Effects of COVID-19 in children: a scoping review with recommendations for physiotherapists

Mamta Shetty[1], Rituka Goklani[1], Ovi Ghadigaonkar[1], Smita Gaikwad[1], Mahima Gaikwad[1], Shirley Gaikwad[1]

[1] MGM School of Physiotherapy, Mahatma Gandhi Mission Institute of Health Sciences, Maharashtra, India

Correspondence to: Mamta Shetty, email: mshetty@mgmsopnm.edu.in

DOI: https://doi.org/10.5114/phr.2024.140780

Received: 27.02.2024 **Reviewed:** 14.03.2024 **Accepted:** 14.03.2024

Abstract

Background: The World Health Organization (WHO) declared coronavirus disease (COVID-19) a pandemic in March 2020, following its rapid global spread within a few months. This review reports the clinical features, diagnostic findings, and extrapulmonary effects of COVID-19 in children.

Aims: To summarise the effects of COVID-19 on different body systems in children.

Material and methods: A comprehensive literature search was conducted using PubMed, Cochrane, Science Direct and CINAHL databases. Studies published between December 2019 and April 2021 were included. Data from the selected studies were extracted by the reviewers.

Results: The studies provided a thorough analysis of the effects of COVID-19 on different body systems in children, providing an updated overview. They examined how COVID-19 affects different body systems in children, including musculoskeletal, cardiovascular, renal, and psychological aspects, ultimately affecting their quality of life.

Conclusions: Children generally have fewer symptoms, milder disease, better prognosis and lower mortality. This systematic review highlights the importance of an integrated and multidisciplinary approach to paediatric rehabilitation after COVID-19 infection. Physiotherapists play a crucial role in this process by providing specialised care and support to promote recovery and improve the quality of life of children affected by the virus.

Key words

COVID-19, children, respiratory system, corona virus, pediatric rehabilitation.

Introduction

Coronavirus disease (COVID-19), with its global transmission, has recently become a major public health crisis [1]. The virus, named 2019nCoV by the World Health Organization (WHO), was first identified in a throat swab sample by the Chinese Centre for Disease Control and Prevention (CCDC) [2]. The virus is contagious and spreading worldwide, and has been declared a pandemic disease [3]. Laboratory-confirmed cases of COVID-19 have been reported at a prevalence of 1 to 1.7% among children and adolescents in Asia, Europe and North America [4,5].

Children infected with this virus have mild symptoms, however 15-35% may be asymptomatic.6 A recent study on the function of respiratory viruses, children are less susceptible to infection with SARS-CoV-1 [6] The paediatric population is less susceptible to this virus due to the scarcity of SARS-CoV-2 angiotensin-converting enzyme 2 (ACE2) receptor in the respiratory tract in children [7]. Recent research suggests that children may be less susceptible to SARS-CoV-2 infection due to the limited presence of the ACE2 receptor in their respiratory tract [8].

In addition, studies have highlighted differences in the expression of key receptors involved in SARS-CoV-2 pathogenesis, ACE-2 and transmembrane serine protease 2 (TMPRSS2), between adults and children. Compared to adults, children have lower levels of ACE-2 and/or TMPRSS2 in both the upper and lower airways, which may contribute to the difference in disease outcome between the two age groups. In general, children infected with COVID-19 either have mild symptoms or remain asymptomatic. However, infants are at higher risk of severe disease, and SARS-CoV-2 infection can lead to childhood multisystem inflammatory syndrome (MIS-C) [9]. In children under 1 year of age, dyspnoea was the most commonly reported symptom. Although decreased respiratory capacity or a weak cough are typical risk factors in young neuromuscular patients, the severity may not be as pronounced as expected. Nevertheless, social distancing remains an important recommendation for children with neuromuscular diseases and their carers to minimise the risk of viral transmission [10].

At the beginning of the pandemic in the early 2020s, the likelihood of children being affected was minimal. However, with the novelty and emergence of different strains of coronavirus, the likelihood of children being affected has increased. Due to the short duration of the SARS-CoV-2 outbreak, limited scientific evidence is available on various aspects of COVID-19, including childhood affection. Scoping reviews are known to be valid tools for mapping the available evidence, clarifying the characteristics of the literature, organising key concepts and their relationships, and thereby analysing knowledge gaps. Therefore, this scoping review provides a clear insight into various physical, psychological and behavioural effects in children due to COVID-19.

Material and methods

Reporting guidelines

This scoping review followed the framework published by Arksey and O'Malley in 2005. The reporting of this review followed the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist.

Eligibility criteria

All studies published between 1 December 2019 and 30 April 2021 in PubMed, CINAHL, Cochrane and Science Direct were included. Language was limited to English only. Studies were screened and selected based on predefined inclusion and exclusion criteria. Articles including human studies, children under 18 years of age with COVID-19 were included. Studies included systematic reviews, randomised controlled trials (RCTs), pilot RCTs, cross-sectional studies, qualitative studies, interventional studies. Articles including an-

imal studies, case studies/case series, conference proceedings, promotional articles were excluded from the study.

Information sources

A comprehensive literature search was conducted in PubMed, Cochrane, CINAHL and Science Direct for the period between 1 December 2019 and 30 April 2021. Language was restricted to English and relevant full-text articles were included.

Search strategy

The search strategy consisted of 3 terms. Words such as 'Covid-19', 'SARS-CoV-2', '2019 novel coronavirus', 'children', 'effects on children' were used with truncation. Within each concept, terms were combined with Booleans such as 'or' 'and' for a more defined search.

Study selection

A total of 28,205 articles were identified from the databases based on the inclusion and exclusion criteria. The initial search strategy yielded a large number of irrelevant studies. Data were screened by reading titles and abstracts. Articles selected for review were extracted by the first reviewer and confirmed by other reviewers. The reviewers then carefully examined the full text of the articles. Disagreements in decision making were discussed among the reviewers.

Data extraction

The studies used for data extraction were compiled in Microsoft Word. Title, author, year of publication, study location, type of study, study population, objectives, methodology and results of the study were the headings under which the data were organised.

Critical appraisal

The methodological quality was assessed using the Oxman and Guyatt classification for review studies. This assessment tool was suggested by the Cochrane Handbook for systematic reviews. The critical appraisal of included studies was assessed to determine the reliability of the study.

Data analysis

A total of 12 studies were summarised and synthesised in tabular form. This method helped to describe COVID-19 in children and the manifestations of COVID-19 in children. This analysis also allowed to identify the current gaps in the literature regarding the effects of COVID-19 in children, thus fulfilling the objective of the review (**Figure 1**).

Table 1. Study inclusion criteria using PICO structure.

PICO	Inclusion	Exclusion
Population	Children of age below 18 years	Adults of age above 18 years.
Intervention	Children affected with COVID-19	Adults affected with COVID-19
Comparison	None	None
Outcome	None	None

Abbreviations: *PICO – international stands for patient/population, intervention, comparison and outcomes.*

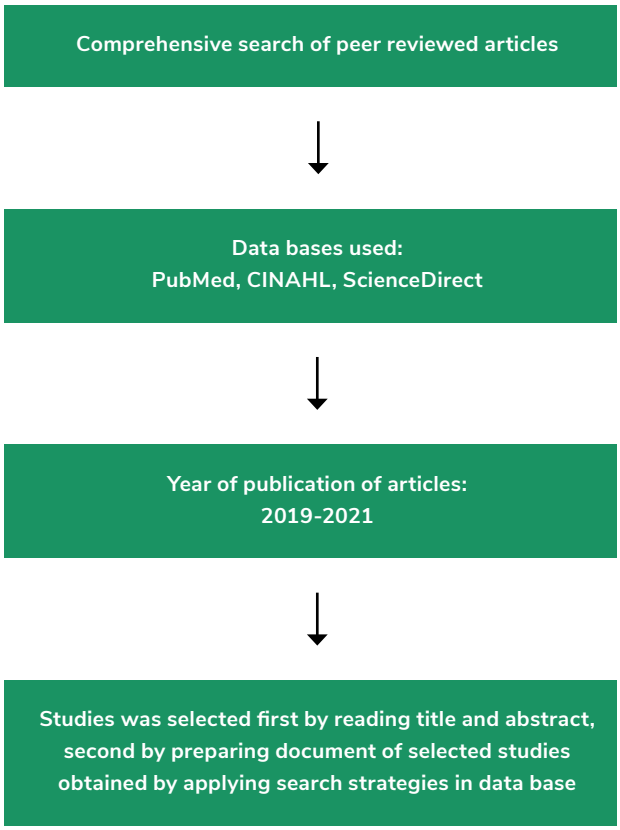

Figure 1. Flow chart of the study search.

A comprehensive search for peer-reviewed articles was conducted using PubMed, Science Direct and CINAHL databases. Articles included in this review were published from December 2019 to April 2021. All studies describing the effect of COVID-19 in children were included in this review. Language was restricted to English, taking into account the cost and time of translation. The following search terms were used: COVID-19 in children, clinical manifestations in children with COVID-19, neurological manifestations, gastrointestinal symptoms, respiratory effects in children with COVID-19, extrapulmonary manifestations, radiological findings. After applying search strategies within databases, data were collected by reading titles and abstracts. The initial search of articles yielded a large number of irrelevant studies, therefore inclusion and exclusion criteria were developed. The reviewers carefully screened the full-text articles. After study selection, 12 articles were included, including 3 systematic reviews and meta-analyses, 3 systematic reviews, 2 observational studies, 1 systematic review and cross-sectional study, 1 descriptive analytical study, 1 qualitative study, 1 retrospective study. Studies were selected if they met the inclusion and exclusion criteria.

Inclusion criteria

Articles including human studies, children under 18 years of age with COVID-19 were included. Studies included: systematic reviews, RCTs, pilot RCTs, cross-sectional studies, qualitative studies, interventional studies.

Exclusion criteria

Articles containing animal studies, case studies/case series, conference proceedings and promotional articles were excluded from the review.

Results

Of the 12 studies, three were systematic reviews and meta-analyses with level Ia evidence, three were systematic reviews with level III evidence, two were observational studies with level II evidence, one was a systematic review and cross-sectional study with level I evidence, one was a descriptive analytical study and one was a qualitative study with level V evidence, and one was a retrospective study. **Table 2** shows the summary of studies in the scoping review.

Table 2. Summary of studies.

No.	Author(s), year of publication and study location	Study type	Study population	Aims	Methodology	Results
1.	Musolino et al. (2020) Rome	Observational study	10 consecutive children with COVID-19 admitted to two tertiary paediatric hospitals.	To determine significance of use of lung ultrasound for evaluation of children with COVID-19	An observational study was conducted to analyse lung ultrasound patterns looking for pleural irregularities, subpleural consolidations, pleural effusions, vertical artefacts and patchy areas of white lung. It included patients with swab-confirmed COVID-19 infection who underwent lung ultrasound within 12 hours of admission. It was performed with a wireless pocket device connected to a probe	Signs of lung involvement, including vertical artefacts, areas of white lung and subpleural consolidation and pleural irregularities, were seen on lung ultrasound in paediatric COVID-19 pneumonia
2.	Mania et al. (2020) Poland	Observational study	106 cases of confirmed SARS-CoV-2 patients with age range of 1 month to 17 years	To study the incidence, clinical presentation and outcome of COVID-19 in children based on the experience of the tertiary care centre and the regional health epidemiological office	The study reported confirmed cases of SARS-CoV-2 infection by polymerase chain reaction using nasopharyngeal swabs. Physical examination and laboratory tests were performed according to clinical indications in children requiring hospital admission	In outpatients, anosmia and dysgeusia (75%) and in hospitalised children headache (49%) and fever (75%) were reported as significant symptoms. Younger children in the hospitalised group had a more severe clinical picture
3.	Tsankov et al. (2020) Canada	Systematic review and meta-analysis	13310 articles were identified out of which 42 were analyzed further for study	This review explored effects of pediatric comorbidities on severity of COVID-19 infection	A systematic review and meta-analysis of PubMed, Embase and Medline databases was conducted, looking at children with and without comorbidities and COVID-19 infection	5.1% of children with comorbidities and 0.2% of children without comorbidities had severe COVID-19 infection. A relative risk ratio of 2.87 was reported in children with obesity

4.	Parisi et al. (2020) Italy	Systematic review	Not mentioned	To study the characteristics of COVID-19 pneumonia in pediatric populations	PubMed and Science Direct databases were used to review the severity of COVID-19 pneumonia in children	This review reports on the characteristics of COVID-19 in the paediatric population, predominantly involving the pulmonary system. Although the severity of infection is less in children, disease progression remains possible and children are considered important vectors of the disease.
5.	Aski et. al (2021) Iran	Systematic review and meta-analysis	21 articles which included 916 children were eligible for this study	To systematically assess the prevalence of cardiac abnormalities due to MIS-C in children with COVID-19	Medline, Web of knowledge, Google Scholar, Scopus and Cochrane manuscript databases were used. This review was conducted in accordance with the PRISMA guidelines	Cardiac abnormalities in children with MIS-C were reported to be common and potentially serious and life-threatening, with a pooled prevalence of 38.0% for significant left ventricular dysfunction, 20.0% for coronary aneurysm or dilatation, 28.1% for ECG abnormalities or arrhythmias, 33.3% for elevated serum troponin levels and 43.6% for elevated proBNP/BNP levels
6.	Lin JE et al. (2020) New York	Systematic review	82 children of age between 5 days to 18 years were included in study	To study the neurological manifestations in children with COVID19	Laboratory-confirmed cases of COVID-19 have been reported in 82 children, 35 of whom have neurological symptoms	A variety of central and peripheral neurological insults have been reported in children associated with COVID-19, ranging from mild headache and anosmia to severe manifestations such as stroke, seizure and encephalopathy
7.	Tian Y et. al (2020) China	Systematic review	2023 patients with COVID-19 showing the presence or absence of gastrointestinal symptoms	This study will determine the gastrointestinal manifestations, pathological findings in patients with COVID-19 and the possibility of faecal transmission	The PubMed database was used for this review, which included laboratory-confirmed COVID-19 cases in retrospective clinical studies	The study reported that diarrhoea was the most common symptom in both adults and children (2%-49.5%), and vomiting was more common in children (6.5-66.7%)
8.	Kosmeri et al. (2020) Greece	Systematic reviews and meta-analyses	Children with COVID-19	The aim of this review is to Haematological manifestations in children with COVID19	The PubMed database was used to search for haematological and complications in symptomatic and asymptomatic children with children with COVID-19	Leukopenia and lymphocytosis were reported to be the most common abnormalities in children with COVID-19

9.	Pousa et al. (2020) Brazil	Systematic review and cross-sectional study	28 articles involving 199 children aged 0-18 years were included in this review	To summarise the most significant extrapulmonary manifestations in paediatric patients with COVID-19 and discuss the clinical, epidemiological and pathophysiological aspects of these clinical presentations in children	An extensive literature search of the PubMed database was performed to identify additional pulmonary manifestations in children with COVID-19	Non-pulmonary manifestations in paediatric patients, in decreasing order of frequency, were gastrointestinal, renal, cardiovascular, neurological, haematological and lymphatic, cutaneous, hepatic, ocular, olfactory and gustatory
10.	Andina Martinez et al. (2021) Spain	Descriptive analytical study	50 children hospitalize d with COVID-19 were included to conduct a study	To study the mucocutaneous involvement in paediatric patients with COVID-19 admitted to a paediatric hospital paediatric institution.	A descriptive-analytical study was carried out in a paediatric institution on children aged between 0 and 18 years	Twenty-one children presented with mucocutaneous manifestations: macular and/or papular exanthema in 18 patients, conjunctival hyperemia in 17, red chapped lips or strawberry tongue in 9 children. Eighteen patients fulfilled criteria for childhood multisystem inflammatory syndrome
11.	Dubey et al. (2020) India	Systematic review	Children with COVID-19	This review briefly examines the psychosocial effects in children with COVID-19	PubMed and Google Scholar databases were searched to discuss the psychological effects of COVID19 on children.	The psychological impact of the COVID-19 outbreak on young children and adolescents was found to be critical. Community-based mitigation programmes, such as closing schools, parks and playgrounds, had disrupted children's usual lifestyles, potentially resulting in promoting distress and confusion among children
12.	Abdulah et al. (2020) Iraq	Qualitative study	15 children of age group 6 to 13 years	To investigate children's psychological well-being through an arts-based qualitative study of children in Iraqi Kurdistan during the COVID-19 outbreak	This study included 15 children aged 6-13 years who were confined to their homes for one month	Children experienced loneliness and had high levels of fear of infection. Children showed increased stress levels at home during outbreaks, within norms of social distancing and lockdown

Discussion

A narrative synthesis of 12 studies was acquired to identify available evidence and describe the gaps in the literature. Findings from the current scoping review report mild to moderate affection of multiple systems in children infected with SARS-CoV-2. In many symptomatic cases, lung ultrasound has shown signs of lung involvement [19]. Children may serve as reservoirs of viral transmission [20]. Pediatric patients with comorbidities having SARS-CoV-2 require more ICU admissions. Childhood obesity is known to increase the risk of severe infection [21].

Respiratory symptoms such as dyspnea, cyanosis, and Acute Respiratory Distress Syndrome were evident approximately 8-10 days after the onset of SARS-CoV-2 infection in children [22]. Mild cardiac changes were observed in children affected with COVID-19, and children with multisystem involvement had high mortality rates [23]. Neurological issues ranging from mild headaches to severe stroke, seizures, and encephalopathies were reported in children affected with COVID-19 [24].

Gastrointestinal symptoms like diarrhea and vomiting were most commonly observed in children [25]. Leukopenia was apparent to be the most significant abnormality of white blood cells in children, while lymphocytosis was noted in infants and neonates [26]. Children with COVID-19 are at risk of liver dysfunction due to increased levels of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) biochemical markers [27]. Children with mucocutaneous manifestations were prone to be admitted to the pediatric intensive care unit [28].

During the COVID-19 pandemic, the usual social life of children has been distressed due to lockdowns, which potentially triggered infuriating and prolonged adverse mental consequences in children [29]. Traumatic events such as home confinement and social distancing resulted in the activation of biological stress response systems in children [30].

Diagnostic findings

Radiographical findings helped in the diagnosis of symptomatic or asymptomatic infection [34]. Asymptomatic infections showed lung abnormalities leading to evidence of ground-glass opacity [34]. COVID-19 pneumonias in children were detected through lung ultrasound. The findings from lung ultrasound included the involvement of vertical artifacts, areas of white lung, subpleural consolidations, and pleural irregularities in children with COVID-19 pneumonia [19]. The radiographic finding of ground-glass opacities (48%) was most common [35].

Analysis of inflammatory markers aids clinicians in the definitive assessment and diagnosis of Multisystem Inflammatory Syndrome in Children (MIS-C). Compared to non-severe COVID-19 patients, MIS-C patients exhibit lower absolute lymphocyte counts and higher absolute neutrophil counts, C-reactive protein, and D-dimer levels. When compared to severe COVID-19 patients, MIS-C patients demonstrate lower lactate dehydrogenase and platelet counts, and higher erythrocyte sedimentation rate levels. Severely affected MIS-C patients exhibit elevated levels of white blood cells, absolute neutrophil counts, C-reactive protein, D-dimer, and ferritin compared to non-severe MIS-C patients. In MIS-C, younger children (0–5 years) tend to have lower CRP and ferritin levels than middle-aged/older children/adolescents [36].

Identification of the virus and/or quantification of viral load was done by RT-PCR for detection of genetic material of SARS-CoV-2. High priority specimens for SARS-CoV-2 were nasopharyngeal swabs, and low priority specimens included oropharyngeal swabs, bronchoalveolar lavage, tracheal aspirates, and sputum [37].

Clinical presentation

The most common symptoms in children aged ≤9 years were fever (46%), cough (37%), headache (15%), diarrhoea (14%) and sore throat (13%).

In children aged 10-19 years, the most common symptoms were headache (42%), cough (41%), fever (35%), muscle aches (30%), sore throat (29%), shortness of breath (16%) and diarrhoea (14%). Less common symptoms included rhinorrhoea, nausea/vomiting, abdominal pain and anosmia. According to Yasuhara J et al [9], dyspnoea was the predominant symptom in the diagnosis of COVID-19 in children under 1 year of age. In addition, children reported fever, cough, nasal congestion, tachypnea, wheezing, fatigue, rhinorrhoea, sore throat and sputum production, with headache thought to be the most common symptom in 11-18 year olds.

Gastrointestinal manifestations

Gastrointestinal manifestations of SARS-CoV-2 infection have been most commonly reported in paediatric patients [27]. SARS-CoV-2 is known to be spread through faeces, especially when the viral load in stool is higher [25]. Even after negative respiratory specimens, SARS-CoV-2 RNA has been reported to be detectable in faeces for 1 to 12 days [38]. The most common symptoms in children were diarrhoea (2%-49.5%) and vomiting (6.5%-66.7%) [25]. Gastrointestinal symptoms are exacerbated by antibiotic-induced dysbiosis of the gut microbiota [25]. ACE-2 is highly expressed in lung cells and enterocytes in the ileum and colon, as ACE-2 is essential for COVID-19 infected cells. The virus binds to ACE-2 to enter lung cells and enterocytes. Due to differences in ACE-2 activity and immunity, children and adolescents may be less susceptible to SARS-CoV-2 infection [38].

Neurological manifestations

Children with COVID-19 present with a spectrum of neurological problems ranging from mild symptoms such as headache and anosmia to severe conditions such as stroke, seizures and encephalopathy [24]. Neurological manifestations result from a variety of causes, including direct viral invasion of the nervous system, endothelial injury and subsequent para- and post-infectious inflammation. Viral infiltration may occur through the olfactory nerves, and endothelial injury may lead to thrombotic events, facilitated by ACE2 receptors interacting with SARS-CoV-2. This interaction triggers pro-inflammatory and pro-coagulant states leading to vasculitis and disruption of vascular integrity. ACE-2 receptors also regulate the sympathoadrenal system in the central nervous system (CNS), affecting blood pressure regulation. In addition, pulmonary or systemic infections can induce cytokine release leading to neurological complications [24]. Autoimmune phenomena such as demyelinating diseases and encephalopathy may be activated by post-infectious inflammation caused by SARS-CoV-2. In genetically predisposed individuals, MIS-C may result from hyperinflammatory responses, with delayed type I and type III interferon responses conferring a higher risk of developing cytokine storms and MIS-C. The immune hyperactivity associated with MIS-C correlates with elevated levels of inflammatory markers, contributing to severe neurological sequelae [24].

Cardiac manifestations

The presence of SARS-CoV-2 has been associated with cardiac involvement, suggesting a possible mechanism involving viral replication and spread from the respiratory tract through the bloodstream and/or lymphatic system. Severe respiratory damage and subsequent profound hypoxia are known to induce oxidative stress, endothelial dysfunction, microvascular injury and myocardial damage due to increased myocardial oxygen demand [39]. Children with MIS-C had ventricular dysfunction with a prevalence of 35-100%, coronary artery dilation or aneurysms with a prevalence of 6-24% and arrhythmias with a prevalence of 7-60% [40]. ACE2 serves as a receptor for the entry of SARS-CoV-2 into cells and is expressed not only in the lungs but also in the heart and blood vessels. Binding of SARS-CoV-2 can lead to changes in ACE2 expression or dysregulation of the renin-angiotensin-aldosterone system (RAAS) pathway. The skewed response of type 1 and type 2 T-helper cells to viral invasion can trigger an exaggerated inflammatory and

immune response, resulting in a cytokine storm. The mechanism by which cytokines damage the myocardium remains unclear [39]. Myocardial involvement is a common manifestation in children with multisystem inflammatory disease [41].

Elevated levels of inflammatory biomarkers such as C-reactive protein, pro-calcitonin and ferritin were found in most cases of Kawasaki disease, and all of these biomarkers, together with interleukin-6, were elevated in myocarditis [42, 43]. Common cardiovascular adverse effects such as decreased cardiac output due to reduced venous return to the right heart, right ventricular dysfunction and impaired left ventricular distensibility occur with mechanical ventilation in critically ill children [44]. Exacerbated hypoxaemia and impaired tissue perfusion occur in children with COVID-19 associated with congenital heart disease. Severe and critical COVID-19 disease is likely to develop in children with CHD complicated by depressed myocardial contractility, pulmonary hypertension, immunodeficiencies (i.e. DiGeorge syndrome) and other comorbid conditions [43].

Hepatic manifestations

Hepatic involvement in children has a prevalence of 11.5% to 25%, with higher levels of transaminases, alkaline phosphatase (ALP), gamma-glutanyl transferase (GGT) and bilirubin (BR) [45]. The cause of liver injury may be direct viral action, an inflammatory response of the host immune system, or drug administration secondary to another organ failure [45]. Liver injury occurs as a result of a "cytokine storm", which is a hyperactive host immune response resulting in an excessive inflammatory response [45]. Mechanical ventilation may cause liver injury because PEEP leads to congestion of the hepatic sinusoids through increased right atrial pressure & retrograde blood flow into the hepatic veins. An evaluation of 46 neonates with COVID-19 by Liu and Coll. showed that 45.5% of them had liver dysfunction with a low mortality rate. Acute hepatitis with cholestasis is induced by SARS-CoV2 and there is no evidence of biliary obstruction. Glycyrrhizin acid has been reported to have anti-inflammatory properties for liver protection [45, 46]. Recent studies have observed diarrhoea and vomiting in approximately 8% to 20% of cases [47].

Respiratory manifestations

The prevalence of children affected by COVID-19 was found to be 1-5% of the total number of patients [48]. Expression of the primary target receptor of SARS-CoV-2, ACE-2, decreases with age. The ACE-2 receptor exerts lung protective effects by limiting angiotensin-2-induced pulmonary capillary leakage and inflammation. The paediatric alveolar epithelium has a remarkable potential for lung regeneration [49].

Renal manifestations

The outcomes of 52 paediatric patients (aged 0-16 years) with severe acute respiratory syndrome coronavirus2 (SARS-CoV-2) hospitalised at Great Ormond Street Hospital for Children NHS Foundation Trust (London, UK) since 25 March 2020 were studied. Of 52 hospitalised children, 24 (46%) had serum creatinine levels above the upper limit of normal and 15 (29%) met BAPN diagnostic criteria for acute kidney injury. It has been suggested that COVID-19-induced kidney injury may result from the binding of the virus spike (S) protein to ACE2, which is located on the outer surface of kidney cells, leading to the activation of angiotensin II. TMPRSS2, a serine 2 transmembrane protease, facilitates this process by cleaving and priming the S protein, allowing the release of viral fusion peptides and promoting membrane fusion. The co-expression of ACE2 and TMPRSS2 is thought to be critical for facilitating SARS-CoV-2 entry into host cells. Transcriptome analysis revealed significant co-expression of ACE2 and TMPRSS2 in podocytes and renal tubular cells. This suggests that SARS-CoV-2 may directly affect these renal cell types through viral invasion, potentially causing cytopathic effects [50].

Other manifestations

Children presented with rash, macules, exanthema, erythema, periorbital erythema, and peri-

toneal or facial desquamation [27]. Quarantine resulted in a variety of psychological distress, neuropsychiatric manifestations and psychosocial stigma. Home confinement had a significant impact on children's psychosocial well-being due to dramatic lifestyle changes, reduced physical activity and limited mental stimulation [51].

Study limitations

The generalisability of the recommendations for physiotherapists may be limited by the heterogeneity of the included studies. The review may have included studies with different methodologies, populations and healthcare settings, making it difficult to develop universally applicable recommendations that adequately address the diverse needs of paediatric patients affected by COVID-19.In addition, the scoping nature of the review may have resulted in a broad overview of the effects of COVID-19 in children, potentially sacrificing depth for breadth. As a result, certain nuances or specific aspects of paediatric rehabilitation following COVID-19 infection may not have been thoroughly explored or adequately addressed in the recommendations for physiotherapists.

Conclusions

COVID-19 tends to affect children less frequently, with milder symptoms and less severe disease. Children with COVID-19 generally have a favourable prognosis and lower mortality rates. Based on the findings of the systematic review of the impact of COVID-19 in children, it is recommended that physiotherapists remain vigilant and proactive in their approach to paediatric care. The review highlights the significant impact of COVID-19 on various body systems in children, including musculoskeletal, cardiovascular, respiratory, renal and psychological aspects. Physiotherapists should prioritise the implementation of evidence-based interventions tailored to the specific needs of paediatric patients recovering from COVID-19. This may include targeted rehabilitation exercises to improve musculoskeletal function, cardiovascular and respiratory conditioning programmes to improve cardiovascular health and fitness, and psychological support to address any mental health challenges arising from the illness. In addition, physiotherapists should work closely with multidisciplinary healthcare teams to ensure comprehensive and holistic care for paediatric patients affected by COVID-19. Regular monitoring of functional status, symptom progression and overall well-being is essential to guide the rehabilitation process and optimise outcomes for children recovering from COVID-19.

Declarations

Ethical Considerations: This study was approved by the Institutional Review Board / Ethics Committee. PRISMA guidelines were followed.

Clinical Trials: This study was not registered as a clinical trial as it did not involve investigational products or interventions that would classify it under clinical trial regulations.

Conflict of Interest: The authors declare no conflict of interest. The study was conducted independently and without any influence from external organizations or entities.

Funding Sources: This research received no external funding and did not receive any grants or financial support from external sources, including non-profit organizations. The study was conducted using the internal resources of the institutions involved.

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