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Association of Race, Ethnicity, and Pediatric Long COVID and MIS-C: A Systematic Review and Meta-Analysis

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Abstract

Background: Pediatric long COVID and other post-COVID conditions, particularly in relation to racial, ethnic, and household social determinants, are not yet well understood. This study aims to synthesize evidence on racial and ethnic disparities in pediatric long COVID and related conditions like MIS-C.

Methods: A systematic review and meta-analysis were performed on studies reporting post-COVID conditions and outcomes by race and ethnicity. Studies were identified through comprehensive database searches, screened for relevance, and assessed for quality. Data on race, ethnicity, and social determinants were extracted and analyzed using random-effects models to estimate pooled odds ratios. Sensitivity analyses were performed to address potential publication bias.

Results: Non-Hispanic Black children had significantly higher odds of ICU admission (OR 1.89, 95% CI 1.01-3.28), MIS-C development (OR 2.37, 95% CI 1.43-3.90), and PIMS-TS (OR 16.28, 95% CI 9.24-28.70) compared to Non-Hispanic White children. Although Hispanic children showed a protective effect against severe MIS-C (OR 0.77, 95% CI 0.64-0.93), their MIS-C incidence remained higher (OR 2.70, 95% CI 1.10-6.65). Elevated risks of MIS-C death were observed for Asian/Pacific Islander (OR 6.79, 95% CI 1.2-38.52) and Alaskan Indian/Native American children (OR 4.07, 95% CI 3.4-44.53). Additionally, Asian children had increased odds of PIMS-

TS (OR 6.42, 95% CI 2.70-15.27), while groups labeled as ‘Other’ were at higher odds for both PIMS-TS (OR 9.75, 95% CI 3.04-31.30) and MIS-C (OR 2.36, 95% CI 1.18-4.71).

Conclusions: Significant racial and ethnic disparities in pediatric long COVID, and MIS-C outcomes emphasize the need for targeted interventions addressing social and healthcare inequities.

Clinical trial number: not applicable

Keywords: Long-COVID, COVID-19, MIS-C, Post-acute Sequelae of SARS-CoV-2, Post-COVID Conditions, Systematic Review

Introduction

Since the onset of the COVID-19 pandemic, some children have experienced long-term symptoms and complications following their initial infection. Children may experience several post-infection complications after SARS-CoV-2. These include a hyperinflammatory multisystem syndrome, referred to as Multisystem Inflammatory Syndrome in Children (MIS-C) in the United States and Pediatric Inflammatory Multisystem Syndrome temporally associated with SARS-CoV-2 (PIMS-TS) in the United Kingdom and Europe, as well as longer-term sequelae collectively referred to as Long COVID. Long COVID is characterized by persistent signs and symptoms persisting for 12 weeks or more after infection, which can affect the cardiovascular, neurological, gastrointestinal, and respiratory systems.[1]

These conditions can profoundly affect a child's life and overall well-being, affecting 10-20% of children within six months of infection and leading to long-term challenges in physical health, social interactions, and academic performance.[2-5] Studies show that 66% of children with Long COVID report a decline in academic performance. Additionally, Long COVID may lead to the development of autoimmune or chronic diseases, further complicating their health.[6]

Pediatric Long COVID and related post-COVID conditions, such as MIS-C and PIMS-TS, present significant challenges. Both MIS-C and PIMS-TS are hyperinflammatory responses triggered by SARS-CoV-2 infection, yet their

diagnostic criteria differ. MIS-C has stricter criteria, requiring at least two inflammatory symptoms and confirmed or probable SARS-CoV-2 infection, while PIMS-TS requires only one symptom and does not require confirmed infection. PIMS-TS usually develops weeks after COVID-19, affecting multiple organs.[7-9] MIS-C was more common early in the pandemic, with cases decreasing significantly by 2023.[10] In the United States, racial and ethnic minority children account for one-third of the population, but over two-thirds of MIS-C cases and 80% of related deaths.[11]

Adults and children from racial and ethnic minority backgrounds have faced higher infection rates and reduced access to quality care throughout the pandemic.[12,13] Adult studies indicate that these groups may be at greater risk for post-COVID conditions, driven by social determinants of health such as socioeconomic status, housing and food insecurity, and pre-existing conditions.[14-16] Race and ethnicity are complex social constructs shaped by physical, social, and environmental factors. This perspective highlights how the lived experiences of race and ethnicity influence health through interconnected social and biological processes, offering a deeper understanding of disparities in Long COVID.

Research focused on post-COVID conditions in pediatric populations is limited, especially in exploring how these conditions vary by race and ethnic identity. This systematic review and meta-analysis aims to determine the association of race, ethnicity, and the prevalence and severity of pediatric post-COVID conditions.

Methods

Study Registration

This study is registered on PROSPERO (CRD42023448599) and follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, the most widely accepted standard for reporting systematic reviews and meta-analyses.[16,17]

Search Strategy

Studies were searched in PubMed using the following terms: Long-COVID, Long-haul COVID, post-COVID sequelae, post-COVID, post-acute COVID syndrome, and (child, children, pediatrics) and (race, ethnicity). An additional search was conducted on OVID Medline from database inception through July 15, 2024, using the terms: Long-COVID, (Long-haul COVID, post-COVID sequelae, post-COVID, post-acute COVID syndrome), and child (children, pediatrics), and race (ethnicity). Additionally, studies of systematic reviews will be cross-referenced, and program literature reserves will be read to yield additional studies.

Although MIS-C and PIMS-TS were not consistently included as standalone search terms, these conditions were pre-specified outcomes of interest. Studies reporting MIS-C or PIMS-TS were captured through broader post-COVID and post-acute SARS-CoV-2 terminology and identified during title and abstract screening. This approach reflects the evolving nomenclature

used to describe pediatric post-COVID inflammatory syndromes, particularly during the early phases of the pandemic.

Studies were included if they met the following criteria: study available in English, observational, containing outcome/numbers on Long-COVID/MIS-C, mentions/has stratified information on race and/ or ethnicity, and average age< 21. The 21 year age cut off was set to align with the CDC and WHO definitions for pediatric MIS-C and ensure inclusion of older adolescents who remain under pediatric care. Preprints retrieved from searches in PubMed, OVID or other cross referenced literature were excluded to ensure all included studies underwent peer review for methodological quality and stability of reported effect estimates.

Two reviewers independently screened all titles, abstracts, and full texts of identified studies. Full-text articles were independently reviewed to confirm eligibility. Studies with matching decisions were automatically classified as included or excluded. When disagreements occurred, a third reviewer reviewed all disputed studies in full, and the majority decision determined the final inclusion status.

Data extraction

Data from the included studies were extracted using a standardized template. Extracted variables included study title, authors, publication year, country, study design, sample size, participant demographics (age, sex, race or ethnicity), inpatient versus outpatient status, sampling approach, primary

outcomes, and measures of association (e.g., odds ratios or risk ratios). Outcomes were standardized across studies whenever possible, and differences in definitions or measurement tools were documented and considered in the qualitative review.

Studies that did not report data on the primary exposure (race or ethnicity) were excluded from the analysis. When studies reported incomplete subgroup data, racial and ethnic categories were harmonized across studies for comparability. If a “missing” category was reported by multiple studies, it was retained as its own group; however, if only a single study reported a “missing” category, those participants were combined into the “Other” category. No imputation of missing data was performed

Study Quality Assessment

The quality of the studies was assessed using the evaluation tool developed by the National Heart, Lung, and Blood Institute (NHLBI). For each study type (observational cohort, cross-sectional, case-control, and case series), a set of standardized questions was provided to evaluate the rigor and methodology of the studies. These questions addressed key aspects such as the study population, sample size justification and power, timeframe adequacy, measurement reliability, loss to follow-up, and control of confounding variables. Different sets of questions were applied depending on the study design (e.g., cohort, case-control, case series, cross-sectional). An Excel matrix was used to document responses, with reviewers assigning

either "yes" (1) or "no" (0) to each question. Scores were then summed and divided by the total possible score. Studies were rated ‘good’ when ≥ 75 % of applicable NHLBI items were affirmative, including clear population definition, robust confounder control, and complete outcome reporting. Studies rated ‘fair’ (50–75 %) typically lacked sample-size justification or adjustment for covariates. Studies scoring <50% were considered to be of poor quality.

Analysis

Grouped outcomes based on severity included: MIS-C ICU admission, severe disease of MIS-C, length of stay for MIS-C patients, death from MIS-C, risk of developing PARDS and MIS-C, risk of having Kawasaki disease and MIS-C, and Neurological morbidity. Grouped outcomes based on development included the development of MIS-C, MIS-C rate, development of Long COVID, and development of PIMS-TS. Meta-analysis outcomes included ICU admission, severe disease, length of stay, death, MIS-C, MIS-C rate, development of Long COVID, and development of PIMS-TS.

Odds ratios were combined across studies, stratified by race and ethnicity, using meta-regression models. When outcomes were reported in fewer than two studies, they were only included in the narrative review. In cases where racial or ethnic groups were not consistently reported across all studies, these additional groups were combined into an "Other" category to standardize comparisons. For instance, if one study reported data on non-

Hispanic White, non-Hispanic Black, and Hispanic children, and another study reported on non-Hispanic White, non-Hispanic Asian, and Native American children, we combined non-Hispanic Black and Hispanic into an "Other" category in the first study, and similarly combined non-Hispanic Asian and Native American into an "Other" category in the second study.

In cases where a study reported multiple detailed racial/ethnic categories that were more broadly represented in other studies, we consolidated these into a single, more general category for consistency. For example, if one study included non-Hispanic White, Hispanic White, non-Hispanic Black, Hispanic Black, Other, and Hispanic Other, while another study included non-Hispanic White, non-Hispanic Black, and Hispanic, we combined Hispanic White, Hispanic Black, and Hispanic Other into a single "Hispanic" category in the first study. If a study had “missing” as a race or ethnic group category, this was not included in the analysis to avoid bias, as there was no way to determine if the missingness was at random.

Heterogeneity was assessed using the Q-test and the I^2 test to quantify variability. We interpreted I^2 < 20 % = low, 20–55 % = moderate, > 55 % = high heterogeneity. Studies were retained in pooled analyses regardless of heterogeneity. Funnel plots were used to assess publication bias when more than two studies were included in the meta-analysis. All data analysis was performed using Stata/SE version 17.0 (StataCorp LLC, 2021, College Station, TX).[18]

Results

Search Results

A total of 287 studies were identified in the initial search. After screening the abstracts and reading the full texts, 31 studies were included: 19 for disease development and 13 for disease severity (Figure 1). Other studies were excluded if they did not meet inclusion criteria or were only available on a preprint server (not peer-reviewed).

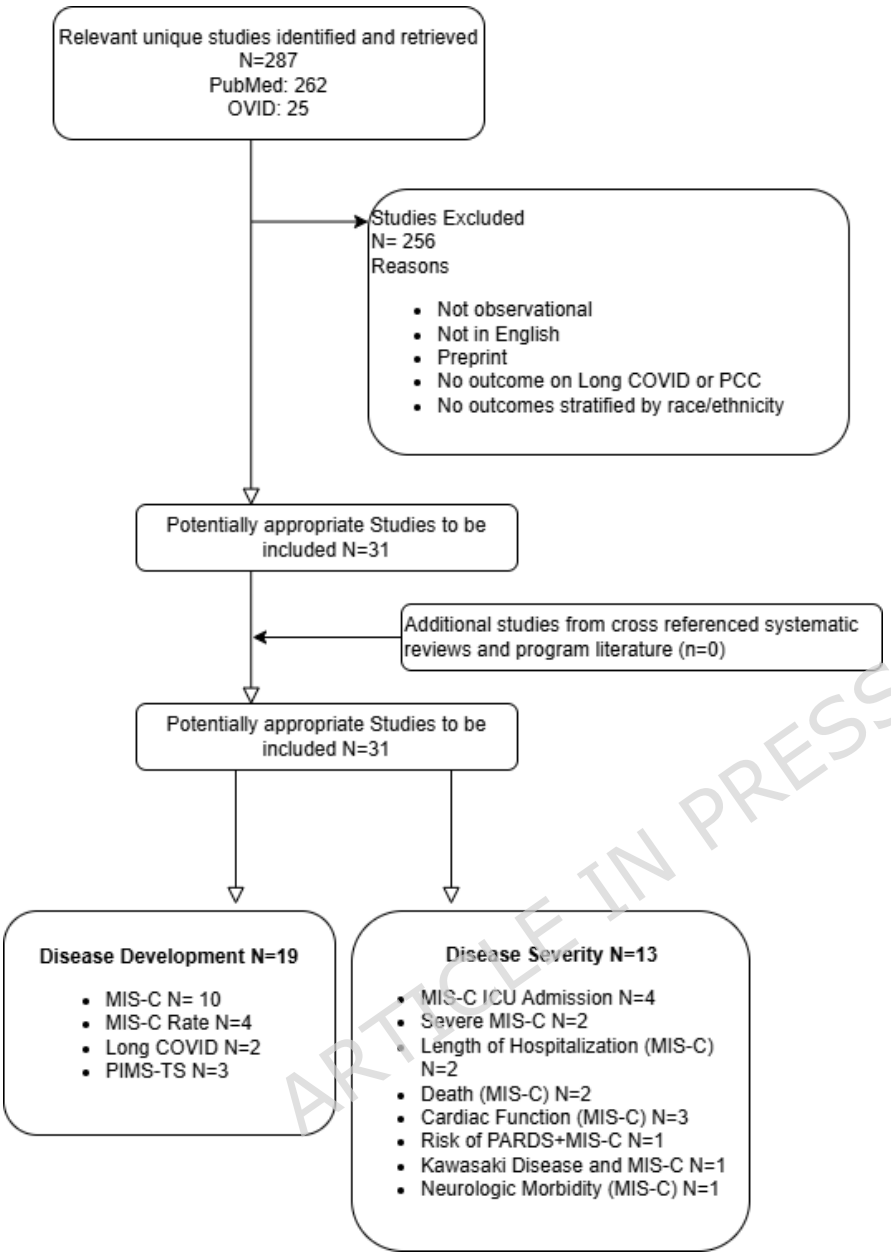

Figure 1 Flow chart of study search results and study selection. Note: some papers had multiple outcomes

All included studies were published between 2020-2024 and had sample sizes ranging from 13 to 3568 participants. Mean or median ages ranged from 3 to 17 years. Percent males ranged from 35.7-70%. Racial and ethnic groups included: non-Hispanic White, non-Hispanic Black, Hispanic/Latino, Hispanic White, Hispanic Black, Asian, non-Hispanic Other, Hispanic Other,

non-Hispanic Multiple races, Indigenous, non-Hispanic AI/AN (American Indian/Alaska Native), non-Hispanic HN/PI (Native Hawaiian/Pacific Islander), non-Hispanic Asian and Pacific Islander, Irish Traveler, Chinese, South Asian, and Afro-Ecuadorians. Studies originated from: the United States, Switzerland, the United Kingdom, Ecuador, Spain, France, Brazil, and Ireland.

For disease assessment, 10 studies measured the development of MIS-C, four studies measured MIS-C rates, two studies assessed Long COVID, and three studies assessed PIMS-TS.

For grouped outcomes of disease severity, four studies measured ICU admission, two measured severities of MIS-C (as defined by symptoms). Two studies measured hospital length of stay (MIS-C), and two studies assessed death among MIS-C patients, three studies measured cardiac outcomes. Individual studies looked at the odds of having PARDS and MIS-C vs only PARDS, the severity of Long COVID, Kawasaki disease, and neurologic morbidity.

Systematic Review

Quality Assessment

Using the NHLBI Study Quality Assessment framework, 31 studies were evaluated: 19 were rated as "good," 12 as "fair," and none as "poor" (Table 1). Potential sources of bias identified during quality assessment are discussed further in the Discussion.

Most studies clearly defined their populations, recruitment methods, and outcomes, and used appropriate analytical designs. However, all studies lacked a formal sample-size justification or power calculation, and none reported loss-to-follow-up information. In addition, many of the studies did not assess exposures more than once. These gaps reduced overall methodological rigor and accounted for many studies being rated as fair rather than good quality. Studies that achieved good ratings typically included robust confounder control, detailed population descriptions, and consistent application of diagnostic criteria.

Disease Development	
Rating	Number of Studies
Good	13
Fair	6
Poor	0
Disease Severity	
Rating	Number of Studies
Good	6
Fair	7
Poor	0

Table 1: Quality assessment of the studies, per NHLBI criteria.

Disease Severity

The majority of included studies were from the US (n=12), while other countries included the UK, Switzerland, Ecuador, and a combined study

with authors from the US, UK, Spain, and France. The grouped outcomes included admission to ICU, MIS-C, severe vs non-severe disease, length of stay in the hospital, death, and cardiac function, in addition to several outcomes that could not be grouped: MIS-C vs MIS-C+ PARDS, Severity of Long COVID, neurologic morbidity, MIS-C vs MIS-C+ Kawasaki disease. These studies varied in study type and sample size and are summarized in Table 2.

For ICU admission, there was a consistent trend of higher odds among non-Hispanic Black patients compared to non-Hispanic White patients. One study also found that Hispanic children were overrepresented in ICU admissions. Most studies included comparable racial and ethnic groups, though one study focused solely on non-Hispanic Black and non-Hispanic White children.

For MIS-C, studies consistently showed that non-Hispanic Black children had a significantly higher likelihood of severe disease compared to non-Hispanic White children. Racial groups were generally comparable across studies.

Disease Severity

	Author, year	Country	N	Age	N Male	Racial groups	Key findings
ICU Admission	Abrams, 2021 [19]	USA	1080	Median: 8 years (IQR 4–12)	56% (n=602)	NH Black, Hispanic, Other	ICU admission was more likely in Black Patients
	Bhavsar, 2021 [20]	USA	14	General Unit: 8 (1-21) ICU: 11.7 (5-18)	35.7% (n=5)	White, NH black, Hispanic, Asian, Other	Hispanic ethnicity overrepresented in MIS-C ICU admission
	Das 2023 [21]	USA	51	Median age 9 (IQR 5-12)	58% (n=30)	White, NH black	ICU admission was more likely in Black Patients
	Wurm, 2024 [22]	Switzerland	204	Not specifically stated (<18)	Not stated	White, Asian, Hispanic, Other	ICU admission was more likely in Black Patients
Severe Disease	Lasa 2022 [23]	USA	76	Median: 12.5 years (IQR 7.5-16.0)	51% (n=39)	NH White, NH Black, Asian, Other, Unknown, Hispanic, Non-Hispanic	NH black was associated with risk for severe disease
	Rao 2023 [24]	USA	66	Median: 9.8 (IQR: 4.6–13.3 years)	60.6% (N=40)	NH White, Black, Asian, Mixed, Hispanic	NH black children had higher odds of severe disease
Length of Stay (MIS-C)	Broad 2021 [25]	UK	70	Range: 3 months-16 years	70% (n=49)	Asian, NH White, NH Black, Mixed, Other	NH black children had longer period of hospitalizations
	Das 2023 [21]	USA	51	Median age 9 (IQR 5-12)	58% (n=30)	White NH Black	NH black children had longer period of hospitalizations
Death (MIS-C)	Bowen 2021 [26]	USA	2459	Median age: 15.8 (IQR 7.9–17.8)	59% (n=1451)	White NH, Black NH, Hispanic, AI/AN; NH, API; NH, Other, Unknown	NH/PI and AI/AN children were at borderline higher risk of death compared to NO white children (p=0.06)
	McCormick 2021 [27]	USA	112	Median: 17 (IQR: 8.5-19)	63% (n=71)	White NH, Black NH, Hispanic, AI/AN; NH, API; NH, Other, Unknown	No statistical difference in deaths by race
Cardiac Function (MIS-C)	Abrams, 2021 [19]	USA	1080	Median: 8 years (IQR 4–12	56% (n=602)	NH White, NH Black, Hispanic, Other	Decreased cardiac function was more likely in NH Black Patients
	Das 2023 [21]	USA	51	Median age 9 (IQR 5-12)	58% (n=30)	NH white, NH Black	No statistical difference in cardiac dysfunction or coronary abnormalities by echocardiogram
	Hensley 2023 [28]	USA	304	median age: 9.1 years	62.2% (n=189)	NH White, NH Black, Other	NH black children had higher odds of BNP>400, and reduced EF compared to NH White patients
PARDS+ MISC	Legarda 2023 [29]	Ecuador	167	Median: 3 (0–14)	56.9% (n=95)	Black, Mixed, Indigenous	No significant difference
KD+ MIS-C	Bautista-Rodriguez 2021 [30]	USA, UK, Spain, France	183	mean age: 7.0 ± 4.7	59.6%(n=109)	Black, Asian, Other	Shock associated with black race
Neurological morbidity	Francoeur 2024 [31]	USA	3568	Median age: 8 (IQR: 1-14)	54.3% (n=1937)	NH white, NH Black, Hispanic, Non-Hispanic, Other	Black race was associated with neurocognitive or functional morbidity based on the presence of severe neurological manifestations in those with MIS-C

Table 2: Evidence table for disease severity, n=13 studies. NH: Non-Hispanic, AI/AN: American Indian/American Native, API: Asian Pacific Islander

Both studies investigating length of stay for MIS-C patients found that non-Hispanic Black patients had longer lengths of stay compared to non-Hispanic white children. Racial groups included varied across studies, with Broad, *et. al including* more groups (non-Hispanic white, non-Hispanic Black, Asian, mixed, and other) than Das, *et. al* (non-Hispanic White, non-Hispanic Black).[21,25]

Death due to MIS-C showed differing results in each study. Bowen, *et. al* found borderline significance among Native Hawaiian/Pacific islander children ([OR]:9.9, 95%CI: 0.9,64.1, p=0.06) and Alaskan Native children ([OR]:10.3, 95%CI: 0.9,66.7, p=0.06) compared to non-Hispanic White children.[26] However, the McCormick, *et. al* found no statistical difference between races in relation to death by MIS-C.[27] Across studies, racial groups were identical.

Both studies on severe MIS-C found that non-Hispanic Black patients were significantly more likely to experience severe disease compared to non-Hispanic White patients. The racial/ethnic groups reported in each study were comparable to one another. For the length of hospital stay among MIS-C patients, both studies reported that non-Hispanic Black children had longer hospital stays than non-Hispanic White children. The racial groups included varied studies, with Broad, *et. al* including more groups than Das, *et. al*. [21,25] In terms of mortality due to MIS-C, one study found borderline

significance for higher death rates among Native Hawaiian/Pacific Islander and Alaskan Native children. However, the other study found no significant differences in mortality across racial groups. The racial groups studied were identical across studies.

Cardiac function was another category of severity outcomes, but outcomes were not appropriately comparable or combinable, so they will be reviewed qualitatively. While Abrams, *et. al* showed decreased cardiac function in non-Hispanic Black children when compared to non-Hispanic white children, Hispanic children and 'other' had slightly higher odds, but this was not statistically significant.[19] Hensley, *et. al* did show that non-Hispanic Black children had statistically significant odds of several cardiac markers (BNP>400, reduced EF), while none of the markers were significant for children described as 'other[28] Das, *et. al* showed that there was a higher percentage of non-Hispanic Black children experiencing cardiac involvement compared to White children, but it was not a significant relationship.[21] Racial groups included were largely comparable, with only Abrams, *et. al* including a broader range of groups (additionally including Hispanic and other groups). [19]

Individual outcomes (PARDS+MIS-C, Kawasaki disease + MIS-C, Neurological morbidity) found varied results regarding disease severity. Children of minority races faced no increased risk of having both PARDs and MIS-C or long-term symptoms. However, those of high-resource backgrounds were less likely to report chronic symptoms. In contrast, non-

Hispanic Black patients were shown to have higher odds of shock regarding MIS-C/Kawasaki Disease, and non-Hispanic Black patients were shown to have higher odds of neurological manifestations.

Disease Development

This analysis included studies from various countries, but primarily the United States (12 of 19 studies) other countries included: the UK, Brazil, and the Republic of Ireland. The grouped outcomes under disease development were the development of MIS-C, MIS-C rate, long COVID, and PIMS-TS. Several studies were excluded from the meta-analysis due to a lack of comparable outcomes or outcome measures across studies. Studies varied in sample size, design, and population characteristics, as summarized in Table 3.

	Author, year	Country	N	Age	N Male	Racial groups	Key findings
MIS-C	Ghmire 2022 [32]	USA	2125	<20	Not Stated	NH White, NH Black, Hispanic	MIS-C may be driven primarily by higher cases of COVID-19 in marginalized populations. Children in lowest quartile neighborhood at higher risk of MIS-C
	Javalker, 2021 [33]	USA	43	Median Age: 9.7 (IQR 6.5-16.3)	58% (n=25)	NH white, Hispanic White, NH Black, Hispanic Black, Asian American, NH Other, Hispanic Other	Black and Hispanic children were more at risk of developing MIS-C than NH White
	Kline, 2022 [34]	USA	47	Suspected: 7 (IQR: 1-12) Confirmed: 7.5 (IQR: 3-11.75)	MIS-C Suspected: 60% MIS-C Confirmed: 57.7%	NH White, NH Black, Asian, Other	Predominantly Hispanic and NH black had MIS-C
	Martin, 2022 [35]	USA	707	11.9 (IQR, 6.0-16.1)	59% (n=416)	White, Asian, Black, Hispanic, Non-Hispanic	Children of Black race at higher risk for MISC
	Revlas Brandt, 2021 [36]	Brazil	652	Median Age: 5	57.1% (n=372)	Brown, White, Black, Indigenous	Most MIS-C cases occurred in children of brown race/skin color
	Steirman, 2021 [37]	USA	1382	< 21	60.2% (830)	NH White, NH Black, Hispanic, NH Asian, NH Multiple, NH AI/AN, NH HN/PI	NH Black, Hispanic, and NH Native Hawaiian/Pacific Islander children are overrepresented in MIS-C cases. NH White, and NH Asian Children are underrepresented
	Swan, 2020 [38]	UK	651	Median age was 4.6 (IQR: 0.3-13.7)	56.4% (n=367)	White, Black, Asian, Other	Children with MIS-C were more likely to be of non-White ethnicity
	Tolopoka, 2022 [39]	USA	77	Median Age: 8.69 years	49.5% (n=38)	White, NH Black, AI/AN, Hispanic, Non-Hispanic	Hispanic ethnicity not statistically significantly associated with MIS-C
	Zambrano 2022 [40]	USA	1058	Median Age: Cases: 8.7 (IQR: 4.7–13.5) Controls: 9.3 (3.8–13.6)	53.4% (n=565)	NH White, NH Black NH Asian, NH/PI, AI/AN, NH Multiracial, Hispanic	MIS-C was more likely in non-Hispanic Black children
	Zambrano 2023 [41]	USA	453	<20 years old	62.5% (n=172)	Non-Hispanic White Non-Hispanic Black Hispanic/Latino of any race (except NHPI/AIAN) Non-Hispanic other/multi	No Statistical relationship found between race and ethnicity and MIS-C
MIS-C Rate	Hobbs, 2022 [42]	USA	38	< 18 years old	64% (n=47)	Hispanic, NH White, NH Black, NH Other	Cumulative incidence was 4.7 times higher in NH Black children than NH White children
	Lee, 2020 [43]	USA	223	Median Age: 7 (IQR: 3-12)	57% (n=127)	NH White, NH Black, Hispanic, Multiracial/other API	NH black, Hispanic, had higher incidence of MIS-C compared to NH White, and API had no difference.
	Payne 2021 [11]	USA	248	Median Age: 8 (IQR: 4-13)	53.6% (n=133)	NH White, NH Black, Hispanic, API, Native American, Other	Incidence of MIS-C was higher in NH Black, Hispanic, API than NH White
	Treston 2022 [44]	Ireland	54	Median age: 7.6 years (IQR: 4 months–15.5 years)	57% (n=31)	White, Irish Traveler, Black, Chinese, Other	Incidence of MIS-C was higher in Black and Irish traveler children
Long Covid	Messiah, 2022 [45]	USA	312	Mean: 6.65	52.9% (n=165)	NH White, NH Black, Hispanic, Other	In adjusted samples, there is no difference between races in risk of long COVID

	Nugawela, 2022 [46]	UK	3246	11-17 years old	37.03% (n=1202)	White, Black, Asian, Mixed, Other	In those that tested positive for SARS-CoV-2, no statistical difference between races
PIMS-TS	Broad, 2021 [25]	UK	70	Range: 3 months-16 years	70% (n=49)	White, Black, Asian, Mixed, Other	minority children were overrepresented in PIMS-TS
	Felenstein, 2021 [47]	UK	29	Median Age: 6.0 (IQR: 3.8-9.9)	69% (n=20)	White, Asian, Afro-Caribbean, Mixed/other	Black, Asian, and minorities overrepresented
	Penner, 2021 [48]	UK	46	Median Age: 10.2 (IQR: 8.8-13.3)	65% (n=30)	White, South Asian, Afro-Caribbean, Other	Overrepresentation of minority groups

Table 3: Evidence table for disease development outcomes, n=19 studies. NH: Non-Hispanic, AI/AN: American Indian/American Native, HN/PI: Hawaiian Native/Pacific Islander, API: Asian Pacific Islander

Regarding MIS-C, almost all studies (except for two) found that MIS-C development is more likely in racial and ethnic minority populations, particularly non-Hispanic Black, and Hispanic children. One of the two studies that did not find this relationship, reported that children from the lowest quartile of socioeconomic status or highest quartile of social vulnerability index neighborhoods were at the greatest risk for developing MIS-C. The racial and ethnic groups compared varied across studies. For example, in Javalker, *et. al,* multiple racial and ethnic groups were included, such as non-Hispanic White, non-Hispanic Black, Hispanic, Asian American, and others, with non-Hispanic Black and Hispanic children being at the highest risk (ORs of 10.3 and 8.8, respectively, compared to non-Hispanic White).[33] In contrast, Tolopoka, *et. al* compared Hispanic children (all) to non-Hispanic children (all), finding no statistically significant association between Hispanic ethnicity and MIS-C (OR: 2.67, 95% CI: 0.28, 14.62).[39] This variability in racial and ethnic group comparisons highlights differences in study design and population characteristics, which may account for the disparities in findings across studies.

Regarding MIS-C rates, all studies(n=3 found that race and ethnic minority children, particularly non-Hispanic Black and Hispanic children, had a higher incidence of MIS-C. One study found no difference in risk between Asian/Pacific Islander and non-Hispanic White children, while another found Asian/Pacific Islander children to be at higher risk. The racial and ethnic groups in the two American studies were comparable, whereas Treston *et. al* included Irish Travelers as an ethnic group.[4] As a result, the "other" category in our analysis included Irish Travelers alongside the groups classified as "other" in the other studies.

Regarding Long COVID, non-Hispanic Black children or those who identified as mixed race and ethnicity were likely to report persistent symptoms, but this was not statistically significant in fully adjusted models in either study. The racial and ethnic groups reported in the two studies varied; while both studies included non-Hispanic Black participants, the other racial ethnic categories differed between the studies.

PIMS-TS was consistently shown to affect minority children across the studies reviewed disproportionately. It is important to note that all studies originated from the UK and did not specify Hispanic/non-Hispanic. For example, multiple studies reported that Black, Asian, and other minority groups were significantly overrepresented compared to White children. In Broad's 2021, *et.al* study from the UK, Black and other racial groups experienced notably higher odds of PIMS-TS.[25] Similarly, Felsenstein *et. al* highlighted a strong overrepresentation of Black and Asian children in their

sample.[48] Penner, *et. al* found that 65% of children affected by PIMS-TS were non-White, with Afro-Caribbean and South Asian children particularly impacted.[47] These consistent findings across studies suggest a clear trend of minority children being disproportionately affected by PIMS-TS.

Meta-Analysis

Severity

Results from the disease severity meta-analysis are shown in Figure 2. A meta-analysis, including four studies of ICU admission for children experiencing MIS-C showed that non-Hispanic Black children are 89% more likely (Odds Ratio [OR] 1.89, 95% CI 1.01,3.28) to be admitted to the ICU than non-Hispanic white children. While this suggests that non-Hispanic Black children may face significantly higher odds of ICU admission compared to non-Hispanic White children, there was moderate heterogeneity among studies, as evidenced by an I^2 of 20.5% (95% CI: 0, 74.80), Cochran's $Q = 3.77$, and $H = 1.12$).

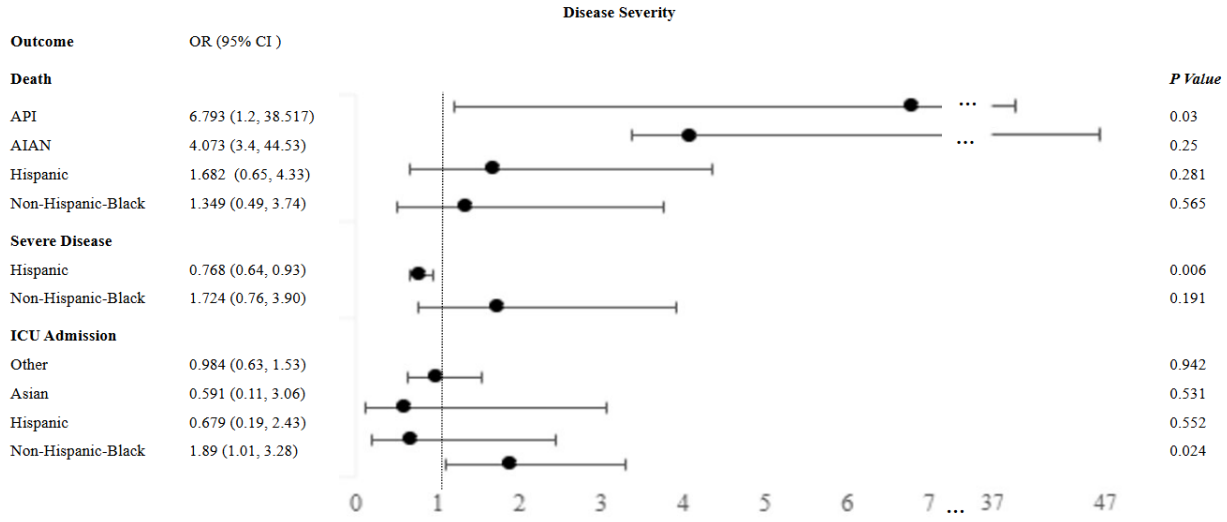

Figure 2 Meta-analysis of COVID-19 disease severity outcomes

Other racial and ethnic groups were not significantly more likely to be admitted to the ICU than non-Hispanic Whites. Three studies were included for the analysis of Hispanic and 'other' children, and two were included for assessing the pooled odds of Asian children. Hispanic children were 0.679 (95% CI: 0.189, 2.434) times as likely, Asian children 0.591 (95% CI: 0.114, 3.057), and other children 0.984 (95% CI: 0.633, 1.530) times as likely to be admitted to the ICU for MIS-C when compared to non-Hispanic white children. In each analysis, no significant heterogeneity was detected across the studies. Funnel plots (Figure 3) suggested evidence of minimal publication bias.

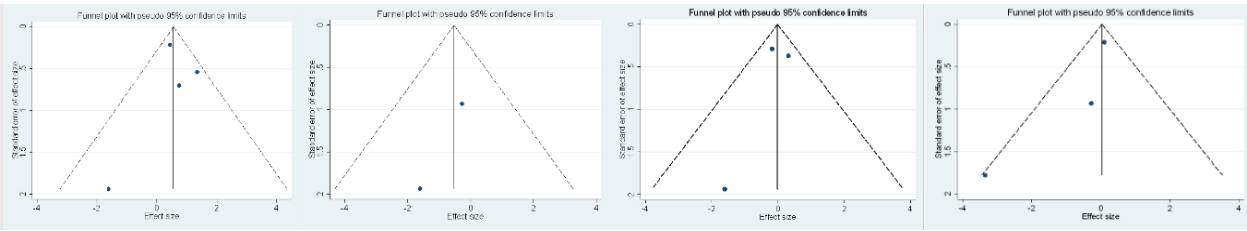

Figure 3 Funnel plots for meta-analyses on ICU admission. Left to right: Non-Hispanic Black, Asian, 'Other', Hispanic

In analyzing the odds of severe versus non-severe disease among minority children, two studies were included, comparing non-Hispanic White children with non-Hispanic Black and Hispanic children. Although the studies also included comparisons with Asian and 'Other' children, these groups were excluded from the analysis due to insufficient data.

Results showed that non-Hispanic Black children are 72% more likely (Odds Ratio [OR] 1.72, 95% CI 0.76, 3.90) to have severe MIS-C than non-Hispanic White children. Hispanic children had a slightly protective effect, being 24% less likely (Odds Ratio [OR] 0.76, 95% CI 0.63, 0.92) to experience severe MIS-C than non-Hispanic White children. There was moderate heterogeneity among the studies comparing non-Hispanic Black children to non-Hispanic White children (Cochran's Q = 2.27, H = 1.51, I^2 = 55.9%), suggesting some variability in effect sizes across studies. In contrast, the comparison between Hispanic and non-Hispanic White children showed no significant heterogeneity (Cochran's Q = 0.69, H = 0.83, I^2 = 0%), indicating consistent findings across studies. Given only two studies were included, usual metrics such as I2, and funnel plots cannot be appropriately interpreted.

In pooled odds ratios comparing the risk of death between racial and ethnic minorities, the odds ratios were not statistically significant in most cases, indicating no supporting evidence of a difference in odds of death from MIS-C between non-Hispanic White children and ethnic minorities, except for Asian/Pacific Islanders (API). Those of API descent were 6.79 (95% CI: 1.20, 38.51) times as likely to die as non-Hispanic White children.

There was no significant heterogeneity observed between studies except for the studies comparing non-Hispanic White children and Asian children, which had moderate heterogeneity (Cochran's Q = 1.55, p = 0.21; I^2 = 35.60%), indicating some variability between the studies, though not statistically significant. Given only two studies were included, usual metrics such as I2, and funnel plots cannot be appropriately interpreted.

Development

Results from the disease development meta-analysis are shown in Figure 4. Pooled odds ratios of development of MIS-C included 5 studies in total (Non-Hispanic Black: 5, Hispanic: 4, Asian: 3, Other: 4). There was no significant difference in the development of MIS-C among Asian or Hispanic children when compared to non-Hispanic White children. Non-Hispanic Black children were 2.37 (95% CI: 1.43, 3.90) times more likely to develop MIS-C than non-Hispanic White children in pooled results. However, there was substantial heterogeneity. Children classified as 'other' were 2.36 (95% CI: 1.18, 4.71) times as likely to develop MIS-C than non-Hispanic White children in pooled results. There was also substantial heterogeneity

observed in this analysis. Funnel plots (Figure 5) were asymmetrical, and all but the comparison of Asians to non-Hispanic White children had studies falling outside of the pseudo 95% CI, indicating publication bias.

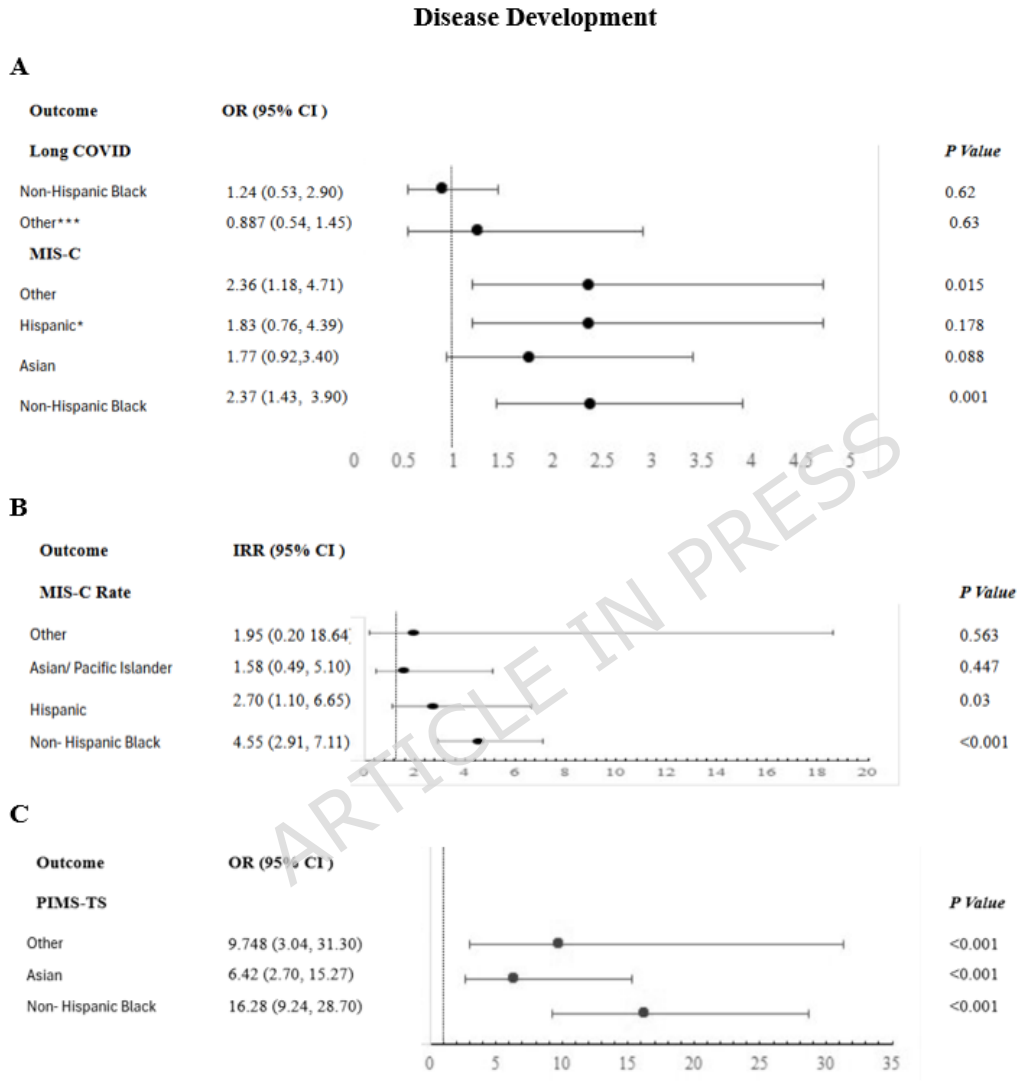

Figure 4 Meta-analysis of COVID-19 disease development outcomes. Panel A shows long COVID and MIS-C pooled odds ratios. Panel B shows the pooled IRR for MIS-C rate, and panel C shows the pooled OR for PIMS-TS. ***: Other was combined from 'other', 'mixed', and 'Asian' from Nugwela, and 'Hispanic' and 'Other' in Messiah, *: Hispanic was combined in Javalker from Hispanic White, Hispanic Black, Hispanic, other Hispanic

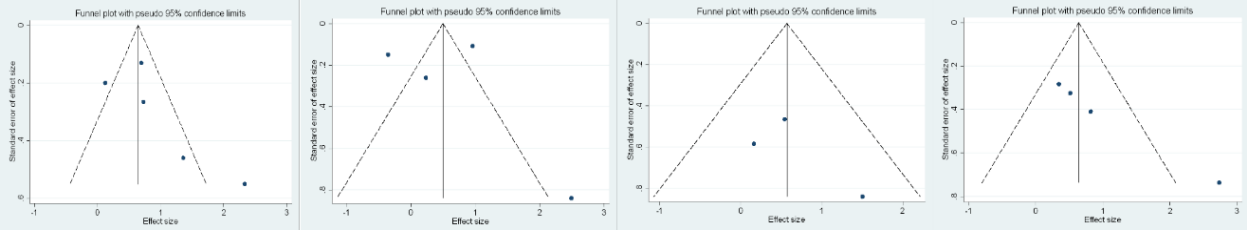

Figure 5 Funnel plots for meta-analyses on the development of MIS-C. Left to right: Non-Hispanic Black, Hispanic, Asian, Other

Pooled odds of MIS-C rate showed that per 100,000 people, Hispanic children were 2.70 (1.10, 6.65) times more likely to have MIS-C than non-Hispanic White children. Non-Hispanic Black children were 4.55 (2.91, 7.11) times to develop MIS-C per 100,000 people compared to non-Hispanic White children. Asian/Pacific Islander and 'Other' Groups were not statistically significant. As only two studies were included in the analyses, typical reporting metrics, such as I^2, and funnel plots cannot be appropriately assessed.

In a meta-analysis of the development of Long COVID, the comparisons between non-Hispanic Black children and 'other' (Asian, mixed Hispanic, other) to non-Hispanic White children were not statistically significant. Non-Hispanic Black children were 8% less likely (Odds Ratio [OR] 0.92, 95% CI: 0.52, 1.32) to develop Long COVID when compared with non-Hispanic White Children. There was no evidence of heterogeneity, with Cochran's Q = 0.96 (p = 0.327) and I^2 = 0%, suggesting consistent effect sizes across the studies.

Similarly, the comparison between non-Hispanic White children and those from 'other' racial/ethnic groups (pooled Asian, mixed, and

Hispanic), showed that 'Other' children had pooled odds of being 9% less likely (Odds Ratio [OR] 0.9, 95% CI: 0.52, 1.29) Heterogeneity was minimal, with Cochran's Q = 0.22 (p = 0.639) and I^2 = 0%. Given that only two studies were included in both analyses, metrics such as I^2 and funnel plots should be interpreted with caution. Due to only two studies being included in the analyses, I^2 and funnel plots cannot be appropriately assessed.

When pooling estimates for PIMS-TS in ethnic minorities compared to White children, each group was found to be statistically significant. In each assessment, two studies were included. Black children were 16.279 (95% CI: 9.236, 28.694) times more likely to develop PIMS-TS compared to white children in pooled results. There was minimal heterogeneity found between studies. In pooled estimates, Asian children were found to be 6.421 (95% CI: 2.70, 15.27) times as likely to develop PIMS-TS when compared to white children. There was moderate heterogeneity found across studies. Children classified as other ('other, mixed) were 9.75 (95% CI: 3.04, 31.30) times as likely to have PIMS-TS when compared to white children in pooled results. Due to only two studies being included in the analyses, I^2 and funnel plots cannot be appropriately assessed.

Funnel plots were generated only for outcomes with at least three contributing studies, which included ICU admission and MIS-C development. For ICU admission (Figure 3), the plots appeared symmetrical, indicating minimal evidence of publication bias. In contrast,

the funnel plots for MIS-C development (Figure 5) showed some asymmetry, suggesting possible small-study or publication bias. No other outcomes met the minimum study threshold for meaningful funnel plot assessment.

Discussion

This systematic review and meta-analysis explored racial and ethnic disparities in post-COVID conditions among children, identifying higher risks of severe outcomes, such as ICU admission, MIS-C, and PIMS-TS. Overall results showed that Non-Hispanic Black children faced significantly higher odds of ICU admission, MIS-C development, and PIMS-TS compared to Non-Hispanic White children. Hispanic children had a lower risk of severe MIS-C but higher overall MIS-C incidence. Asian/Pacific Islander and Alaskan Indian/Native American children showed elevated risks of MIS-C death, with Asian children also at higher odds for PIMS-TS. Additionally, children categorized as 'Other' had increased odds of both PIMS-TS and MIS-C. These findings align with adult studies, which also reveal disparities in Long COVID outcomes, and underscore the urgent need for targeted interventions to address the disproportionate burden of post-COVID conditions in minority groups. Ensuring equitable access to healthcare and early management strategies is critical to mitigating these disparities.[49,50]

Previous research on racial and ethnic disparities in adult acute COVID outcomes has shown that minority populations face higher rates of hospitalization, ICU admission, and mortality (Latino: hospitalization: RR,

3.06; 95% CI, 3.01-3.10; ICU admission: RR, 4.20; 95% CI, 4.08-4.33; death: RR, 3.85; 95% CI, 3.68-4.01; Non-Hispanic Black: hospitalization: RR, 2.85; 95% CI, 2.81-2.89; ICU admission: RR, 3.17; 95% CI, 3.09-3.26; death: RR, 2.58; 95% CI, 2.48-2.69).[51] Such parallels suggest a shared vulnerability among minority groups across age categories, potentially driven by structural inequities such as reduced access to healthcare, socio-economic disadvantages, and systemic racism in healthcare delivery.[52] Pediatric populations are particularly vulnerable, as children from minority backgrounds are more likely to experience delayed diagnoses, barriers to specialist care, and reduced healthcare continuity.[53]

Structural inequities, such as housing instability, income inequality, and disparities in insurance coverage, may compound Covid-19-related pediatric risks. For example, Black and Hispanic families were disproportionately impacted by pandemic-related economic and health challenges, leading to delayed care-seeking behaviors and greater severity at presentation.[54,55] These socio-economic factors, combined with potential biologic differences such as genetic predisposition or immune response variability, underscore the need for intersectional strategies to address disparities in post-COVID outcomes.

The findings of this review contribute significantly to the limited literature on disparities in pediatric post-COVID conditions. By synthesizing data across diverse studies, this review provides a nuanced understanding

of how race and ethnicity influence severe outcomes such as MIS-C and PIMS-TS. These insights have substantial implications for public health, particularly in improving pandemic preparedness and ensuring that healthcare interventions reach the most vulnerable populations. To mitigate disparities in future pandemics, it is critical to design inclusive studies, improve data collection on race and ethnicity, and implement equitable healthcare strategies. Expanding pediatric vaccination campaigns and culturally tailored public health messaging are immediate steps toward reducing the disproportionate burden on minority populations.[56]

This study had limitations that warrant careful consideration. First, the small number of studies reporting race and ethnicity in pediatric post-COVID conditions limited the scope of subgroup analyses, with key outcomes often relying on data from only two to three studies. This constraint may have introduced bias and heightened heterogeneity, necessitating cautious interpretation of results. For instance, ICU admission and MIS-C mortality findings were particularly vulnerable to these limitations. Furthermore, publication bias could only be evaluated for ICU admission and MIS-C development, and slight asymmetry in the latter suggests potential small-study effects that should be interpreted with caution. Second, inconsistencies in the classification of racial and ethnic categories across studies, particularly between U.S.-based and European datasets, complicated direct comparisons and may have introduced misclassification bias. Standardized reporting of race and ethnicity is

critical to ensure comparability and rigor in future research. Third, methodological challenges arose from the varying effect size metrics used across studies. Although outcomes were primarily pooled by odds ratios or incident rate ratios, applying the rare disease assumption to harmonize measures may have introduced error in some analyses. Although the included studies were generally rated as fair to good quality, several common issues such as small sample sizes, missing methodological details, and limited adjustment for confounding factors reduced the overall rigor of the findings. In addition, multiple sources of bias were evident. Selection bias was frequent due to reliance on hospitalized cohorts, recall bias likely affected survey-based long COVID outcomes, and residual confounding, particularly from socioeconomic variables and vaccination status, may have influenced the observed effect estimates. Collectively, these factors limit the certainty of the pooled associations.

Despite these limitations, this review underscores the urgent need for targeted interventions to address the disproportionate burden of post-COVID conditions among racial and ethnic minority children. Ensuring equitable access to healthcare, improving diagnostic pathways, and tailoring public health interventions to the needs of these populations are critical steps in mitigating disparities. Addressing structural inequities and enhancing research on pediatric disparities will be essential to advancing health equity and improving outcomes in future pandemics.

Conclusions

This review highlights critical racial and ethnic disparities in pediatric post-COVID conditions, underscoring the need for targeted public health strategies and equitable healthcare delivery. Future research should prioritize large-scale, diverse pediatric studies to better address these inequities and inform policymaking, ensuring effective and inclusive responses in future health crises**.**

List of abbreviations:

- **M**IS-C: multisystem inflammatory syndrome in children
- PIMS-TS: Paediatric Inflammatory Multisystem Syndrome (PIMS)

Declarations:

Ethics approval and consent to participate: Not applicable. This study is a systematic review of previously published research. No new data were collected directly from individuals, and no participants were involved in this study.

Consent for publication: Not applicable. This systematic review is based solely on previously published studies, which are publicly available. No identifiable personal data were used or reported in this review, and no additional consent for publication was required.

Availability of data and materials: All data supporting the findings of this systematic review and meta-analysis are available within the published

articles included in the review. The search strategy, inclusion criteria, and data extraction methods have been clearly detailed in the manuscript to ensure reproducibility. Requests for further information can be directed to the corresponding author.

Competing Interests: The authors declare no competing interests.

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Authors' information (optional)

References

1. Affairs (ASPA) AS for P. About Long COVID [Internet]. www.covid.gov. 2023. Available from: https://www.covid.gov/be-informed/longcovid/about#term
2. Rao S, Gross RS, Mohandas S, Stein CR, Case A, Dreyer B, et al. Postacute Sequelae of SARS-CoV-2 in Children. Pediatrics. 2024 Feb 7;153(3).
3. Baptista de Lima J, Salazar L, Fernandes A, Teixeira C, Marques L, Afonso C. Long COVID in Children and Adolescents: A Retrospective Study in a Pediatric Cohort. The Pediatric Infectious Disease Journal [Internet]. 2023 Apr 1 [cited 2023 Jul 31];42(4):e109. Available from: https://journals.lww.com/pidj/Fulltext/2023/04000/Long_COVID_in_Children_and_Adolescents__A.13.aspx
4. Gonzalez-Aumatell A, Bovo MV, Carreras-Abad C, Cuso-Perez S, Domènech Marsal È, Coll-Fernández R, et al. Social, Academic and Health Status Impact of Long COVID on Children and Young People: An

Observational, Descriptive, and Longitudinal Cohort Study. Children. 2022 Oct 31;9(11):1677.
5. MacLean A, Wild C, Hunt K, Nettleton S, Skea ZC, Ziebland S. Impact of Long Covid on the school experiences of children and young people: a qualitative study. BMJ Open [Internet]. 2023 Sep 1 [cited 2025 Jan 4];13(9):e075756. Available from: https://bmjopen.bmj.com/content/13/9/e075756
6. Mayo Clinic . COVID-19 (coronavirus): Long-term Effects [Internet]. Mayo Clinic. 2020. Available from: https://www.mayoclinic.org/diseases-conditions/coronavirus/in-depth/coronavirus-long-term-effects/art-20490351
7. Sarkar M, Pal P, Raychaudhuri D, Sen B, Chowdhoury SR, Chattopadhyay A, et al. PIMS-TS vs. MIS-C: Diagnostic Criteria in COVID-19–Associated Hyperinflammation in Children. Indian Journal of Pediatrics. 2021 Aug 9;88(11):1149–50.
8. Guidance: Paediatric multisystem inflammatory syndrome temporally associated with COVID-19 [Internet]. Available from: https://www.rcpch.ac.uk/sites/default/files/2020-05/COVID-19-Paediatric-multisystem-%20inflammatory%20syndrome-20200501.pdf
9. World Health Organization. Multisystem inflammatory syndrome in children and adolescents with COVID-19 [Internet]. 2020 May [cited 2025 Jan 4]. Available from: https://iris.who.int/bitstream/handle/10665/332095/WHO-2019-nCoV-Sci_Brief-Multisystem_Syndrome_Children-2020.1-eng.pdf
10. Yousaf AR, Lindsey KN, Wu MJ, Shah AB, Free RJ, Simeone RM, et al. Notes from the Field: Surveillance for Multisystem Inflammatory Syndrome in Children — United States, 2023. MMWR Morbidity and Mortality Weekly Report [Internet]. 2024 Mar 14 [cited 2025 Jan 4];73(10):225–8. Available from: https://www.cdc.gov/mmwr/volumes/73/wr/mm7310a2.htm#:~:text=COVID%2D19%20vaccination%20remains%20an
11. Payne AB, Gilani Z, Godfred-Cato S, Belay ED, Feldstein LR, Patel MM, et al. Incidence of Multisystem Inflammatory Syndrome in Children among US Persons Infected with SARS-CoV-2. JAMA Network Open [Internet]. 2021 Jun 10 [cited 2025 Jan 4];4(6):e2116420. Available from: https://pubmed.ncbi.nlm.nih.gov/34110391/
12. Centers for Disease Control. Multisystem Inflammatory Syndrome in Children (MIS-C) Associated with SARS-CoV-2 Infection 2023 Case Definition | CDC [Internet]. Cdc.gov. 2024 [cited 2025 Jan 4]. Available

from: https://ndc.services.cdc.gov/case-definitions/multisystem-inflammatory-syndrome-in-children-mis-c-2023/

13. Kim S, Arora I, Hsia D, Knowler W, LeBlanc E, Mylonakis E, et al. New-Onset Diabetes after COVID-19. The Journal of Clinical Endocrinology and Metabolism [Internet]. 2023 May 19 [cited 2025 Jan 4];108(11). Available from: https://pubmed.ncbi.nlm.nih.gov/37207448/
14. Hooper MW, Nápoles AM, Pérez-Stable EJ. COVID-19 and Racial/Ethnic Disparities. JAMA [Internet]. 2020 May 11 [cited 2025 Jan 4];323(24):2466–7. Available from: https://jamanetwork.com/journals/jama/fullarticle/2766098?utm_medium=email&utm_source=govdelivery
15. Bruce L, Tallman R. Promoting racial equity in COVID-19 resource allocation. Journal of Medical Ethics. 2021 Jan 29;47(4):208–12.
16. PRISMA. Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) website [Internet]. www.prisma-statement.org. 2020 [cited 2025 Jan 4]. Available from: https://www.prisma-statement.org/
17. National Institue for Health and Care Research. PROSPERO [Internet]. York.ac.uk. 2025 [cited 2025 Jan 5]. Available from: https://www.crd.york.ac.uk/PROSPERO/searchquick.php
18. STATA Corp. Stata Statistical Software [Internet]. Stata.com. 2019 [cited 2025 Jan 4]. Available from: https://www.stata.com/products/
19. Abrams JY, Oster ME, Godfred-Cato SE, Bryant B, Datta SD, Campbell AP, et al. Factors linked to severe outcomes in multisystem inflammatory syndrome in children (MIS-C) in the USA: a retrospective surveillance study. The Lancet Child & Adolescent Health. 2021 May;5(5):323–31.
20. Bhavsar SM, Clouser KN, Gadhavi J, Anene O, Kaur R, Lewis R, et al. COVID-19 in Pediatrics: Characteristics of Hospitalized Children in New Jersey. Hospital Pediatrics. 2020 Dec 22;11(1):79–87.
21. Das BB, Shakti D, Ghaleb S, Akam-Venkata J, Moskowitz WB, Osakwe O, et al. Racial and Ethnic Disparity in Multisystem Inflammatory Syndrome in Children Associated With SARS-CoV-2 in Mississippi, USA. Clinical Pediatrics. 2022 Jul 7;62(1):8–16.
22. Wurm J, Uka A, Buettcher M, Kottanattu L, Schöbi N, Trück J, et al. Clinical and Laboratory Biomarkers as Predictors of Severity in Pediatric Inflammatory Multisystem Syndrome-temporally Associated With SARS-CoV-2: Data From a Prospective Nationwide Surveillance Study in Switzerland. The Pediatric Infectious Disease Journal. 2024 Mar 20;43(7):675–81.

23. Lasa JJ, Alali A, Anders M, Tume SC, Muscal E, Tejtel SKS, et al. Cardiovascular sequelae from COVID-19: perspectives from a paediatric cardiac ICU. Cardiology in the Young. 2022 Feb 24;33(1):1–8.
24. Rao M, Bond C, Haggstrom A, Bhumbra S. Severity of multisystem inflammatory syndrome in children (MIS-C) in patients with and without mucocutaneous findings. Pediatric Dermatology. 2023 Jan 10;40(2).
25. Broad J, Forman J, Brighouse J, Sobande A, McIntosh A, Watterson C, et al. Post-COVID-19 paediatric inflammatory multisystem syndrome: association of ethnicity, key worker and socioeconomic status with risk and severity. Archives of Disease in Childhood. 2021 Mar 16;106(12):1218–25.
26. Bowen A, Miller AD, Zambrano LD, Wu MJ, Oster ME, Godfred-Cato S, et al. Demographic and Clinical Factors Associated With Death Among Persons <21 Years Old With Multisystem Inflammatory Syndrome in Children—United States, February 2020–March 2021. Open Forum Infectious Diseases. 2021 Jul 19;8(8).
27. McCormick DW, Richardson LC, Young PR, Viens LJ, Gould CV, Kimball A, et al. Deaths in Children and Adolescents Associated With COVID-19 and MIS-C in the United States. Pediatrics [Internet]. 2021 Aug 12;148(5):e2021052273. Available from: https://pediatrics.aappublications.org/content/pediatrics/early/2021/08/11/peds.2021-052273.full.pdf
28. Hensley M, Goodman M, Madani R, Jaggi P, Keesari R, Zhang Q, et al. Cardiac complications in children with acute COVID-19 vs multisystem inflammatory syndrome in children (MIS-C). American Heart Journal. 2023 Sep;263:177–82.
29. Legarda EM, Martínez J, Sisa I. Comparison of Pediatric Patients With and Without Multisystem Inflammatory Syndrome Associated With COVID-19. Pediatric Infectious Disease Journal. 2022 Dec 28;42(4).
30. Bautista-Rodriguez C, Sanchez-de-Toledo J, Clark BC, Herberg J, Bajolle F, Randanne PC, et al. Multisystem Inflammatory Syndrome in Children: An International Survey. Pediatrics [Internet]. 2021 Feb 1 [cited 2025 Jan 4];147(2). Available from: https://pubmed.ncbi.nlm.nih.gov/33234669/
31. Francoeur C, Alcamo AM, Robertson CL, Wainwright MS, Roa JD, Lovett ME, et al. Severe Pediatric Neurological Manifestations With SARS-CoV-2 or MIS-C Hospitalization and New Morbidity. JAMA Network Open. 2024 Jun 10;7(6):e2414122–2.
32. Ghimire LV, Chou FS, Aljohani OA, Moon-Grady AJ. Racial and Socioeconomic Disparities in Multisystem Inflammatory Syndrome in

Children in the United States. The American Journal of Cardiology. 2023 Jul 1;198:50–2.

33. Javalkar K, Robson VK, Gaffney L, Bohling AM, Arya P, Servattalab S, et al. Socioeconomic and Racial and/or Ethnic Disparities in Multisystem Inflammatory Syndrome. Pediatrics [Internet]. 2021 May 1 [cited 2022 Jun 18];147(5):e2020039933. Available from: https://publications.aap.org/pediatrics/article/147/5/e2020039933/180784/Socioeconomic-and-Racial-and-or-Ethnic-Disparities?autologincheck=redirected
34. Kline JN, Isbey SC, McCollum NL, Falk MJ, Gutierrez CE, Guse SE, et al. Identifying pediatric patients with multisystem inflammatory syndrome in children presenting to a pediatric emergency department. The American Journal of Emergency Medicine [Internet]. 2022 Jan [cited 2025 Jan 4];51:69–75. Available from: https://pubmed.ncbi.nlm.nih.gov/34688203/
35. Martin B, DeWitt PE, Russell S, Anand A, Bradwell KR, Bremer C, et al. Characteristics, Outcomes, and Severity Risk Factors Associated With SARS-CoV-2 Infection Among Children in the US National COVID Cohort Collaborative. JAMA Network Open [Internet]. 2022 Feb 8 [cited 2025 Jan 4];5(2):e2143151–1. Available from: https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2788844
36. Relvas-Brandt L de A, Gava C, Camelo FS, Porto VBG, Alves RFS, Costa MSCD, et al. Síndrome inflamatória multissistêmica pediátrica: estudo seccional dos casos e fatores associados aos óbitos durante a pandemia de COVID-19 no Brasil, 2020. Epidemiologia e Serviços de Saúde [Internet]. 2021 Nov 8;30(4):e2021267. Available from: https://www.scielosp.org/article/ress/2021.v30n4/e2021267/pt/
37. Stierman B, Abrams JY, Godfred-Cato SE, Oster ME, Meng L, Yip L, et al. Racial and Ethnic Disparities in Multisystem Inflammatory Syndrome in Children in the United States, March 2020 to February 2021. Pediatric Infectious Disease Journal. 2021 Aug 10;40(11):e400–6.
38. Swann OV, Holden KA, Turtle L, Pollock L, Fairfield CJ, Drake TM, et al. Clinical characteristics of children and young people admitted to hospital with covid-19 in United Kingdom: prospective multicentre observational cohort study. BMJ [Internet]. 2020 Aug 27;370. Available from: https://www.bmj.com/content/370/bmj.m3249
39. Tolopka T, Kuehne J, Mainali K, Beebe M, Garcia M, Salameh M, et al. The Role of Childhood Obesity in Acute Presentations and Outcomes of Hospitalized COVID-19 Patients. Cureus. 2022 Sep 7;14(9).

40. Zambrano LD, Ly KN, Link-Gelles R, Newhams MM, Akande M, Wu MJ, et al. Investigating Health Disparities Associated With Multisystem Inflammatory Syndrome in Children After SARS-CoV-2 Infection. The Pediatric Infectious Disease Journal [Internet]. 2022 Sep 7 [cited 2024 Aug 20];41(11):891–8. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9555608/
41. Zambrano LD, Wu MJ, Martin L, Malloch L, Chen S, Newhams MM, et al. Risk Factors for Multisystem Inflammatory Syndrome in Children: A Case-control Investigation. The Pediatric Infectious Disease Journal [Internet]. 2023 Jun 1 [cited 2025 Jan 4];42(6):e190–6. Available from: https://pubmed.ncbi.nlm.nih.gov/37000922/
42. Hobbs CV, Kim SS, Vemula P, Inagaki K, Harrison VA, Malloch L, et al. Active Surveillance With Seroprevalence-based Infection Rates Indicates Racial Disparities With Pediatric SARS-CoV-2 Requiring Hospitalization in Mississippi, March 2020–February 2021. The Pediatric Infectious Disease Journal [Internet]. 2022 Jun 7 [cited 2025 Jan 4];41(9):736–41. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9359681/
43. Lee EH, Kepler KL, Geevarughese A, Paneth-Pollak R, Dorsinville MS, Ngai S, et al. Race/Ethnicity Among Children With COVID-19–Associated Multisystem Inflammatory Syndrome. JAMA Network Open [Internet]. 2020 Nov 30;3(11):e2030280. Available from: https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2773289
44. Treston B, Petty-Saphon N, Collins A, Murray SS, Colgan A, Fitzgerald E, et al. Multisystem inflammatory syndrome in the context of paediatric COVID -19 infection in the Republic of Ireland April 2020 to April 2021. Acta Paediatric [Internet]. 2022 Aug 27 [cited 2025 Jan 4];111(12):2344–51. Available from: https://pubmed.ncbi.nlm.nih.gov/36030064/
45. Messiah SE, Xie L, Sunil M, Shaikh S, Veeraswamy A, Rabi A, et al. Comparison of Long-Term Complications of COVID-19 Illness among a Diverse Sample of Children by MIS-C Status. Int J Environ Res Public Health [Internet]. 2022 Oct 17 [cited 2025 Jan 4];19(20):13382–2. Available from: https://pubmed.ncbi.nlm.nih.gov/36293968/
46. Nugawela MD, Stephenson T, Shafran R, De Stavola BL, Ladhani SN, Simmons R, et al. Predictive model for long COVID in children 3 months after a SARS-CoV-2 PCR test. BMC Medicine [Internet]. 2022 Nov 30 [cited 2025 Jan 4];20(1). Available from: https://bmcmedicine.biomedcentral.com/articles/10.1186/s12916-022-02664-y

47. Penner J, Abdel-Mannan O, Grant K, Maillard S, Kucera F, Hassell J, et al. 6-month multidisciplinary follow-up and outcomes of patients with paediatric inflammatory multisystem syndrome (PIMS-TS) at a UK tertiary paediatric hospital: a retrospective cohort study. The Lancet Child & Adolescent Health [Internet]. 2021 Jul [cited 2025 Jan 4];5(7):473–82. Available from: https://pubmed.ncbi.nlm.nih.gov/34043958/
48. Felsenstein S, Duong P, Lane S, Jones C, Pain CE, Hedrich CM. Cardiac pathology and outcomes vary between Kawasaki disease and PIMS-TS. Clinical Immunology. 2021 Aug;229:108780.
49. Jacobs MM, Evans E, Ellis C. Racial, ethnic, and sex disparities in the incidence and cognitive symptomology of long COVID-19. Journal of the National Medical Association [Internet]. 2023 Feb [cited 2025 Jan 4];115(2). Available from: https://pubmed.ncbi.nlm.nih.gov/36792456/
50. Khullar D, Zhang Y, Zang C, Xu Z, Wang F, Weiner MG, et al. Racial/Ethnic Disparities in Post-acute Sequelae of SARS-CoV-2 Infection in New York: an EHR-Based Cohort Study from the RECOVER Program. Journal of General Internal Medicine [Internet]. 2023 Feb 16 [cited 2025 Jan 4];38(5). Available from: https://pubmed.ncbi.nlm.nih.gov/36795327/
51. Acosta AM, Garg S, Pham H, Whitaker M, Anglin O, O'Halloran A, et al. Racial and Ethnic Disparities in Rates of COVID-19–Associated Hospitalization, Intensive Care Unit Admission, and In-Hospital Death in the United States From March 2020 to February 2021. JAMA Network Open. 2021 Oct 21;4(10):e2130479.
52. Berger Z, Altiery De Jesus V, Assoumou SA, Greenhaligh T. Long COVID and Health Inequities: The Role of Primary Care. The Milbank Quarterly. 2021 Mar 30;99(2):519–41.
53. Tabet M, Kirby RS, Xaverius PK. Racial and Ethnic Differences in Factors Associated With Delayed or Missed Pediatric Preventive Care in the US Due to the COVID-19 Pandemic. JAMA network open. 2023 Jul 10;6(7):e2322588–8.
54. Chun Y, Roll S, Miller S, Lee H, Larimore S, Grinstein-Weiss M. Racial and Ethnic Disparities in Housing Instability During the COVID-19 Pandemic: the Role of Assets and Income Shocks. Journal of Economics, Race, and Policy. 2022 Dec 2;6(2).
55. Ahmed Ashour Ahmed, Song Y, Wadhera RK. Racial/Ethnic Disparities in Delaying or Not Receiving Medical Care During the COVID-19 Pandemic. Journal of General Internal Medicine. 2022 Feb 8;37(5):1341–3.

56. Vernon-Wilson E, Tetui M, DeMarco M, Grindrod K, Waite NM. Connect, collaborate and tailor: a model of community engagement through infographic design during the COVID-19 pandemic. BMC Public Health. 2024 Sep 19;24(1).