

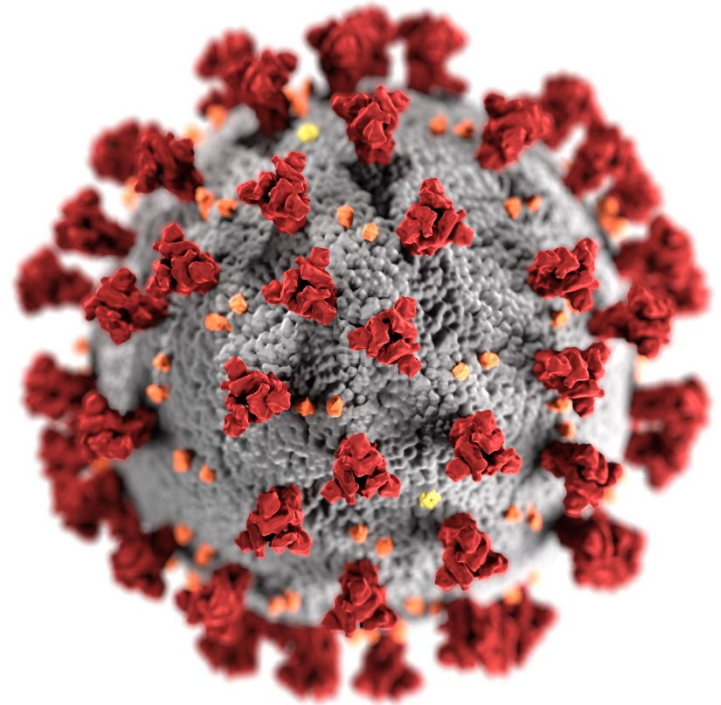
Burden, Prevalence, and Trends of Long-Term Sequelae of SARS-CoV-2

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ACIP

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cdc.gov/coronavirus

There are many terms used to refer to these conditions

- **Long COVID**
 - Commonly used
- **Post-COVID Condition(s)**
 - CDC and WHO
- **Post-Acute Sequelae of SARS-CoV-2 (PASC)**
 - NIH



A general framework for post-COVID conditions

- Umbrella term for the wide range of physical and mental health consequences, present for **four weeks and beyond after SARS-CoV-2 infection**, including for *patients who had initial mild or asymptomatic acute infection*.

Framework for Variety of Conditions Following SARS-CoV-2 Infection

General consequences of illness and hospitalization

- Post ICU syndrome
- Other complications of treatment or illness

Post acute consequences of SARS-CoV-2 infection

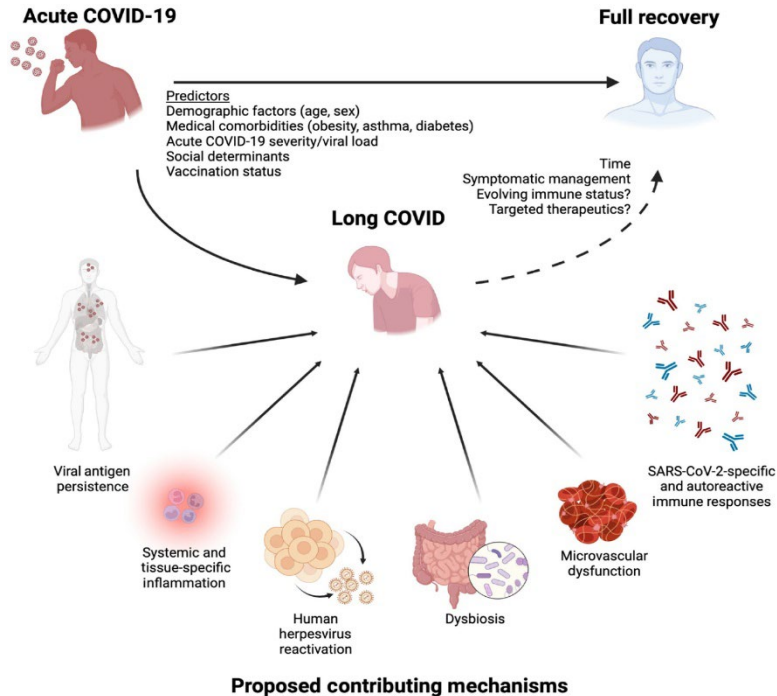
- System specific pathology (e.g. lung fibrosis, stroke)
- Clinically significant symptoms with unclear pathology (e.g. ME/CFS*-like, dysautonomia)
- On-going symptoms following MIS-C

Conditions frequently overlap
Patients may experience any combination

*ME/CFS: Myalgic Encephalomyelitis/Chronic Fatigue Syndrome



Multiple proposed potential mechanisms for post-COVID conditions



- Proposed mechanisms could include viral persistence, systemic and tissue specific inflammation, auto immunity, microvascular dysfunction
- Whether potential mechanisms differ for children is unknown

Trends in Immunology

[Peluso and Deeks. Early clues regarding the pathogenesis of long-COVID: Trends in Immunology \(cell.com\) 2022](#)

Symptoms of post-COVID conditions are similar among children and adults

- **Dyspnea or increased respiratory effort**
- **Fatigue**
- **Anosmia or dysgeusia**
- **Chest pain**
- **Headache**
- **Lightheadedness**
- Palpitations and/or tachycardia
- Arthralgia
- Myalgia
- Paresthesia
- Cough
- Abdominal pain
- Diarrhea
- Insomnia and other sleep difficulties
- Fever
- Impaired daily function and mobility
- Pain
- Rash (e.g., urticaria)
- Mood changes
- Menstrual cycle irregularities
- Post-exertional malaise and/or poor endurance
- “Brain fog,” cognitive impairment



<https://www.cdc.gov/coronavirus/2019-ncov/long-term-effects/index.html>

[Borch L et al. Long COVID symptoms and duration children. European Journal Pediatrics 2022](#)

There is a wide range in the reported prevalence of post-COVID conditions among adults

- Self-report of symptoms on surveys range from 13.3% at ≥ 1 month to 2.5% at ≥ 3 months
- Based on electronic health record data
 - Of non-hospitalized adults with COVID-19, 7.7% experienced one or more of 10 identified late-onset conditions 1 to 4 months post infection²
 - Burden of at least one symptom at 6 months differs by severity of acute COVID:³
 - Overall: 73.4/1,000 patients
 - Non-hospitalized: 44.5/1,000 patients
 - Hospitalized: 217.1/1,000 patients
 - ICU 360.5/1,000 patients

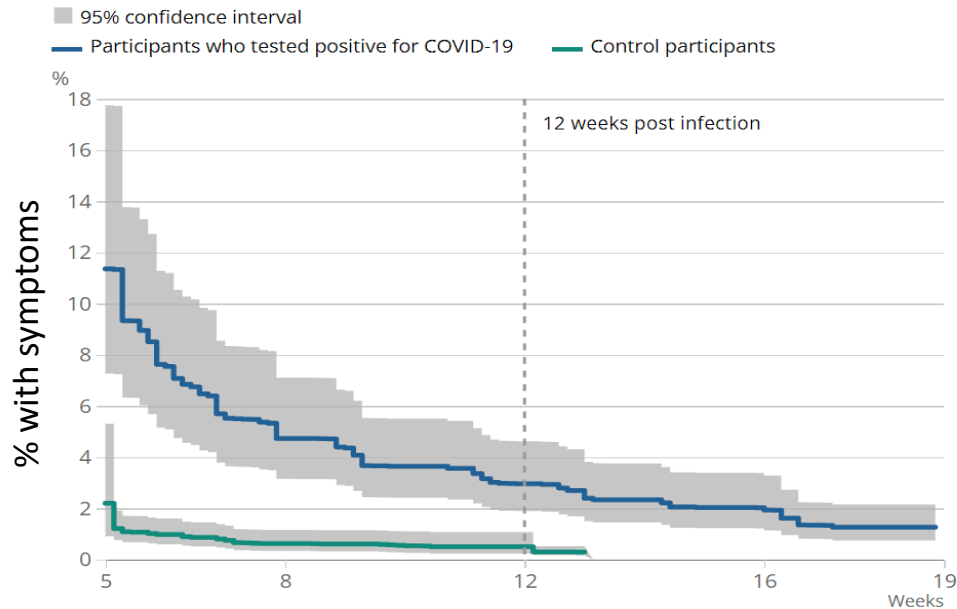
1. [Sudre CH et al Nature Medicine 27, 626-631 \(2021\)](#)
2. [Chevinsky JR et al. Clinical Infectious Diseases 73 \(S1\) 2021](#)
3. [Xie Y et al. Nature Communications 12, 6571 \(2021\)](#)



Duration of post-COVID conditions can vary among adults

- Most patients report no acute symptoms at 4 weeks and the proportion reporting on-going symptoms decreases 4-12 weeks
- Improvement slows around 12 weeks after infection
- Women and men follow same pattern, but more women report symptoms

UK Coronavirus Infection Survey: Report of symptoms lasting 4 or more weeks- April 2020 – August 2021



Source: Office for National Statistics - Coronavirus Infection Survey
[Technical article, figure 2. Office for National Statistics \(ons.gov.uk\)](#)

Children present unique challenges in understanding post-COVID conditions

- Difficulties assessing symptoms in young children include
 - **Inability of younger children to describe symptoms**
 - **Inconsistent manifestation of symptoms**
 - **Assessments of conditions may be dependent on expected developmental milestones**
- Limitations of current research
 - Varying time points from infection for assessments
 - Lack of control groups
 - Small sample sizes in most reports



Similar to adults there is a wide range in prevalence of post-COVID conditions among children

- Symptoms lasting 4 weeks or longer following SARS-CoV-2 infection are common among children and adolescents.
- The most common symptoms include:
 - Headache or respiratory symptoms (~7%)
 - Sleep disorders (~8%)
 - Fatigue (9%)
 - Mood disorders (~16%)

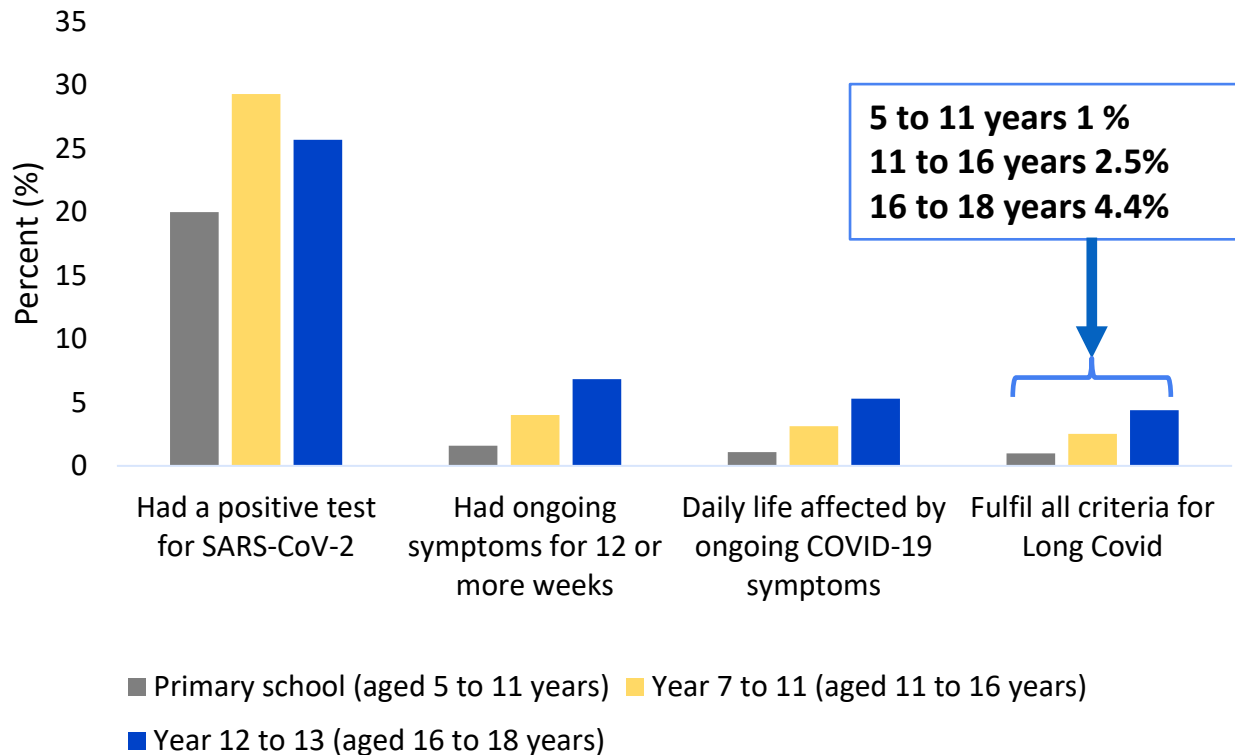
[Zimmermann et al. The Challenge of Studying Long COVID: An Updated Review : The Pediatric Infectious Disease Journal \(lww.com\)](#)

[Lopez-Leon et al. Long-COVID in Children and Adolescents: A Systematic Review and Meta-analyses | medRxiv](#)



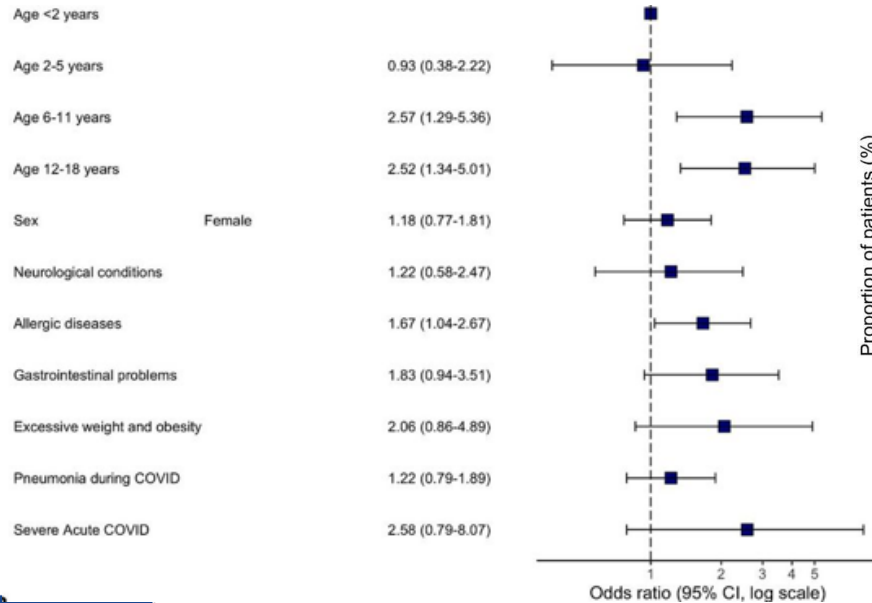
Non-hospitalized children also experience post-COVID conditions

- Survey of school age children and parents in the UK (n = 4,530)
 - Weighted to ages 5 - 18 years, UK population
- Occurrence higher among adolescents 16-18 years

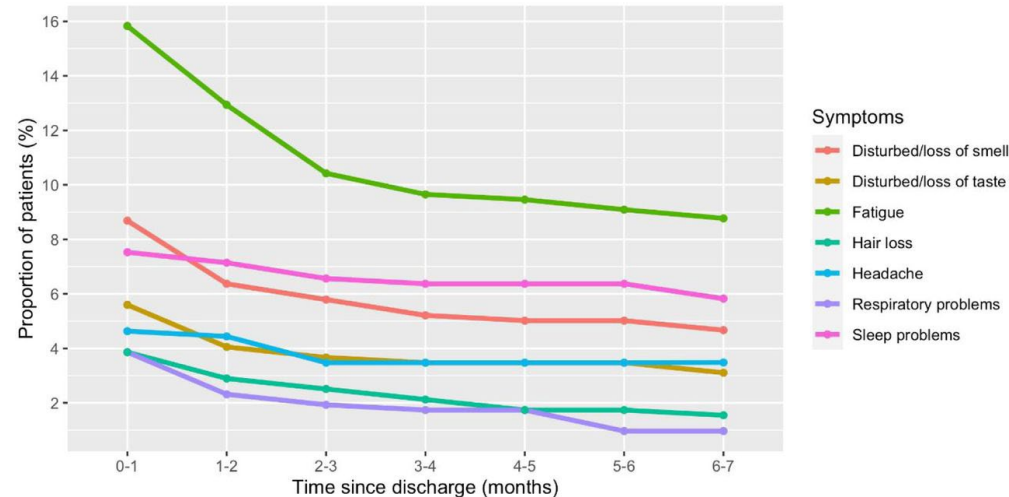


Risk factors of post-COVID conditions in children previously hospitalized for COVID-19

- Risk factors include older age and allergic disease

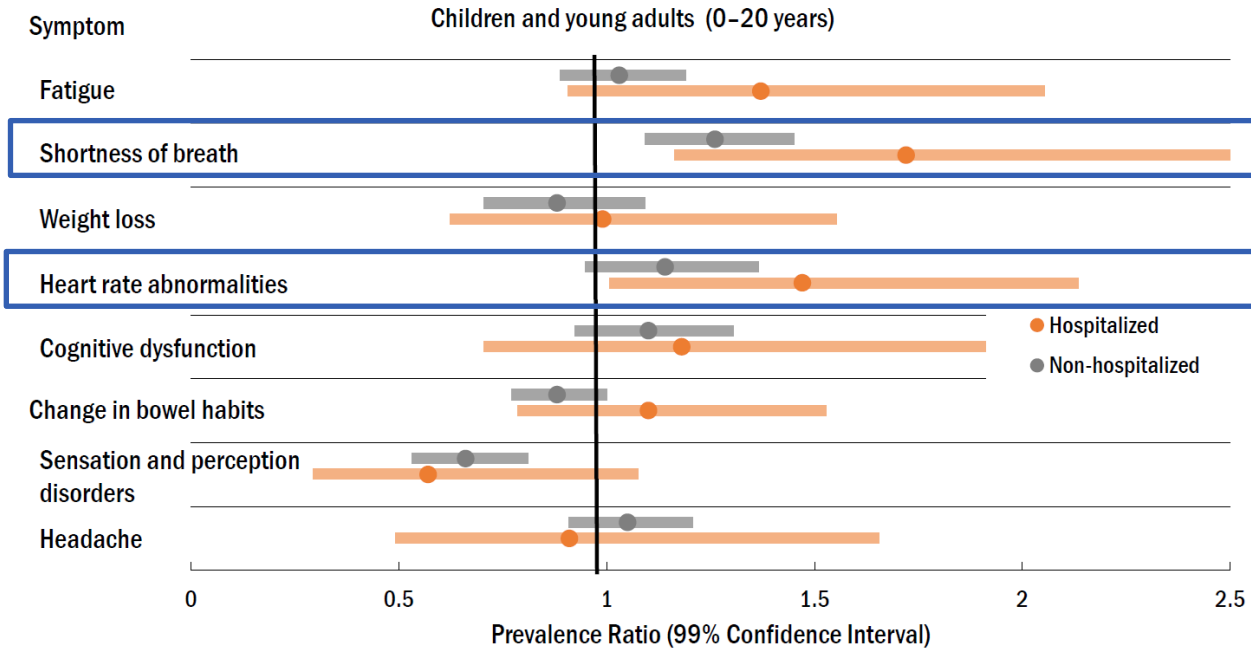


- Symptoms decrease over time



New symptoms 31-150 days after testing positive for SARS-CoV-2

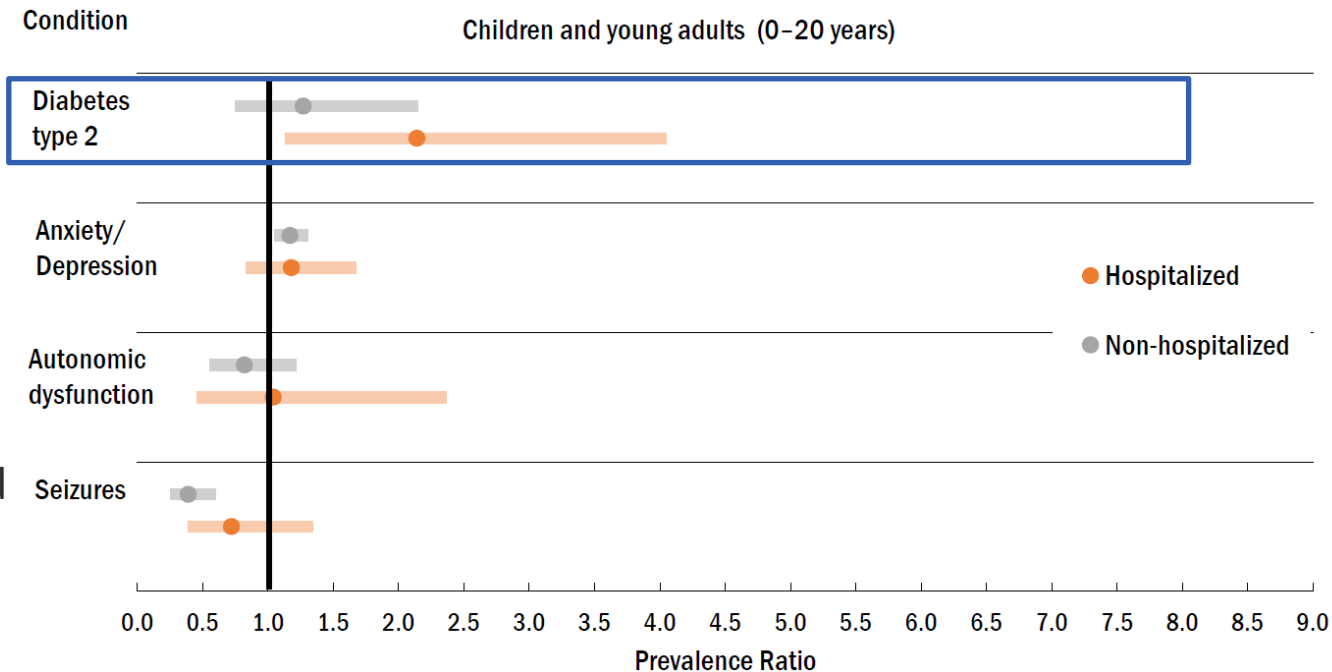
- Children, adolescents, and young adults who tested positive for COVID-19 were more likely than patients who tested negative to have **shortness of breath and heart rate abnormalities**



Prevalence ratio is the proportion with symptom & COVID-19 + divided by the proportion with the symptom & COVID-19 -

New conditions 31-150 days after testing positive for SARS-CoV-2

- Children, adolescents, and young adults who tested positive for COVID-19 were more likely than patients who tested negative to have new type 2 diabetes



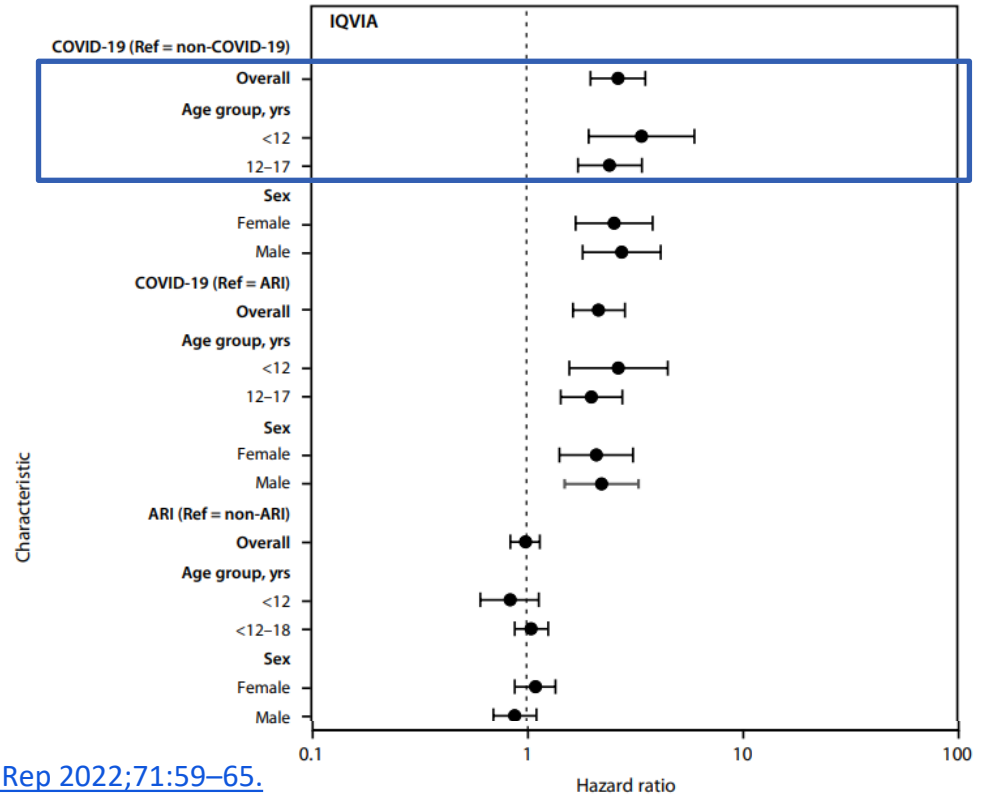
Prevalence ratio is the proportion with symptom & COVID-19 + divided by the proportion with the symptom & COVID-19 -

Risk for Newly Diagnosed Diabetes >30 Days After SARS-CoV-2 Infection Among Persons Aged <18 Years — United States, March 1, 2020–June 28, 2021

Centers for Disease Control and Prevention

MMWR

- Retrospective cohorts constructed using IQVIA healthcare claims data from March 1, 2020, through February 26, 2021
- Incidence of new diabetes diagnosis among COVID-19 patients, matched by age and sex, was higher compared to no COVID-19 diagnosis and to pre-pandemic non-COVID acute respiratory infection (ARI)
- Hazard ratio of **2.66** overall



Barrett CE, et al. MMWR Morb Mortal Wkly Rep 2022;71:59–65.



Children and adolescents who had COVID-19 have an increased risk of a wide range of new conditions and symptoms ≥ 4 weeks following COVID-19 compared to children and adolescents without COVID-19

Hazard Ratio (95% CI of bolded hazard ratio does not include 1) *

New outcome	Overall	2–4 years	5–11 years	12–17 years
Symptom				
Smell and taste disturbances	1.17	1.22	0.94	1.23
Circulatory signs and symptoms	1.07	1.17	1.11	1.04
Malaise and fatigue	1.05	1.13	1.08	1.03
Musculoskeletal pain	1.02	1.16	1.06	1.00
Condition				
Acute pulmonary embolism	2.01	— [†]	— [†]	2.03
Myocarditis and cardiomyopathy	1.99	2.39	2.84	1.66
Venous thromboembolic event	1.87	— [†]	2.69	1.52
Acute and unspecified renal failure	1.32	1.52	1.38	1.27
Type 1 diabetes	1.23	1.01	1.31	1.20
Coagulation and hemorrhagic disorders	1.18	1.47	1.28	1.10
Type 2 diabetes	1.17	1.24	1.14	1.18
Cerebrovascular disease	1.16	1.66	1.14	1.18
Asthma	1.07	1.12	1.02	0.96

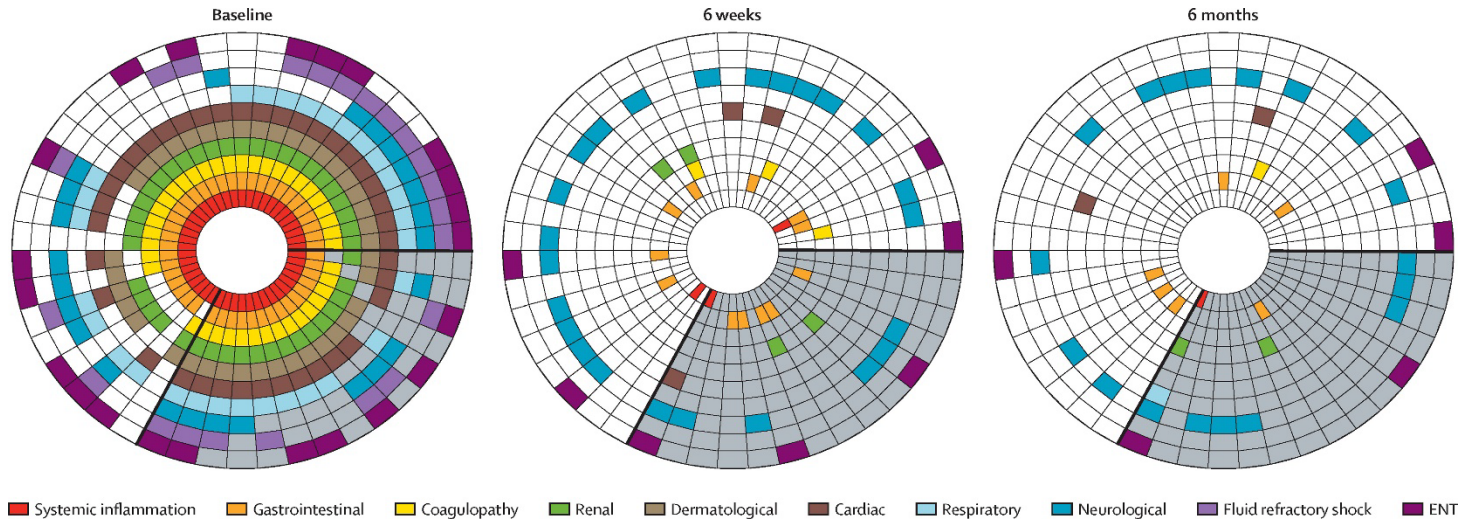


US Commercial Medical Claims Data, March 1, 2019–September, 2021. Unpublished CDC data.

†: <10 events

Children with Multisystem Inflammatory Syndrome (MIS-C) appear to have higher risk of ongoing symptoms following MIS-C

- Continued difficulties at 6 months were reported by 35% of children and 21% of the children's parents
- Specific system involvement decreased by 6 months



[Penner J. et al. 6 month follow-up MIS-C. Lancet Pediatric 2021](#)

Post-COVID conditions may be less likely to occur after vaccine breakthrough

- While most studies on post-COVID conditions occurring after vaccine breakthrough have focused on adults, two included adolescents: ^{1,2}
 - Less likely to have symptoms between 12 and 20 weeks after infection compared to persons unvaccinated (OR 0.22, 95% 0.20, 0.25)
 - Lower the occurrence of post-COVID conditions in persons with infection after vaccination (who tend to have milder infections) than infections in persons who are unvaccinated



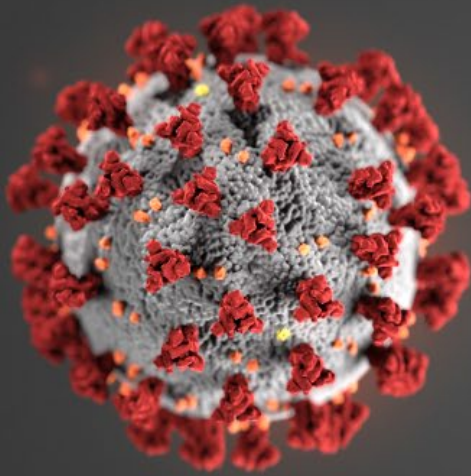
[1. Simon et al. Reduced Incidence of Long-COVID Symptoms | medRxiv 2022](#)

[2. Tarquet et al. Six-month sequelae of post-vaccination SARS-CoV-2 infection | medRxiv 2022](#)

Summary of post-COVID conditions among children and adolescents and unanswered questions

- **Post-COVID conditions occur** among children and adolescents with COVID-19 regardless of acute illness severity, but at higher frequency among:
 - Hospitalized or those who had more severe illness
 - Adolescents
- Remaining areas of uncertainty:
 - **Frequency, severity, and duration** of post-COVID conditions
 - **Groups disproportionately impacted** by post-COVID conditions
 - Association of **SARS-CoV-2 variants** with the incidence of post-COVID conditions
 - Impact on daily activities and participation in school





For more information:

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The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

