

The Diagnosis and Treatment of Pediatric Long COVID

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Objective

- The Participant will be able to describe guidance regarding assessment and treatment options for children with long COVID.




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What is long COVID and how do we diagnose it?



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Long COVID



WHO: Post COVID-19 condition in children and adolescents occurs in individuals with a history of confirmed or probable SARS-CoV-2 infection, when experiencing symptoms lasting at least 2 months which initially occurred within 3 months of acute COVID-19.

CDC: post-COVID conditions as an umbrella term for the wide range of health consequences that are present four or more weeks after infection with SARS-CoV-2.



NIHR/UK Research: Long COVID is a condition in which a child or young person has symptoms (at least one of which is a physical symptom) that: Have continued or developed after a diagnosis of COVID-19 (confirmed with one or more positive COVID tests), Impact their physical, mental or social wellbeing, Are interfering with some aspect of daily living, and Persist for a minimum duration of 12 weeks after initial testing for COVID-19 (even if symptoms have waxed and waned over that period).




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Long COVID

- Clinical Diagnosis
 - Epidemiological link to SARS-CoV-2 infection
 - Symptom or constellation of symptoms that are new or worsened by the infection

Have you had a COVID-19 infection?
Have you noticed any new or worsened symptoms since the infection?



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Symptom pattern in Pediatric Long COVID

Table 3. Children's experience of COVID-19 by confirmation of infection and pre-existing conditions.

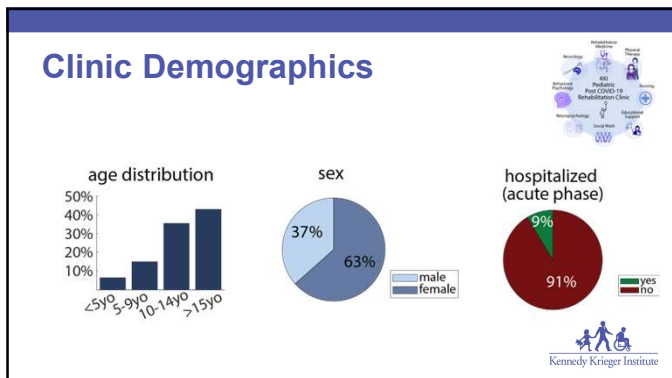
Characteristics	All (N = 510)	Clinical diagnosis (N = 154)	Positive test (N = 145)	Unconfirmed but suspected (N = 209)	Pre-existing conditions (N = 287)	No pre-existing conditions (N = 223)
Constant symptoms, n (%)	129 (25.3)	45 (28.8)	50 (34.5)	34 (16.3)	76 (26.5)	53 (23.8)
Alternating recovery/symptoms, n (%)	252 (49.4)	78 (50)	66 (45.5)	108 (51.7)	144 (50.2)	108 (48.4)
Long period of wellness followed by symptoms, n (%)	97 (19)	21 (13.5)	24 (16.6)	52 (24.9)	46 (16)	51 (22.9)
Undetermined, n (%)	32 (6.3)	12 (7.7)	5 (3.4)	15 (7.2)	21 (7.3)	11 (4.9)

Results were not significantly affected by age, comorbidities or sex (p > 0.05).

Buonsenso et al. 2022



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Long COVID Symptoms In Children And Adolescents Are Similar To Adults

Systemic: fatigue

Pain: headaches, abdominal, chest

Orthostatic intolerance, dizziness

Depression, anxiety

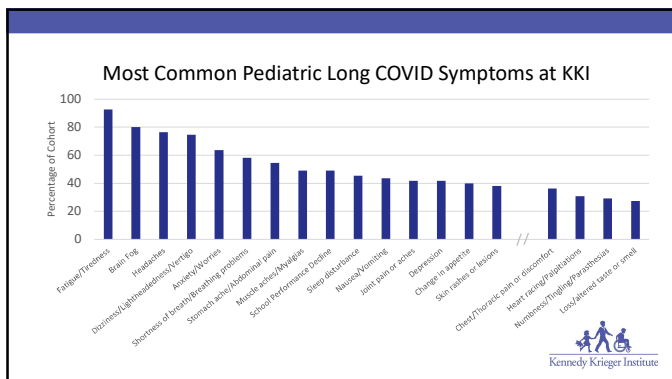
Dysgeusia, parosmia/anosmia

Palpitations, dyspnea

Cognitive fatigue, "brain fog"

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How common is pediatric long COVID?

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Prevalence of Long COVID in Pediatrics

Prevalence estimates:

Individual studies: 4-66% **Larger estimates: 1-25%**

Study	Country	Study Design	Sample Size	Prevalence	Notes
Wang et al. 2021	USA	Retrospective	1,113	25%	Multi-center
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Zimmerman et al. 2021 Lopez-Leon et al. 2022

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Prevalence of Long COVID in Pediatrics

Long COVID was defined as: "Any symptoms lasting **3 months** or longer that you **did not have prior to having COVID-19?**" among those who reported receiving either a **positive test** or a **doctor's diagnosis** of COVID-19 and were **symptomatic**.

73 million children in the US → 950,000 children that had or currently have PCC

Percent of Children with Long COVID

SOURCE: National Center for Health Statistics, National Health Interview Survey, 2022

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Differences In Pediatric Long COVID Evaluation

Developmental Trajectories

Tean et al. 2014

- Assessment of children is different than adults:
 - Inability of younger children or children with developmental disabilities to verbalize symptoms
 - Children have fewer preexisting chronic health conditions → may not require the same laboratory or radiographic tests
 - Long COVID can represent a stark departure from baseline
 - Assessments dependent on expected developmental milestones

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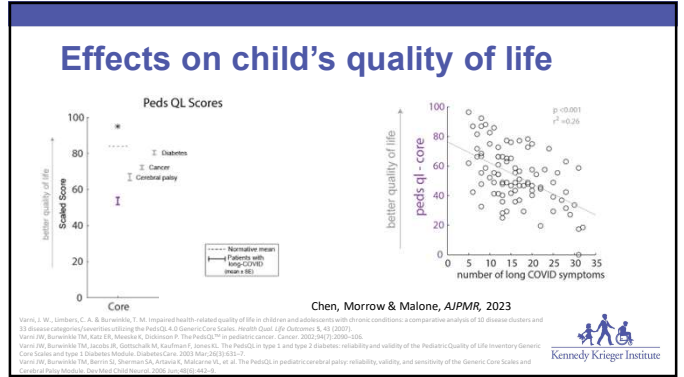
What impact does long COVID have on children?

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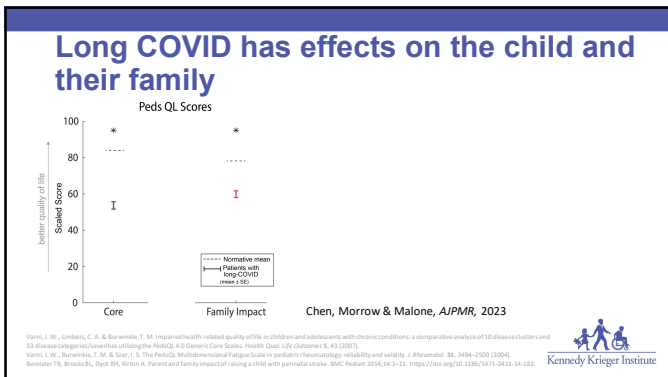
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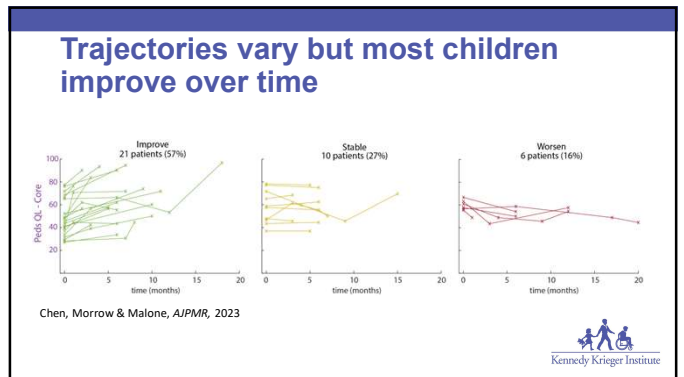
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How do we treat pediatric long COVID?



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- Multidisciplinary team-based approach:
 - Medical
 - Psychosocial
 - Cognitive
 - Physical
- Goal to improve patients' overall functioning:
 - Day to day tasks
 - Physical activity
 - School
 - Extracurricular activities & social engagement



ANALYSIS & PERSPECTIVE: PEDI-ONLY
Post-Acute/Long-COVID in Pediatrics
 development of a multi-disciplinary rehabilitation clinic and preliminary case series

Norma, Aronica K. PhD¹, Jay, Rosera PhD², Ursig, Gray PhD³, Jones, David Scott PhD⁴, Henning, Blake PhD⁵, Collins, Kyla R. DPT⁶, Nelson, Laura K. PhD^{7*}

American Journal of Physical Medicine & Rehabilitation September 26, 2022 • Volume 91 • Issue 6 • 5195-5204. DOI:10.1093/ptj/ptj1289




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Treatment approach


- Evaluate for other etiologies of symptoms (e.g., anemia for fatigue)
- Symptom management
 - Primary with lifestyle and rehabilitation-based interventions
 - Hydration
 - Regular meals, sodium
 - Exercise & physical activity (physical therapy referrals)
 - Sleep
 - Stress management (therapist, counselor referrals)
 - Nonpharmacologic therapies (yoga, acupuncture, relaxation therapies with deep breathing exercises)
 - Medications as needed to treat symptoms (e.g., pain, POTS)

Biopsychosocial framework



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Treatment approach




Clinical Guidance | Free Access
Multi-disciplinary collaborative consensus guidance statement on the assessment and treatment of postacute sequelae of SARS-CoV-2 infection (PASC) in children and adolescents

Laura A. Malone MD, PhD, Amanda Morrow MD, Yui Chen MD, Dorina Curtis MD, MPH, Sarah D. de Rosier MD, MPH, Monica Casati MD, Taha K. Chertoff MD, Theresa M. Cogio MD, ESHA Tenor A. Hall PsyD, JAPRN, Ellen Henning PhD, Shetal Jethava MD, Arika M. Johnson MD, Dana Klein C. Kumbhani MD, Christina Karamela MD, Catherine Luthers MD, Lisa Li MD, Henry C. Liu MD, Tran Locke MD, Carol MacArthur MD, Michele Mann MD, Shantel A. McCaffrey MD, Rosanna Ng PhD, Lucian Orsini MD, Sarah Ryan MD, S. Christy Sarrafman MD, MPH, Sarah Sampson MPH, S. Kristen Seaton Tisdell MD, PhD, MPH, Julie K. Silver MD, Treggery Zimmerman MD, Beata Strag DMF, Serahne Swain MD, Scourge Torrey MD, Monica Verdusco Gaudier MD, Cybil Nisde Williams MD, MCh, Lori Allison Zintzenbach M.D., Louise Elaine Yau MD, MPH. — See fewer authors —

First published: 28 September 2022 | <https://doi.org/10.1002/pmj.1289>

Systemic/constitutional (Table 3)	Fatigue (generalized, exertion related) or postprandial malaise Sleep disturbances Fever	Respiratory/ pulmonary (Table 7)	Shortness of breath or dyspnea Chest (thoracic) pain or tightness Cough Difficulty with activity/exercise intolerance
Mental health and psychiatric (Table 8)	Anxiety Depressive/mood Unexplained behavioral symptoms Unexplained by systemic findings School avoidance Regression of academic or social milestones	Cardiology (Table 9)	Palpitations or tachycardia Dizziness/light-headedness Syncope Chest pain Difficulty with activity/exercise intolerance
Autonomic dysfunction (Table 9)	Dizziness/light-headedness Orthostatic intolerance Headache Nausea	Ophthalmology (Table 6)	Abnormal (or no) smell or taste
Neurological (Table 6)	Headache Syncope or presyncope Tremulousness Paresthesias or numbness Dizziness and vertigo Difficulty with attention/concentration Difficulty with memory Cognitive fatigue or "brain fog"	Musculoskeletal (Table 10) Neurology (Table 11) Gastrointestinal (Table 11)	Weakness Muscle sore or joint pain Nausea/vomiting/reflux Abdominal pain Bowel irregularities (constipation/diarrhea) Weight loss Lack of appetite




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Fatigue

- Characterization/patterns and screening for ****Crashes****
- Evaluate sleep
- Rule out other medical causes of fatigue

Post-exertional malaise (PEM)

Worsening of symptoms after minor physical, cognitive, or emotional exertion




Curren@kriegerinstitute.org (2022) 10(1)-44
https://doi.org/10.1007/s10824-022-00261-4

ADOLESCENT MEDICINE (MA GOLDSTEIN, SECTION EDITOR)

Long-Term COVID 19 Sequelae in Adolescents: the Overlap with Orthostatic Intolerance and ME/CFS


Amanda K. Morrison^{1,2}, Laura A. Malton^{1,3,4}, Christina Kokorek^{1,5}, Lindsay S. Petracca⁶, Ella F. Extein⁷, Katie L. Lubiner⁸, Laine Neuwander⁹, Peter C. Rowland¹⁰





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Fatigue Treatment Strategies

- Optimize physical activity through **PACING**
 - Energy conservation/energy bucket
 - Gradual increase in exercise as tolerated
 - AVOID PEM or post-exertional symptom exacerbation
- Support mental health
 - Validate symptoms
 - It's **NOT** "all in your head"
 - CBT may help with comorbid mood concerns, coping with physical symptoms, structuring routine, prioritizing activities







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Dizziness/Lightheadedness

Orthostatic

- With standing
- Worse with standing in line, hot environments
- Improves with sitting or lying down

↓


Screen for OI and POTS

Vestibular

- With standing
- Worse with positional head changes
- Gait/balance difficulties
- Tinnitus or hearing loss

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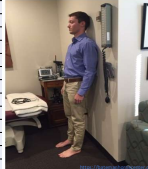

Hearing/vestibular evaluation and vestibular PT



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Standing Tolerance Test

SUPINE	Heart rate	Blood Pressure	Dizziness (N/10)	Headache (N/10)	Blurry Vision (N/10)	Fatigue (N/10)	Other
1:00							
2:00							
3:00							
4:00							
5:00							
6:00							
7:00							
8:00							
9:00							
10:00							
11:00							
12:00							
1:00							
2:00							
3:00							
4:00							
5:00							
6:00							
7:00							
8:00							
9:00							
10:00							
11:00							
12:00							

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Standing Tolerance Tests

Orthostatic intolerance: (Sweat 2018)

- Abnormal autonomic response
- Symptoms develop in an upright posture and improve in supine position

Postural orthostatic tachycardia syndrome (POTS):

- Diagnostic criteria <20 years of age (Ruza 2018):
 - Within 10 minutes of standing:
 - Heart rate increase of ≥ 40 beats per minute (bpm) OR
 - An upright heart rate of at least 120 bpm
 - PLUS
 - Worsening of orthostatic symptoms

Morrow, Villatoro, Kokorelis, Rowe & Malone, *Clinical Pediatrics*, In Press

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OI/POTS Management

- Lifestyle Interventions** (Fu 2018, Bryarty 2019):
 - Increase fluid (2-3L) and salt intake (4-8g)
 - Compression garments (30mmHg)
 - Physical countermeasure maneuvers
 - Exercise training
- Medications** (Miller 2018)
 - No FDA approved medications
 - First line considerations
 - Increase blood volume (fludrocortisone)
 - Increase vasoconstriction (midodrine)
 - Decrease HR (beta blockers)

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Cognitive difficulties

- "Brain fog":
 - Concentration difficulties
 - Memory problems
 - Attention issues
 - Declining school performance
- Semi-flexible brief neuropsychological screening protocol was administered

Cognitive Constructs	3-4 years	5-7 years	8-15 years	16-17 years	18+ years
Verbal Skills	DAS-II Naming Vocabulary	DAS-II Reading Vocabulary (10-16 years) or WASI-II Vocabulary (9 years)	WASI-II Vocabulary		
Nonverbal Reasoning	DAS-II Matrices	DAS-II Matrices II (16-17 years) or WASI-II Matrix Reasoning (9 years)	WASI-II Matrix Reasoning		
Working Memory	DAS-II Digit Forward	WISC-IV Digit Span	WISC-IV Digit Span		
Attention	---	TEA-III Score (6 years)	TEA-III Score and Score DT	CAMS Sequences (16 years) STA (17 years)	TEA Executive Counting and Errorless Counting with Distractions
Processing Speed	---	NEPSY-II Inhibition-Sorting	---	Dual-DSMT	---
Executive Function	---	NEPSY-II Inhibition and Switching	---	DKEFS Verbal Fluency	---
Verbal Memory	---	---	---	---	CWLS-3
Performance Validity Indicator	---	---	---	---	---
Questionnaires (Caregiver-Report)	3-4 years	5-7 years	8-15 years	16-17 years	18+ years
Psychosocial and Behavior	Conners Early Childhood (3.5 years)	Conners Early Childhood (5 years)	---	CBRS	BASC-3, CAMRS
Executive Functioning	---	---	---	---	BRF
Behavioral Screeners	---	ADHD-RS (5-15 years), VBRS (5-15 years), CBRS (5-15 years), K-CATS - Anxiety, Depression, OCD subscales (9 years)	---	---	---
Questionnaires (Self-Report)	3-4 years	5-7 years	8-15 years	16-17 years	18+ years
Anxiety	---	---	RCMAS-2 (8 to 7 years), MASC-2 (8+ years)	---	BAI
Depression	---	---	---	---	BDI-2

Ng, Vargas, Jashar, Morrow & Malone, *Arch Clin Neuropsychol*, 2022

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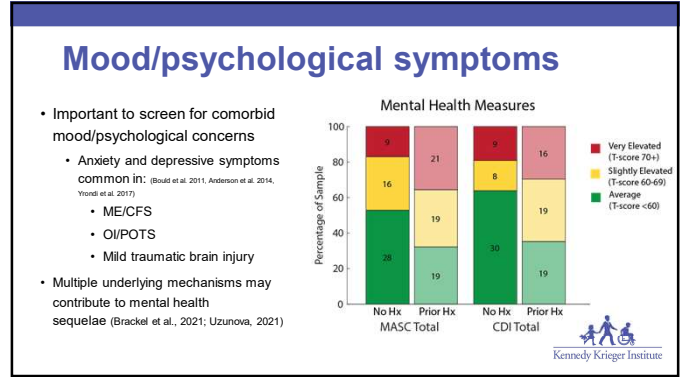
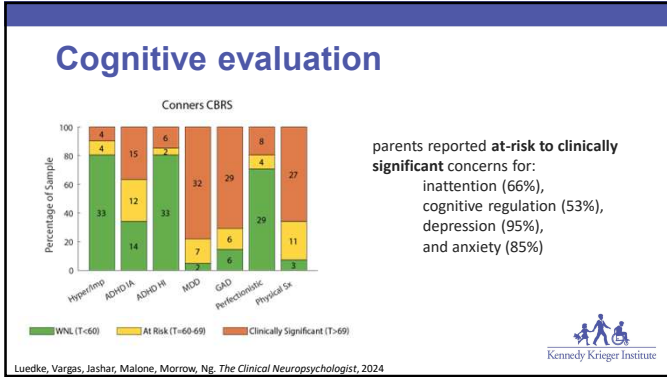
Cognitive evaluation

Neuropsychological Test Results

Many children will score in average range, but still be symptomatic in daily life.

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How does school factor into the treatment of pediatric long COVID?

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Chronic illnesses with school absenteeism have long term impacts

- Worse academic performance and/or long-term education attainment occurs in children with chronic medical conditions
 - Absenteeism alone partially explains poorer academic attainment
 - Absenteeism in early education can have educational and socioeconomic effects in adulthood

3 months = 1/3 of a school year

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School & Activity Accommodations

Important to have a meeting with school to discuss accommodations & obtain collateral from multiple sources (e.g., 504, individualized education program [IEP], individualized health plan)

Possible Interventions

- Prioritizing academic demands & excuse/limit nonessential classwork/homework
- Increased time for exams or assignments (i.e., x1.5, x2.0) & rest breaks during instruction
- Copies of teacher notes prior to start of class/note taker in class
- Adjusted school days (i.e., shortened/alternative)
- Adapted PE or reduced demands during physical activity
- Allow access to water/salty snacks

Pacing both with physical and cognitive activity!

Make lifestyle interventions accessible at school

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What causes long COVID?

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Possible Long COVID Mechanisms

[Peluso and Deeks. Early clues regarding the pathogenesis of long-COVID: Trends in Immunology \(cell.com\) 2022](https://doi.org/10.1016/j.imm.2022.05.002)

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Conclusions

- Most children recover completely with SARS-CoV-2 infection, but some children will develop long COVID.
- Pediatric long COVID can affect the physical, mental, and social well-being of children's lives. Early recognition is key!
- Many children improve over time but need treatment and support throughout recovery.
- Schools can help identify children struggling.
- School accommodations may be necessary for some children.
- The mechanism underlying long COVID is still being researched but it is likely multifactorial.

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Project ECHO[®] Kennedy Krieger Institute
Pediatric Long COVID ECHO

Project ECHO: Kennedy Krieger Institute offers an educational opportunity for providers through

- A teleworking model that links specialist teams with community providers for clinical case discussion and brief didactic presentations
- Air all levels, all team environment
- Sharing best practices, providing feedback on real patient cases, and expanding community

Goal: To expand the workforce capacity and increase knowledge of best practices and evidence-based care for healthcare professionals treating children and adolescents with persistent COVID-19 symptoms.

Learning Objectives
 After attending this activity, the learner will demonstrate the ability to:

1. Recognize the prevalence and presentations of long COVID in children and adolescents.
2. Utilize evidence-based practices in the management of pediatric long COVID.
3. Identify resources to address physical, social, and mental health concerns in children and adolescents with long COVID.

Meeting time: Fall 2024 (dates TBD)
Venue: Zoom live videoconference


Target audience: Primary care providers (MD, DO, PA, NP), school nurses, school educators, physical therapists, occupational therapists, and mental health providers (psychologists, social workers)

Kennedy Krieger ECHO Pediatric Long COVID website:
<https://www.kennedykrieger.org/training/programs/project-echo/current-echo-series/pediatric-long-covid-echo>



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Pediatric Long COVID Research Study



We would like to learn more about school navigation experiences for children with long COVID. We are interested in talking to educational professionals.

If chosen to be in the study, you will be paid \$50 for participating in a virtual interview or focus group, lasting between 45 to 90 minutes.

If interested, please contact our research assistant at villatoroc@kennedykrieger.org.



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Acknowledgements

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