systematic review/meta-analysis	17 studies	Bacterial pathogens and resistance in paediatric bloodstream infections
18	Irfan *et al*. (2021) [19]	Global	Systematic review/meta-analysis	129 studies	Favourable paediatric prognosis; higher mortality in LMICs
19	Santos *et al*. (2022) [20]	Global	Systematic review/meta-analysis	98 articles (2,275 patients)	MIS-C clinical characteristics, treatment, and outcomes
20	van Hinsbergh *et al*. (2020) [21]	Global	Systematic review/meta-analysis	—	Neurodevelopmental sequelae of parechovirus CNS infection; long-term follow-up needed
21	Kabeerdoss *et al*. (2021) [22]	Global	Review	—	Severe COVID-19, MIS-C, and Kawasaki disease
22	Donà *et al*. (2020) [23]	Global	Scoping review	—	Paediatric antimicrobial stewardship programmes
23	Araujo da Silva *et al*. (2020) [24]	Global	Systematic review	—	Antimicrobial stewardship in neonatology
24	Díaz-González *et al*. (2020) [25]	Global	Systematic review	—	Schools as centres for dengue health education
25	Fang *et al*. (2021) [26]	Global	Narrative review	—	Kawasaki-like illness associated with COVID-19
26	Dhar *et al*. (2022) [27]	Global	Systematic review/meta-analysis	18 studies	Systemic inflammatory syndrome in COVID-19
27	Tang *et al*. (2021) [28]	Global	Systematic review	—	MIS-C case studies during the COVID-19 pandemic

No.	Study (year) [ref.]	Country/region	Design	Sample	Key findings
28	Sood *et al*. (2021) [29]	Global	Systematic review/meta-analysis	17 studies	MIS-C clinical features, pathogenesis, and treatment
29	Guimarães *et al*. (2021) [30]	Global	Systematic review	—	MIS-C clinical presentation and outcomes
30	Radia *et al*. (2021) [31]	Global	Systematic review	35 studies	MIS-C clinical features and presentation
31	Freitas *et al*. (2020) [32]	Global	Systematic review	—	Congenital Zika syndrome
32	Antoniou *et al*. (2020) [33]	Global	Systematic review	—	Zika virus and risk of microcephaly
33	Messina *et al*. (2020) [34]	Global	Systematic review	—	Carriage of antibiotic-resistant bacteria in healthy children
34	Li *et al*. (2020) [35]	Global	Systematic review/meta-analysis	—	Viral co-infection and RSV severity
35	Verwey *et al*. (2020) [36]	Global	Systematic review	—	Pulmonary function sequelae after RSV
36	Tola *et al*. (2020) [37]	Global	Systematic review/meta-analysis	—	MDR-TB treatment outcomes in children
37	Howard-Jones & Marais (2020) [38]	Global	Review	—	Tuberculosis in children: screening, diagnosis, management
38	Marais *et al*. (2020) [39]	Global	Review	—	Advances and challenges in childhood and adolescent TB
39	Wang *et al*. (2021) [40]	Global	Narrative review	—	Kawasaki disease management given overlap with COVID-19

ALRI, acute lower respiratory infection; CNS, central nervous system; LMICs, low- and middle-income countries; MDR-TB, multidrug-resistant tuberculosis; MIS-C, multisystem inflammatory syndrome in children; RSV, respiratory syncytial virus; TB, tuberculosis; —, not reported.

Table 2. Key clinical features and management by disease

Disease	Typical clinical features	Severe manifestations	Management approach
COVID-19	Fever (63.3%), cough (33.7%)	ARDS, MIS-C, death (rare)	Supportive; severity-stratified antimicrobials, inotropes, anti-inflammatory agents
MIS-C	Fever (100%), GI symptoms (82%), abdominal pain (68%), cardiac involvement (66%)	Shock, hypotension, myocardial dysfunction	IVIG, corticosteroids, inotropic support
RSV	Bronchiolitis, pneumonia	Respiratory failure, ICU admission	Supportive (oxygen, hydration)
Chikungunya	Fever, rash, arthralgia	Severe disease in infants <1 year; thrombocytopenia	Supportive; vector control
Dengue	Febrile phase, plasma leakage	Severe dengue, shock	Supportive; careful fluid management
Zika	Mild rash, fever, conjunctivitis	Neurological (less severe postnatally)	Supportive; prevention of congenital infection
Measles	Fever, rash, respiratory symptoms	Pneumonia, encephalitis, death	Supportive; vaccination (prevention)
Influenza	Fever, cough, myalgia	Respiratory failure, secondary bacterial infection	Antivirals where indicated; supportive
Parechovirus	Fever, rash, seizures (neonates)	CNS infection, neurodevelopmental delay	Supportive; long-term follow-up
AMR pathogens	Variable by pathogen	Life-threatening resistant infections	Paediatric-focused stewardship; access to novel agents

AMR, antimicrobial resistance; ARDS, acute respiratory distress syndrome; CNS, central nervous system; GI, gastrointestinal; ICU, intensive care unit; IVIG, intravenous immunoglobulin; MIS-C, multisystem inflammatory syndrome in children; RSV, respiratory syncytial virus.

4. DISCUSSION

This systematic review provides an integrated synthesis of the epidemiology, clinical manifestations, and management of emerging infectious diseases in children during the pivotal 2020–2022 period. Three principal interpretations emerge. First, the direct burden of SARS-CoV-2 in children was modest compared with adults, with most paediatric cases mild or asymptomatic and mortality very low. This finding, consistent across multiple systematic reviews, should inform resource allocation and public health messaging [2–4]. However, the indirect burden was substantial: MIS-C emerged as a novel and severe post-infectious complication frequently requiring intensive care, and pandemic-related disruption to immunisation and pathogen circulation created vulnerabilities that are likely to persist beyond the acute phase of the pandemic [5,6,29].

Second, the review highlights important gaps and inconsistencies in the literature. Most included studies were observational and heterogeneous in design, case definitions, and outcome reporting [28,30]. For MIS-C, diagnostic criteria evolved over time, complicating comparison across studies [22,31]. For arboviral diseases, surveillance data are sparse and the true burden in children is likely underestimated [8,17]. For antimicrobial resistance, paediatric-specific data are limited and children remain under-represented in clinical trials of novel antimicrobials [11,18]. These gaps underscore the need for standardised reporting frameworks and strengthened paediatric surveillance systems.

Third, the review identifies clear clinical and policy implications. Clinically, paediatricians should maintain a high index of suspicion for MIS-C in children presenting with persistent fever and multisystem involvement after SARS-CoV-2 infection, and for parechovirus in neonates with sepsis-like illness [7,21]. Health systems should restore and strengthen routine immunisation, integrate antimicrobial stewardship into paediatric care, and ensure equitable access to diagnostics and therapeutics in low- and middle-income countries [18,23,24]. In contrast to existing guidance, which tends to be pathogen-specific, this review supports a cross-cutting, systems-level approach to paediatric emerging infections [1,11].

4.1. Limitations

Several limitations should be acknowledged. First, the review is subject to publication bias: studies reporting severe outcomes are more likely to be published than those reporting mild or null findings, potentially overestimating the severity of emerging infections in children. Second, the restriction to English-language publications and the exclusion of grey literature may have omitted relevant data from non-English-speaking regions and low-resource settings. Third, heterogeneity in study design, case definitions, laboratory methods, and outcome measures limited the extent to which findings could be compared. Fourth, the 2020–2022 timeframe captures the acute and early post-acute phases of the pandemic but not longer-term trends or the impact of subsequent variants and vaccine roll-out. Fifth, although four major databases were searched, relevant studies may exist in regional or specialised databases. Finally, the quality of the included studies varied, and many primary studies were single-centre or retrospective, limiting generalisability.

5. CONCLUSION

The 2020–2022 period demonstrated that emerging infectious diseases in children are characterised by dynamic epidemiology, heterogeneous clinical presentations, and evolving management paradigms. SARS-CoV-2 infection in children was typically mild, but MIS-C represented a serious and previously unrecognised post-infectious complication [2,5,6]. Pandemic-related interventions disrupted the circulation of RSV and influenza, creating atypical epidemiological patterns and post-lockdown surges [12,13]. Arboviral diseases, particularly chikungunya and dengue, continued to impose a significant burden, especially in endemic regions and among infants [8,15]. Antimicrobial resistance remained a persistent and growing threat, exacerbated by pandemic-related disruption to stewardship [11].

In answer to the review's overarching question, the epidemiology, clinical manifestations, and management of paediatric emerging infections during 2020–2022 were shaped by the interplay between direct pathogen effects and indirect pandemic consequences. While children were largely spared severe acute COVID-19, they were not spared its broader impacts on health systems, vaccine delivery, and pathogen ecology [1,3].

Recommendations for practice include maintaining vigilance for MIS-C and other post-infectious syndromes, prioritising catch-up immunisation, and integrating antimicrobial stewardship into routine paediatric care [7,23]. For policy, strengthened global surveillance for paediatric emerging infections, equitable access to vaccines and therapeutics, and inclusion of children in clinical trials of novel agents are recommended [11]. Priority areas for future research include standardised case definitions for MIS-C, longitudinal studies of neurodevelopmental outcomes after parechovirus and Zika infection, and implementation research on antimicrobial stewardship in low-resource paediatric settings [17,21,24].

Declarations

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Ethical approval: Not applicable. This review synthesised data from previously published studies and involved no human participants.

Data availability: All data analysed in this review are available in the published studies cited.

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