



Post-Acute COVID-19 Syndrome in the Pediatric Population And Strategies for the Next Phase

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Conflict of Interest

X	No, Nothing to disclose
	Yes, please specify

Long Covid (PASC) in adults

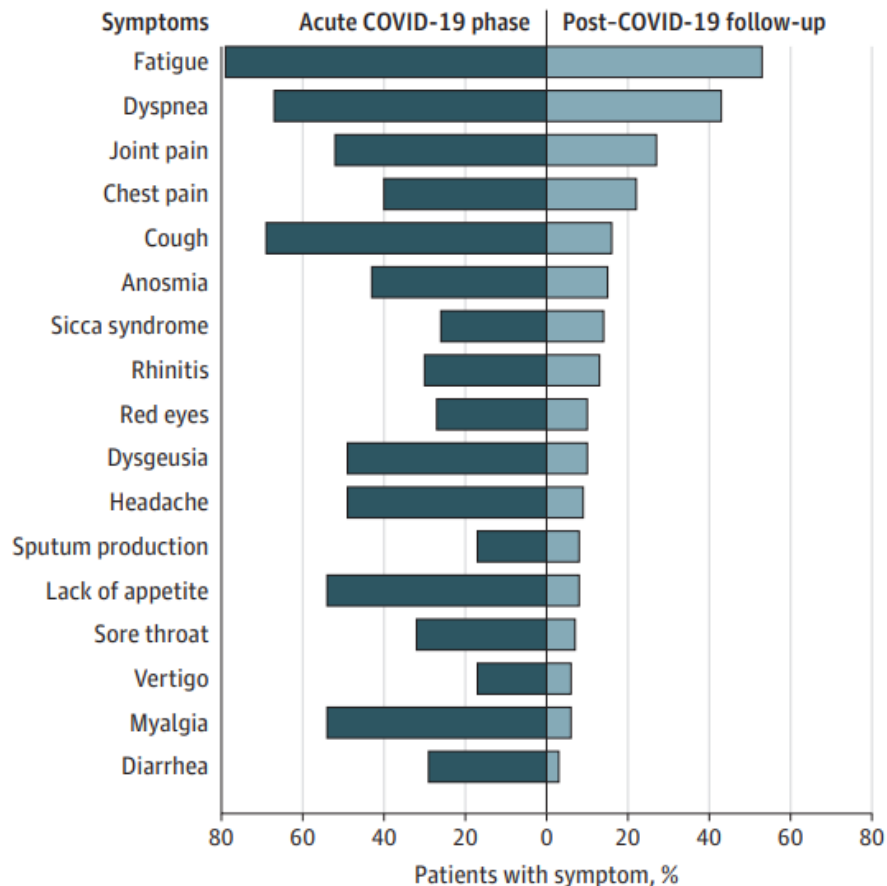
Research Letter

July 9, 2020

Persistent Symptoms in Patients After Acute COVID-19

Angelo Carfi, MD¹; Roberto Bernabei, MD¹; Francesco Landi, MD, PhD¹; [et al](#)

Figure. COVID-19–Related Symptoms



Short communication

How and why patients made Long Covid

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PATIENTS' REPORTED SYMPTOMS



CHANGE IN COVID PRACTICE



PATIENTS' MOVEMENTS



LONG COVID in adults
Recognized by WHO



COVID-19 Health and Wellbeing **Initial** Follow Up Survey for Children
PARENT REPORT FOR CHILDREN AND YOUNG PEOPLE
(less than 18 years of age)

The question on our minds

This is for people like you, whose child or children have had Covid-19. We would like your help to answer a question that is on our minds and may be on yours: "What does Covid-19 mean for the long-term health and well-being of your child?"

How you can help

This is a new illness. Being included in this survey means you can help us build a better understanding of the acute and long term care and support needed for Covid-19 for children globally. As far as possible, we do not want to leave anyone out. Our aim is that every child with Covid-19 has a chance to take part, whether they have been treated in hospital or at home. We do not know how long symptoms in children will last, so, to find out, we would like to repeat this survey asking you about your child's health in three to six months' time after the first symptoms appearance.



CODICE IDENTIFICATIVO DEL PARTECIPANTE: [][][][][]-[][][][][]

1. Informazioni su di lei e sulla sua malattia da COVID-19 (se sta completando il sondaggio per conto di un bambino o di un adulto che lei assiste, tutte le domande riguarderanno la salute e il benessere dell'interessato/a)

Data di completamento del sondaggio (GG/MM/AAAA): [G][G][M][M][2][0][A][A]

Qual è la sua data di nascita (GG/MM/AAAA): [G][G][M][M][2][0][A][A]

Negli ultimi 6 mesi, si è vaccinato/a contro l'influenza? ☐ Sì ☐ No ☐ Non sono sicuro/a

Negli ultimi 5 anni, si è vaccinato/a contro lo pneumococco? ☐ Sì ☐ No ☐ Non sono sicuro/a

Approssimativamente, quando ha sperimentato i primi sintomi del COVID-19? [G][G][M][M][2][0][A][A]

È stato/a ricoverato/a in ospedale a causa del COVID-19? ☐ Sì ☐ No

• Approssimativamente, quando è stato/a ricoverato/a per la prima volta in ospedale? [G][G][M][M][2][0][A][A]

• Approssimativamente, quando è stato/a dimesso/a per la prima volta dall'ospedale? [G][G][M][M][2][0][A][A]

• È stato/a nuovamente ricoverato/a in ospedale o in una struttura sanitaria dopo la malattia da Covid-19? ☐ Sì ☐ No

In caso affermativo, quante volte? [Numero_] In caso affermativo, specifichi la ragione: _____

Nome dell'ospedale/degli ospedali: _____

Se è mai stato/a ricoverato/a in ospedale/in una struttura sanitaria per Covid-19, è stato/a ricoverato/a in terapia intensiva (ICU/ITU)? ☐ Sì ☐ No ☐ Non sono sicuro/a

2. Informazioni sul suo stato di salute ora

Sente di essersi completamente ripreso/a dal COVID-19?

☐ Fortemente in disaccordo ☐ In disaccordo ☐ Leggermente in disaccordo ☐ Leggermente d'accordo
☐ D'accordo ☐ Pienamente d'accordo

Preliminary Evidence on Long COVID in children

Danilo Buonsenso, MD^{a,b,c}; Daniel Munblit, MD, PhD^{d,e,f}; Cristina De Rose, MD^a, Dario Sinatti, MD^a, Antonia Ricchiuto, MD^a, Angelo Carfi, MD^g; Piero Valentini^{a,c}

Characteristics	Value
age	11.0 (4.4)
sex: F	62 (48.1%)
ethnicity	
white	115 (89.1%)
black	4 (3.1%)
Latino/Hispanic	9 (7%)
Arab	1 (0.8%)
Comorbidities	
Neurological	13 (10.1%)
Heart diseases	1 (0.8%)
Asthma	5 (3.9%)
Allergic rhinitis	4 (3.1%)
Skin problems	6 (4.7%)
Gut problems	1 (0.8%)
Hematology	0 (0%)
Oncology	1 (0.8%)
Immune system diseases	1 (0.8%)
Genetic conditions	1 (0.8%)
Diabetes	0 (0%)
Kidney problems	0 (0%)
Excessive weight obesity	3 (2.3%)
Rheumatology	1 (0.8%)
Symptomatic	96 (74.4%)
Hospitalized	6 (4.7%)
Admitted to PICU	3 (2.3%)
Diagnosed with any of the following conditions AFTER acute COVID-19	
MIS-C	3 (2.3%)
Pulmonary embolism	0 (0%)
Myocarditis	2 (1.6%)
Asthma	3 (2.3%)
Coagulopathy	0 (0%)
Kidney problems	0 (0%)
Type I Diabetes	0 (0%)
Distance from diagnosis of acute COVID-19 (days)	162.5 (113.7)
< 60 days	31 (24%)
60-119 days	30 (23.3%)
120 or more days	68 (52.7%)
Persistent symptoms	
None	54 (41.9%)
1 or 2	46 (35.7%)
3 or more	29 (22.5%)
Days at follow-up	
QoL Before COVID-19	96.3 (5.3)
QoL at time of survey	92.9 (9.1)

	All	According to Symptoms			According to Hospitalization			According to days from COVID-19 diagnosis		
Persisting symptoms	N 129	Asymptomatic N 33	Symptomatic N 96	P value	Not Hospitalized N 123	Hospitalized N 6	P Value	< 60 N 31	60-119 N 30	>120 N 68
Fatigue (compared to before Covid-19 diagnosis)				0.453			0.36			
Less	1 (0.8%)	0 (0%)	1 (1%)		1 (0.8%)	0 (0%)		0 (0%)	1 (3.3%)	0 (0%)
A bit less	16 (12.4%)	2 (6.1%)	14 (14.6%)		16 (13%)	0 (0%)		6 (19.4%)	4 (13.3%)	6 (8.8%)
Same	98 (75.9%)	29 (87.9%)	69 (71.9%)		94 (76.4%)	4 (66.7%)		24 (77.4%)	21 (70%)	53 (77.9%)
A bit more	13 (10.1%)	2 (6.1%)	11 (11.5%)		11 (8.9%)	2 (33.3%)		1 (3.2%)	4 (13.3%)	8 (11.8%)
More	1 (0.8%)	0 (0%)	1 (1%)		1 (0.8%)	0 (0%)		0 (0%)	0 (0%)	1 (1.5%)
Nasal congestion/rhinorrhea	16 (12.4%)	1 (3%)	15 (15.6%)	0.112	15 (12.2%)	1 (16.7%)	1	5 (16.1%)	2 (6.7%)	9 (13.2%)
Chest tightness	8 (6.2%)	0 (0%)	8 (8.3%)	0.196	8 (6.5%)	0 (0%)	na	5 (16.1%)	2 (6.7%)	1 (1.5%)
Chest pain	4 (3.1%)	1 (3%)	3 (3.1%)	1	4 (3.3%)	0 (0%)	na	2 (6.5%)	1 (3.3%)	1 (1.5%)
Persistent cough	7 (5.4%)	1 (3%)	6 (6.2%)	0.796	6 (4.9%)	1 (16.7%)	0.761	2 (6.5%)	1 (3.3%)	4 (5.9%)
Persistent muscle pain	13 (10.1%)	1 (3%)	12 (12.5%)	0.221	13 (10.6%)	0 (0%)	0.919	5 (16.1%)	2 (6.7%)	6 (8.8%)
Joint pain or swelling	9 (6.9%)	1 (3%)	8 (8.3%)	0.525	8 (6.5%)	1 (16.7%)	0.838	4 (12.9%)	2 (6.7%)	3 (4.4%)
Headache	13 (10.1%)	1 (3%)	12 (12.5%)	0.221	13 (10.6%)	0 (0%)	0.87	1 (3.2%)	7 (23.3%)	5 (7.4%)
Altered smell	6 (4.6%)	0 (0%)	6 (6.2%)	0.321	6 (4.9%)	0 (0%)	na	1 (3.2%)	1 (3.3%)	4 (5.9%)

	All	According to Symptoms			According to Hospitalization			According to days from COVID-19 diagnosis		
Persisting symptoms	N 129 (3.1%)	Asymptomatic N 33	Symptomatic N 96	P value	Not Hospitalized N 123	Hospitalized N 6	P Value	< 60 N 31 (3.2%)	60-119 N 30 (3.2%)	>120 N 68 (3.2%)
Lack of concentration	13 (10.1%)	1 (3%)	12 (12.5%)	0.221	13 (10.6%)	0 (0%)	na	2 (6.5%)	3 (10%)	8 (11.8%)
Insomnia	24 (18.6%)	2 (6.1%)	22 (22.9%)	0.059	23 (18.7%)	1 (16.7%)	1	6 (19.4%)	7 (23.3%)	11 (16.2%)
Hypersomnia	4 (3.1%)	2 (6.1%)	2 (2.1%)	0.579	4 (3.3%)	0 (0%)	1	1 (3.2%)	0 (0%)	3 (4.4%)
Weight loss	10 (7.7%)	2 (6.1%)	8 (8.3%)	0.965	9 (7.3%)	1 (16.7%)	0.971	2 (6.5%)	5 (16.7%)	3 (4.4%)
Diarrhea	2 (1.5%)	0 (0%)	2 (2.1%)	0.985	2 (1.6%)	1 (16.7%)	0.971	3 (9.7%)	2 (6.7%)	5 (7.4%)
Stomach/abdominal pain	3 (2.3%)	0 (0%)	3 (3.1%)	0.72	3 (2.4%)	0 (0%)	na	1 (3.2%)	1 (3.3%)	0 (0%)
Constipation	8 (6.2%)	1 (3%)	7 (7.3%)	0.647	7 (5.7%)	0 (0%)	na	1 (3.2%)	0 (0%)	2 (2.9%)
Skin rashes	9 (6.9%)	3 (9.1%)	6 (6.2%)	0.876	9 (7.3%)	1 (16.7%)	0.838	1 (3.2%)	2 (6.7%)	5 (7.4%)
Palpitations	5 (3.8%)	1 (3%)	4 (4.2%)	1	5 (4.1%)	0 (0%)	na	2 (6.5%)	3 (10%)	4 (5.9%)
Menstruation	2 (1.5%)	0 (0%)	2 (2.1%)	0.985	2 (1.6%)	0 (0%)	na	2 (6.5%)	2 (6.7%)	1 (1.5%)
other: yes	3 (2.3%)	1 (3%)	2 (2.1%)	1	3 (2.4%)	0 (0%)	na	1 (3.2%)	1 (3.3%)	0 (0%)
Any persisting symptoms				0.009			0.041			
None	54 (41.9%)	21 (63.6%)	33 (34.4%)		53 (43.1%)	1 (16.7%)		11 (35.5%)	10 (33.3%)	33(48.5%)
1-2	46 (35.6%)	9 (27.3%)	37 (38.5%)		41 (33.3%)	5 (83.3%)		12 (38.7%)	13 (43.3%)	21 (30.9%)
3 or more	29 (22.5%)	3 (9.1%)	26 (27.1%)		29 (23.6%)	0 (0%)		8 (25.8%)	7 (23.3%)	14 (20.6%)

	All	According to Symptoms			According to Hospitalization			According to days from COVID-19 diagnosis		
Persisting symptoms	N 129	Asymptomatic N 33	Symptomatic N 96	P value	Not Hospitalized N 123	Hospitalized N 6	P Value	< 60 N 31	60-119 N 30	>120 N 68
Do symptoms distress the child?				0.595			0.52	0 (0%)	0 (0%)	3 (4.4%)
Not at all	66 (51.1%)	15 (45.5%)	51 (53.1%)		64 (52%)	2 (33.3%)		19 (61.3%)	15 (50%)	32 (47.1%)
Only a little	36 (27.9%)	12 (36.4%)	24 (25%)		36 (10.6%)	0 (0%)		8 (25.8%)	5 (16.7%)	23 (33.8%)
Quite a lot	14 (10.8%)	4 (12.1%)	10 (10.4%)		13 (10.6%)	1 (16.7%)		3 (9.7%)	6 (20%)	5 (7.4%)
A great deal	2 (1.5%)	1 (3%)	1 (1%)		2 (1.6%)	0 (0%)		0 (0%)	1 (3.3%)	1 (1.5%)
Prefer not to say	11 (8.5%)	1 (3%)	10 (10.4%)		8 (6.5%)	3 (50%)		1 (3.2%)	3 (10%)	7 (10.3%)

Clinical characteristics, activity levels and mental health problems in children with Long COVID: a survey of 510 children

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Sammie Mcfarland, Founder of Long COVID Kids, UK

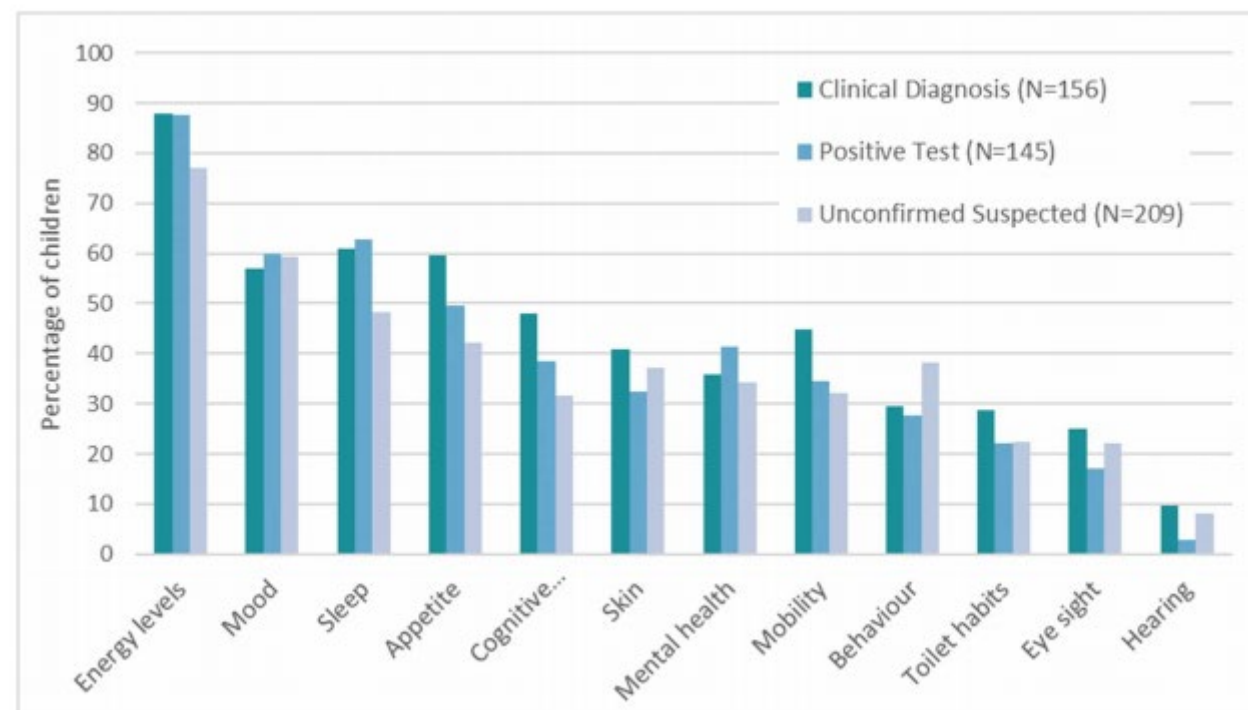
Frances K Simpson, MSc, Coventry University Group and Long COVID Kids, UK

[illegible]

Symptom	All N=510	Had Pre- conditions N=287	No Pre- conditions N=223	Female N=287	Male N=222	Age less than 10 yrs N=196	Age 10 yrs or older N=314	1-2 months N=82	3- 6 months N=108	7+ months N=320
Muscle aches and pains	349 (68.4%)	204 (71.1%)	145 (65%)	201 (70%)	147 (66.2%)	111 (56.6%)	238 (75.8%)	60 (73.2%)	70 (64.8%)	219 (68.4%)
Muscle and joint pain	309 (60.6%)	179 (62.4%)	130 (58.3%)	180 (62.7%)	129 (58.1%)	102 (52%)	207 (65.9%)	51 (62.2%)	69 (63.9%)	189 (59.1%)
Neurological										
Headache	401 (78.6%)	239 (83.3%)	162 (72.6%)	231 (80.5%)	169 (76.1%)	138 (70.4%)	263 (83.8%)	63 (76.8%)	86 (79.6%)	252 (78.8%)
Unexplained irritability	262 (51.4%)	149 (51.9%)	113 (50.7%)	150 (52.3%)	112 (50.5%)	117 (59.7%)	145 (46.2%)	41 (50%)	56 (51.9%)	165 (51.6%)
Dizziness	245 (48%)	148 (51.6%)	97 (43.5%)	150 (52.3%)	94 (42.3%)	60 (30.6%)	185 (58.9%)	39 (47.6%)	55 (50.9%)	151 (47.2%)
Twitches	55 (10.8%)	34 (11.8%)	21 (9.4%)	35 (12.2%)	20 (9%)	16 (8.2%)	39 (12.4%)	9 (11%)	10 (9.3%)	36 (11.2%)
Word repetition	52 (10.2%)	25 (8.7%)	27 (12.1%)	29 (10.1%)	22 (9.9%)	21 (10.7%)	31 (9.9%)	7 (8.5%)	14 (13%)	31 (9.7%)
Tics	47 (9.2%)	25 (8.7%)	22 (9.9%)	26 (9.1%)	21 (9.5%)	18 (9.2%)	29 (9.2%)	5 (6.1%)	8 (7.4%)	34 (10.6%)
Stuttering	40 (7.8%)	17 (5.9%)	23 (10.3%)	23 (8%)	17 (7.7%)	15 (7.7%)	25 (8%)	4 (4.9%)	7 (6.5%)	29 (9.1%)
Swearing	26 (5.1%)	15 (5.2%)	11 (4.9%)	9 (3.1%)	17 (7.7%)	10 (5.1%)	16 (5.1%)	2 (2.4%)	5 (4.6%)	19 (5.9%)
Growling	24 (4.7%)	12 (4.2%)	12 (5.4%)	11 (3.8%)	12 (5.4%)	15 (7.7%)	9 (2.9%)	5 (6.1%)	4 (3.7%)	15 (4.7%)
General										
Tiredness and weakness	444 (87.1%)	249 (86.8%)	195 (87.4%)	248 (86.4%)	195 (87.8%)	168 (85.7%)	276 (87.9%)	70 (85.4%)	98 (90.7%)	276 (86.2%)
Fatigue	410 (80.4%)	235 (81.9%)	175 (78.5%)	236 (82.2%)	173 (77.9%)	142 (72.4%)	268 (85.4%)	64 (78%)	93 (86.1%)	253 (79.1%)
Post-exertional malaise	274 (53.7%)	161 (56.1%)	113 (50.7%)	158 (55.1%)	116 (52.3%)	95 (48.5%)	179 (57%)	44 (53.7%)	57 (52.8%)	173 (54.1%)
Fever	151 (29.6%)	81 (28.2%)	70 (31.4%)	94 (32.8%)	56 (25.2%)	68 (34.7%)	83 (26.4%)	22 (26.8%)	29 (26.9%)	100 (31.2%)
Flu-like symptoms	121 (23.7%)	69 (24%)	52 (23.3%)	78 (27.2%)	42 (18.9%)	47 (24%)	74 (23.6%)	20 (24.4%)	20 (18.5%)	81 (25.3%)
Other										
Sepsis	7 (1.4%)	5 (1.7%)	2 (0.9%)	4 (1.4%)	3 (1.4%)	3 (1.5%)	4 (1.3%)	0 (0%)	1 (0.9%)	6 (1.9%)
Appendicitis	7 (1.4%)	6 (2.1%)	1 (0.4%)	5 (1.7%)	2 (0.9%)	4 (2%)	3 (1%)	0 (0%)	0 (0%)	7 (2.2%)
Peritonitis	1 (0.2%)	0 (0%)	1 (0.4%)	0 (0%)	1 (0.5%)	0 (0%)	1 (0.3%)	0 (0%)	0 (0%)	1 (0.3%)

Table 3. Children experience of COVID-19 by confirmation status of COVID-19 infection, and by the pre-existence of comorbidity conditions

	All N=510	Clinical Diagnosis N=156	Positive Test N=145	Unconfirmed but suspected N=209	Had Pre- Conditions N=287	No Pre- Conditions N=223
Constant COVID-19	129 (25.3%)	45 (28.8%)	50 (34.5%)	34 (16.3%)	76 (26.5%)	53 (23.8%)
Alternance recovery/symptoms	252 (49.4%)	78 (50%)	66 (45.5%)	108 (51.7%)	144 (50.2%)	108 (48.4%)
Long wellness followed by symptoms	97 (19%)	21 (13.5%)	24 (16.6%)	52 (24.9%)	46 (16%)	51 (22.9%)
Undetermined	32 (6.3%)	12 (7.7%)	5 (3.4%)	15 (7.2%)	21 (7.3%)	11 (4.9%)



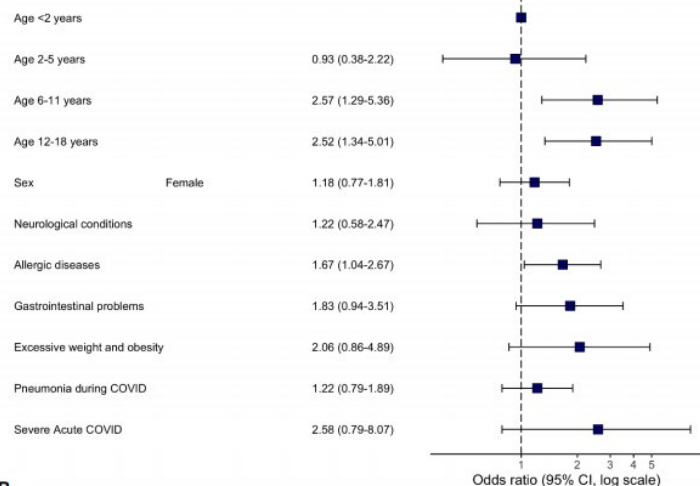


Early View

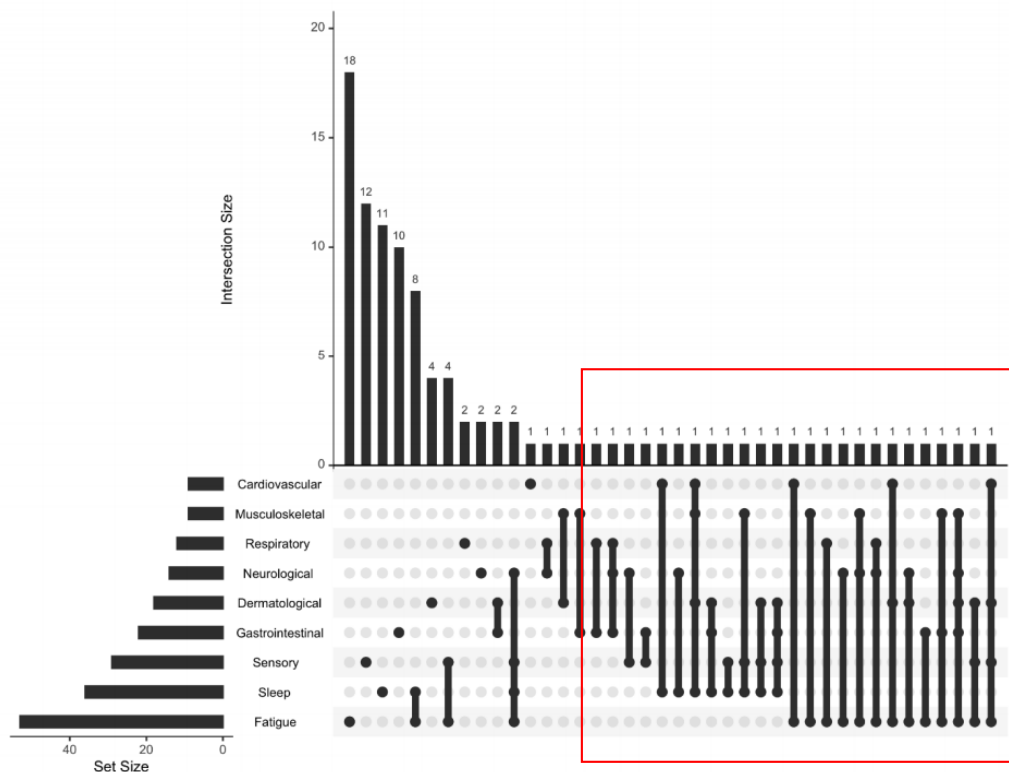
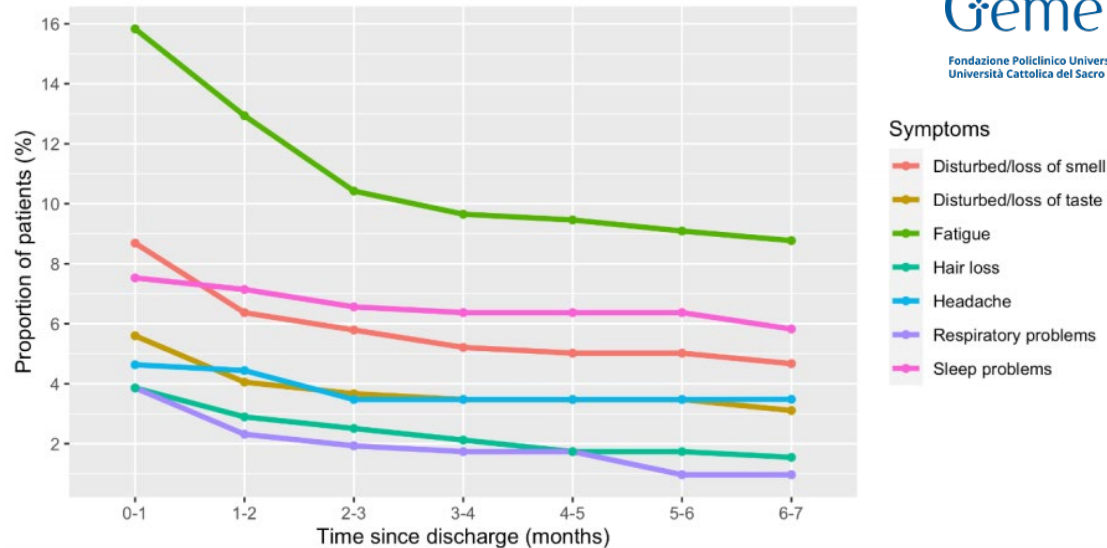
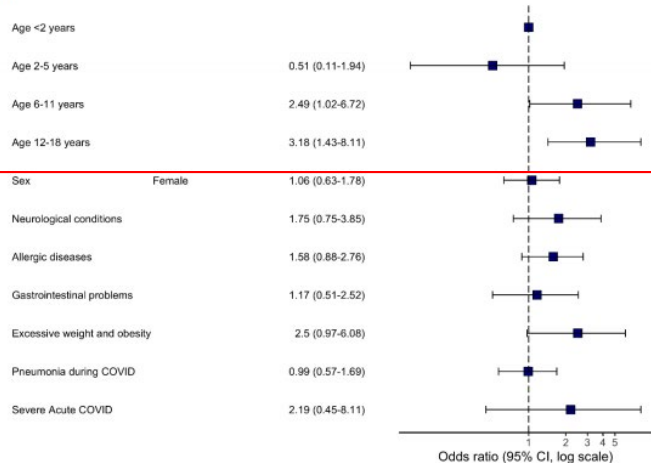
Original research article

Risk factors for long covid in previously hospitalised children using the ISARIC Global follow-up protocol: A prospective cohort study

A



B



Illness duration and symptom profile in symptomatic UK school-aged children tested for SARS-CoV-2

Erika Molteni*, Carole H Sudre*, Liane S Canas, Sunil S Bhopal, Robert C Hughes, Michela Antonelli, Benjamin Murray, Kerstin Kläser, Eric Kerfoot, Liyuan Chen, Jie Deng, Christina Hu, Somesh Selvachandran, Kenneth Read, Joan Capdevila Pujol, Alexander Hammers, Tim D Spector, Sebastien Ourselin, Claire J Steves, Marc Modat, Michael Absoud, Emma L Duncan

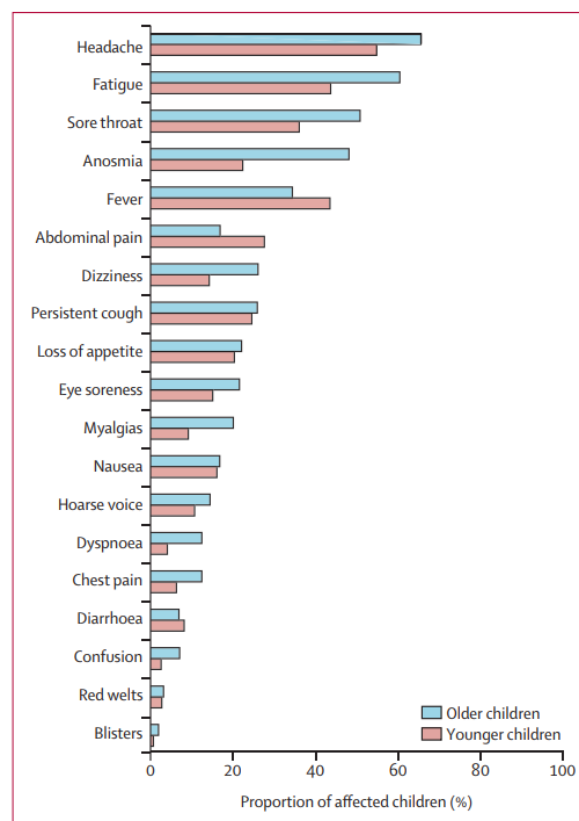


Figure 2: Prevalence of symptoms reported over the course of illness in younger (age 5-11 years, n=588) and older (age 12-17 years, n=1146) children testing positive for SARS-CoV-2
Data refers to children with symptom onset between Sept 1, 2020,

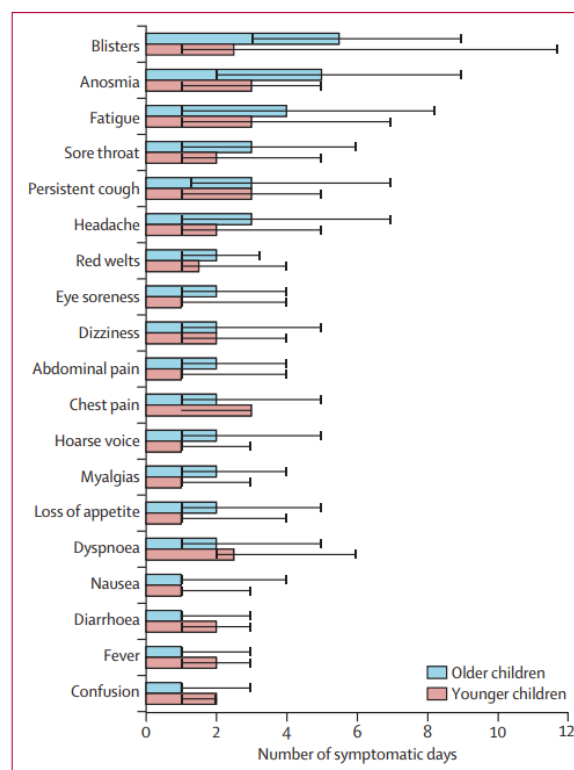


Figure 3: Median duration of each symptom and IQR in younger (age 5-11 years) and older (age 12-17 years) children
Data refers to children with symptom onset between Sept 1, 2020, and Jan 24, 2021. Black bars represent IQRs.

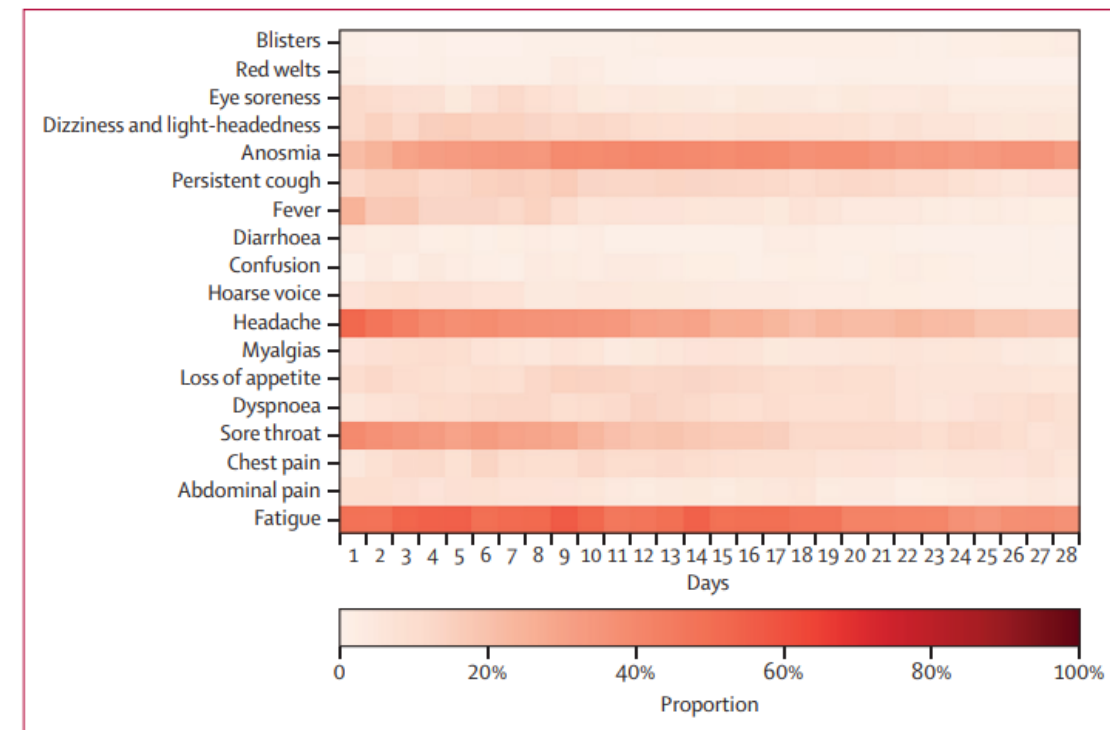


Figure 4: Heat maps showing symptom duration in school-aged children (age 5-17 years) testing positive for SARS-CoV-2 in whom at least one symptom persisted for at least 28 days
n=77. Colour bar provides a percentage comparison. Data refers to children with symptom onset between Sept 1, 2020, and Jan 24, 2021.

RESEARCH LETTER

Long-term Symptoms After SARS-CoV-2 Infection in Children and Adolescents

Children can experience SARS-CoV-2 postviral syndromes, but it is unclear to what extent these individuals are affected by long COVID. Evidence is predominantly limited to select populations without control groups,¹⁻⁴ which does not allow estimating the overall prevalence and burden in a general pediatric population. We compared symptoms compatible with long COVID in children and adolescents (hereafter “children”) reported within 6 months after SARS-CoV-2 serologic testing.



Supplemental content

Methods | Ciao Corona is a longitudinal cohort study investigating SARS-CoV-2 seroprevalence in 55 randomly selected schools in the canton of Zurich in Switzerland,^{5,6} which has a linguistically and ethnically diverse population of 1.5 million residents in urban and rural settings. Schools were selected randomly from the 12 cantonal districts, with number of schools proportional to population size. In Switzerland, children attended schools in person (with protective measures) in 2020-2021, except during a 6-week nationwide lockdown (March 16 to May 10, 2020).

Table. Participant Characteristics, Most Frequently Reported Symptoms After Serologic Testing (October 2020 Through March-April 2021), and Self-rated Health Among Seropositive and Seronegative Children

	No. (%)	
	Seropositive (n = 109)	Seronegative (n = 1246)
Female sex	58 (53)	669 (54)
Age, y		
6-11	66 (61)	703 (56)
12-16	43 (39)	543 (44)
≥1 Symptom lasting >12 wk	4 (4)	28 (2)
Tiredness	3 (3)	10 (1)
Difficulty concentrating	2 (2)	8 (1)
Increased need for sleep	2 (2)	0
Congested or runny nose	1 (1)	3 (<1)
Stomachache	1 (1)	3 (<1)
Chest tightness	1 (1)	0
≥1 Symptom lasting >4 wk	10 (9)	121 (10)
Tiredness	7 (6)	51 (4)
Headache	5 (5)	39 (3)
Congested or runny nose	3 (3)	40 (3)
Stomachache	3 (3)	18 (1)
Sleep disturbances	3 (3)	14 (1)
Cough	2 (2)	15 (1)
Self-rated health ^a		
Excellent	43 (41)	497 (41)
Good	56 (53)	680 (55)
Fair	5 (5)	48 (4)
Poor	2 (2)	2 (<1)

^a The item self-rated health was assessed with the Health Behavior in School-Aged Children-Survey Instrument (eMethods in the Supplement). Self-rated health was not reported for 3 seropositive and 19 seronegative children.



Case report and systematic review suggest that children may experience similar long-term effects to adults after clinical COVID-19

Jonas F. Ludvigsson^{1,2,3,4} 



Long COVID in children and adolescents

Long-lasting manifestations	Mild and tolerable	Moderate	Severe and incapacitating
Weakness	6 (100%)	0	0
Muscle pain	3 (100%)	0	0
Joint pain	3 (100%)	0	0
Fatigue	12 (100%)	0	0
Sleep difficulty	1 (33%)	1 (33%)	1 (33%)
Shortness of breath	5 (71%)	2 (29%)	0
Cough	4 (100%)	0	0
Excess sputum	3 (100%)	0	0
Headache	3 (100%)	0	0
Exercise intolerance	5 (71%)	0	2 (29%)
Walking intolerance	2 (40%)	1 (20%)	2 (40%)

LONG COVID IN CHILDREN

Observations From A Designated Pediatric Clinic

Pulmonary evaluation	
Chest radiograph changes	12 (133)††
Pulmonary function tests	
Abnormal spirometry, FEV1 < 80% or FEV1/FVC < 0.8, n = 60	5 (8.3)
Abnormal exercise challenge test, ‡‡ ΔFEV1 ≥ 12%, n = 51	3 (5.9)
Positive bronchodilator response, ΔFEV1 ≥ 12%, n = 29	15 (51.7)
Air trapping by plethysmography, RV/TLC > 125%, n = 55	15 (27.3)
Diffusion capacity < 70%, n = 50	1 (2.0)§§
Cardiac evaluation	
Abnormal findings on electrocardiograph	2 (2.2)¶¶
Abnormal findings on echocardiography, n = 63	0 (0)
Abnormal holter, n = 4	0 (0)
Abnormal cardiac MRI, n = 3	1 (33.3)
Maximal pulse during exercise stress test <180 b/min, n = 51	34 (66.7)

Clinical features of pediatric post-acute COVID-19: a descriptive retrospective follow-up study

Characteristics	Value
Loss of taste and/or smell	27 (29%)
Stuffy nose	26 (28%)
Sneezing	22 (24%)
Diarrhea	17 (18%)
Myalgia	13 (14%)
Shortness of breath	10 (11%)
Drowsiness	7 (8%)
Decreased appetite	5 (5%)
Conjunctivitis	5 (5%)
Wheezing	5 (5%)
Vomiting	4 (4%)
Sensory disturbances	4 (4%)
Sweatiness	2 (2%)
Epistaxis	2 (2%)
Periorbital edema	1 (1%)
Seizures	1 (1%)

Post-acute COVID-19 follow-up characteristics

Days since symptoms onset, median (interquartile range)	55 (30–104)
Persistent symptoms, No. (%)	
None	45 (49%)
1	18 (19%)
2	9 (10%)
≥ 3	20 (22%)



Pediatric long-COVID: An overlooked phenomenon?

TABLE 1 Results – Patient characteristics, survey

Total number of children	89
The median age of children	13 (IQR: 9–15)
Age range	2–18
Positive PCR tests	47 52.8%
Positive serology tests	31 34.8%
Positive medical histories	34 38.2%
Unknown	8 9.0%
Complaints	
Fatigue	77 87%
Dyspnea	49 55%
Concentration difficulties	40 45%
Headaches	34 38%
Thoracic pain complaints	31 35%
Stomach ache	29 33%
Myalgia	25 28%
Diarrhea	21 24%
Memory loss	12 13%
Cardiac palpitations	16 18%
Skin irritation/lesions	6 7%
Dizziness	3 3%
Brain fog	2 2%
Weight loss	2 2%
Loss of appetite	2 2%
Persistent fever	2 2%
Other ^a	8 9%
Total admitted to the hospital because of long-COVID ^b	16 18%
Limitations in daily functioning	
No limitations	7 8%
Mild limitations in daily functioning ^c	43 48%
Severe limitations in daily functioning ^d	32 36%



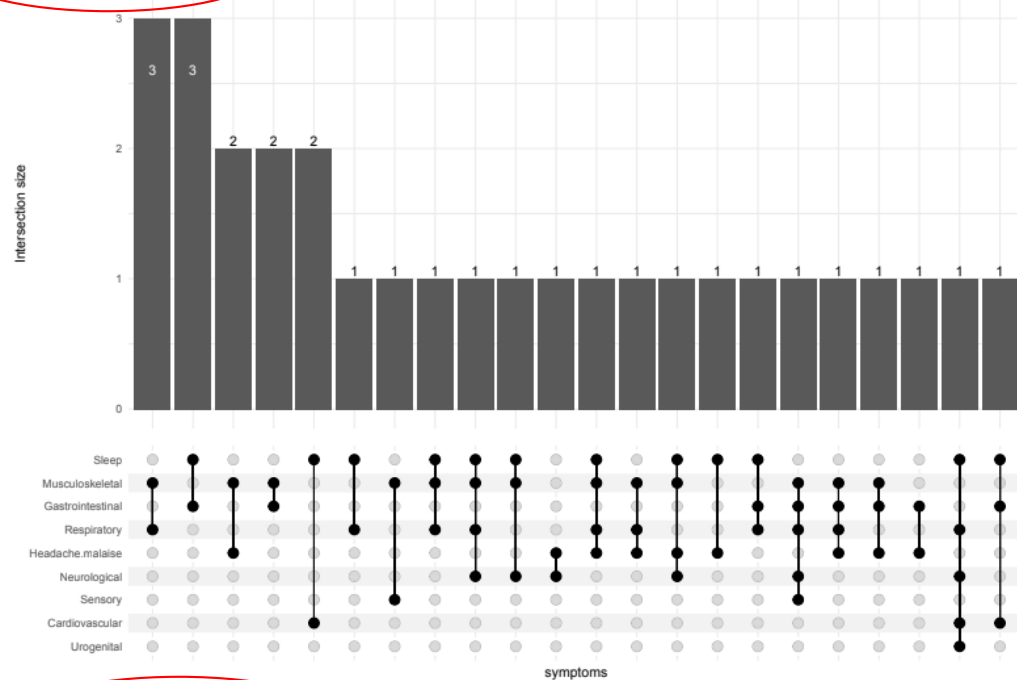
PASC in children and adults from the same households. (submitted)

		Children		Adults	
		Laboratory-confirmed RT-PCR "+" (n=249)	Laboratory-confirmed RT-PCR "-" (n=37)	Laboratory-confirmed RT-PCR "+" (n=172)	Laboratory-confirmed RT-PCR "-" (n=49)
Age (mean, standard deviation)	1-3 months follow-up	10.1 (4.65)	10.5 (4.21)	44.5 (8.26)	42.3 (9.06)
	6-9 months follow-up	10.6 (4.65)		44.6 (10.3)	
Number of participants by follow-up	1-3 months follow-up	179	37	101	20
	6-9 months follow-up	138		100	
Gender (% females)	1-3 months follow-up	48.9%		44.0%	
	6-9 months follow-up	61.5%	52.6%	45.7%	46.3%
Average number of children/adults per household		1.44		1.08	
Of them: infected		87 %		80 %	

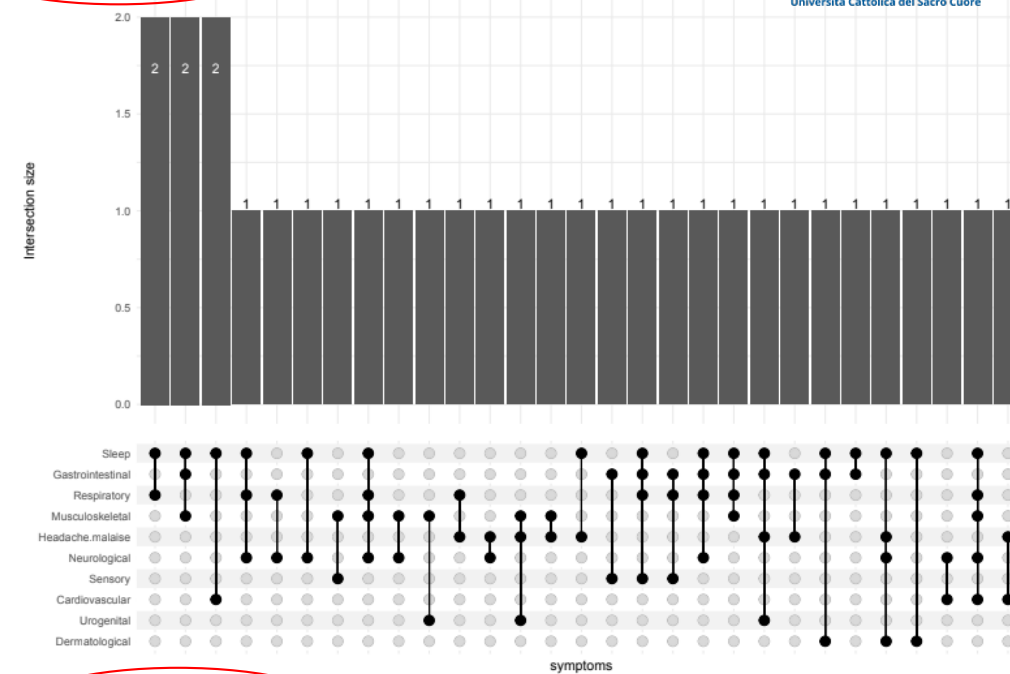
Symptom group	1-3 months follow-up			6-9 months follow-up		
	Sample correlation	Bootstrapped confidence interval	Number of observations	Sample correlation	Bootstrapped confidence interval	Number of observations
Bleeding	0,184	(0,042;0,325)	63	0,325	(0,2; 0,444)	22
Cardiovascular	0,121	(-0,027;0,273)	85	0,201	(0,117;0,314)	79
Dermatological	0,240	(-0,101;0,186)	85	0,172	(0,002;0,318)	79
Gastrointestinal	0,011	(-0,027;0,146)	85	0,159	(0,075;0,226)	79
Headache, malaise	-0,028	(-0,046;-0,014)	63	0,062	(0,084;0,217)	79
Musculoskeletal	-0,035	(-0,017;0,019)	85	-0,038	(-0,075;-0,001)	79
Neurological	0,080	(-0,120;0,040)	85	0,070	(-0,025;0,045)	79
Respiratory	-0,094	(-0,129;-0,058)	85	-	-	22
Sensory	-	-	63	-	-	79
Sleep	-	-	85	-	-	79
Urogenital	-	-	85	-	-	22
Any symptom	0,091	(-0,148;-0,054)	85	0,086	(0,078;0,285)	79

Children's symptoms not affected by adult ones

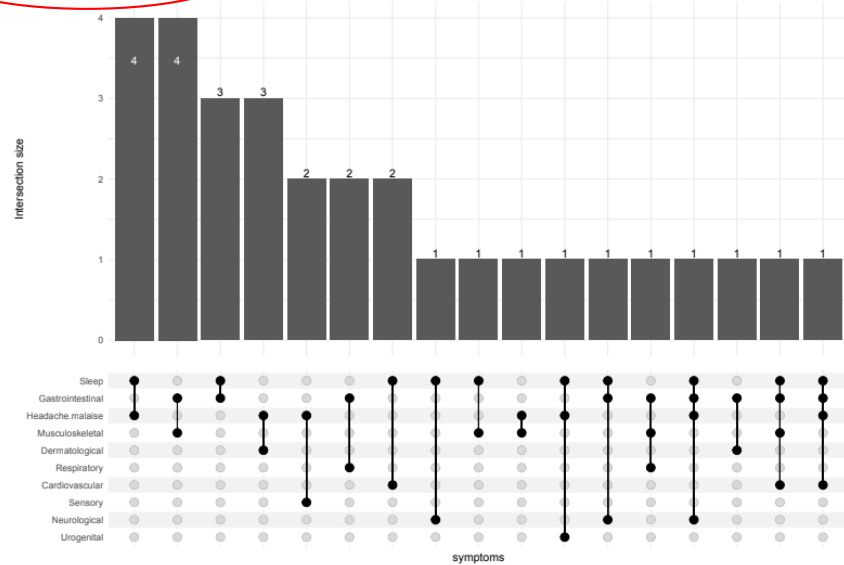
Adults, 1-3 months follow-up



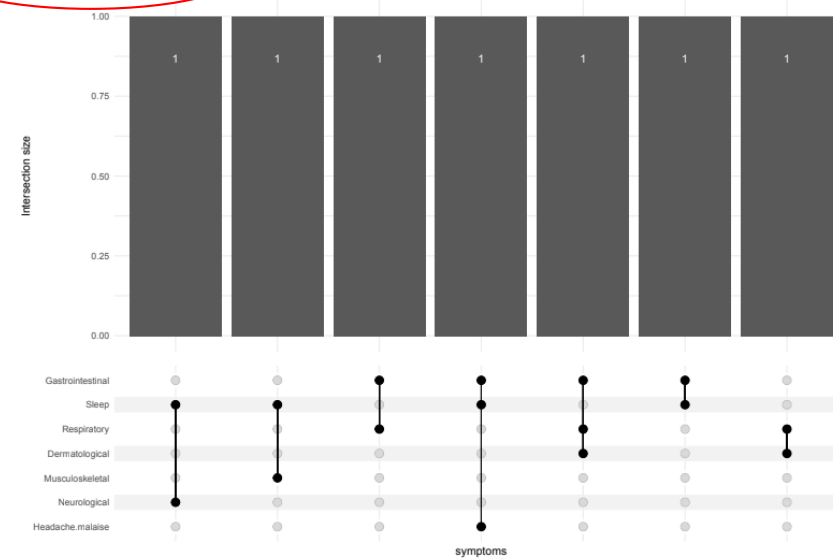
Adults, 6-9 months follow-up



Children, 1-3 months follow-up



Children, 6-9 months follow-up



Evidence of lung perfusion defects and ongoing inflammation in an adolescent with post-acute sequelae of SARS-CoV-2 infection



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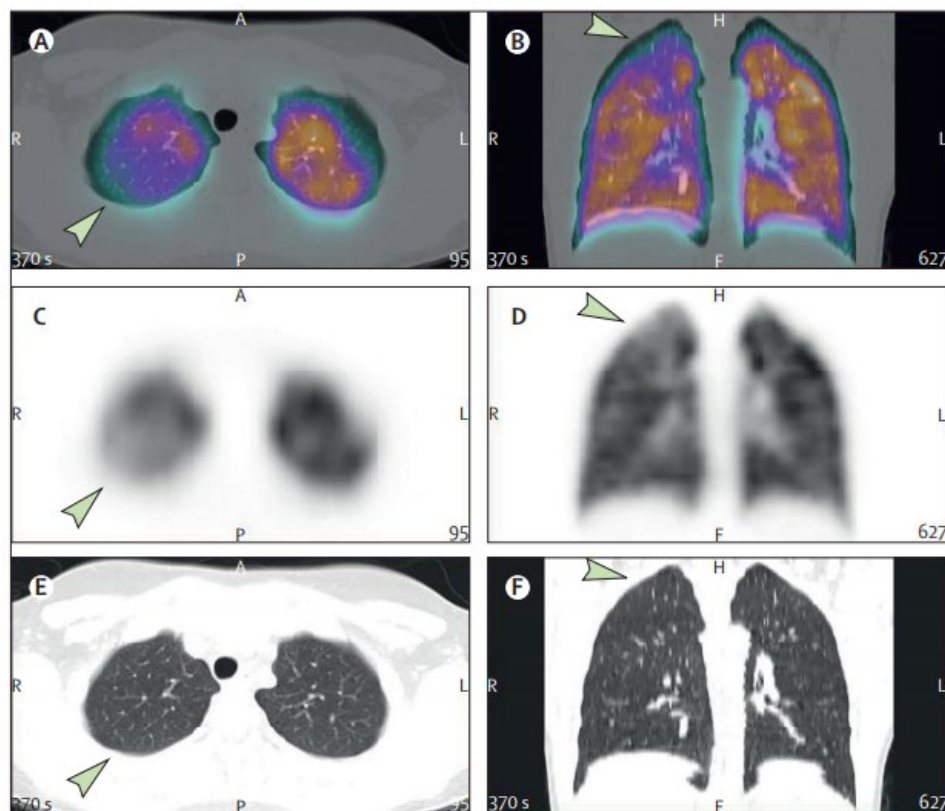
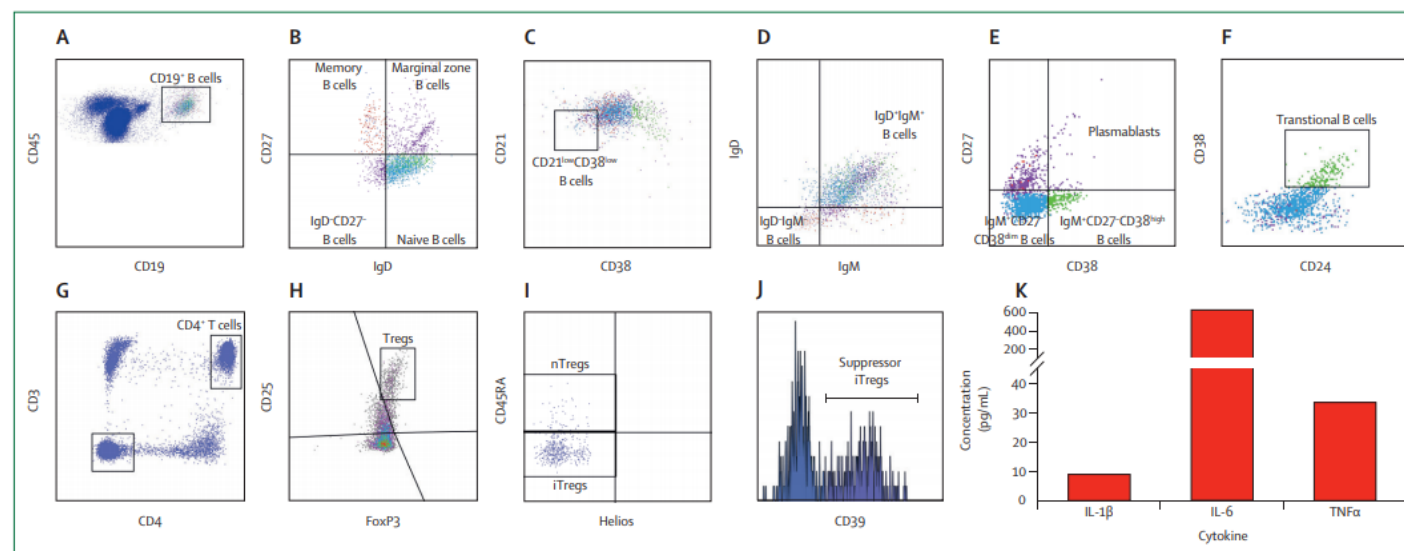


Figure 2: Lung SPECT/CT

Lung SPECT/CT scan with ^{99m}Tc -macroaggregated albumin showed hypoperfusion in the apical segment of the right upper lobe, clearly evident on axial and coronal hybrid images (A, B; arrow) as well as on functional slices (C, D; arrow). This finding did not correspond to parenchymal alterations on co-registered CT images (E, F; arrow). SPECT/CT=single photon emission computed tomography with co-registered CT.





Similar patterns of [^{18}F]-FDG brain PET hypometabolism in paediatric and adult patients with long COVID: a paediatric case series

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Abstract

Purpose Several weeks after COVID-19 infection, some children report the persistence or recurrence of functional complaints. This clinical presentation has been referred as “long COVID” in the adult population, and an [^{18}F]-FDG brain PET hypometabolic pattern has recently been suggested as a biomarker. Herein, we present a retrospective analysis of 7 paediatric patients with suspected long COVID who were explored by [^{18}F]-FDG brain PET exam. Metabolic brain findings were confronted to those obtained in adult patients with long COVID, in comparison to their respective age-matched control groups.

Methods Review of clinical examination and whole-brain voxel-based analysis of [^{18}F]-FDG PET metabolism of the 7 children in comparison to 21 paediatric controls, 35 adult patients with long COVID and 44 healthy adult subjects.

Results Despite lower initial severity at the acute stage of the infection, paediatric patients demonstrated on average 5 months later a similar brain hypometabolic pattern as that found in adult long COVID patients, involving bilateral medial temporal lobes, brainstem and cerebellum ($p\text{-voxel} < 0.001$, $p\text{-cluster} < 0.05$ FWE-corrected), and also the right olfactory gyrus after small volume correction ($p\text{-voxel} = 0.010$ FWE-corrected), with partial PET recovery in two children at follow-up.

Conclusion These results provide arguments in favour of possible long COVID in children, with a similar functional brain involvement to those found in adults, regardless of age and initial severity.

Fig. 1 Individual [^{18}F]-FDG PET of each of the seven children patients (P1 to P7), including the follow-up of two of them (P4b and P7b). An example of normal PET metabolism in a child of 10 years old is also presented (C). Hypometabolism is found in olfactory regions for children #1,3,4,5,6; in temporal regions for children #1,3,4,5,6,7; in the brainstem for children #1,3,4,5,6,7; in the cerebellum for all children. At follow-up, the brain metabolism was improved at least for the brainstem

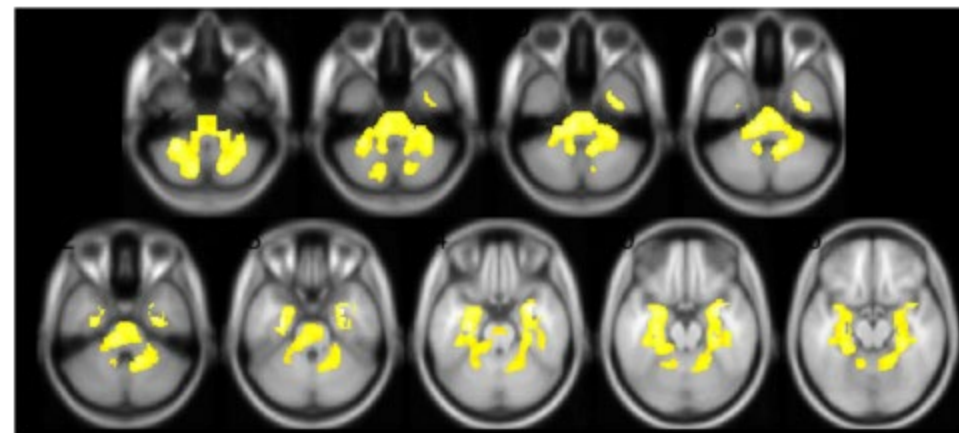
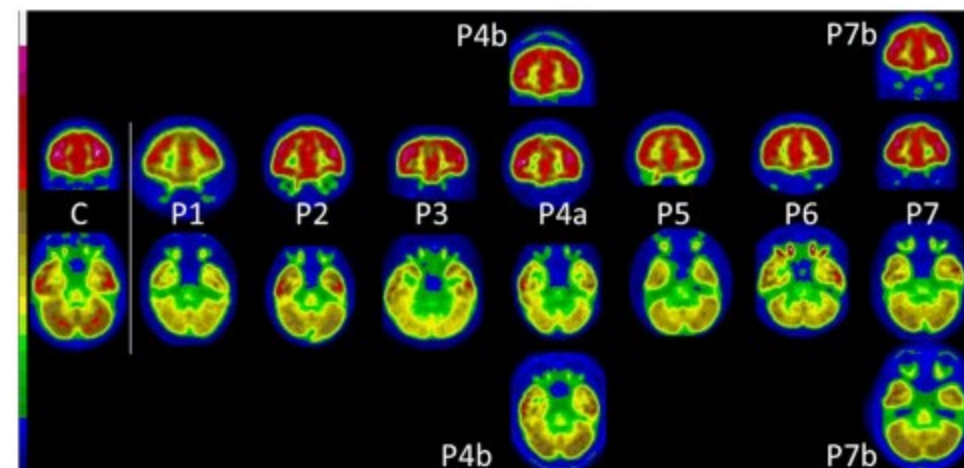
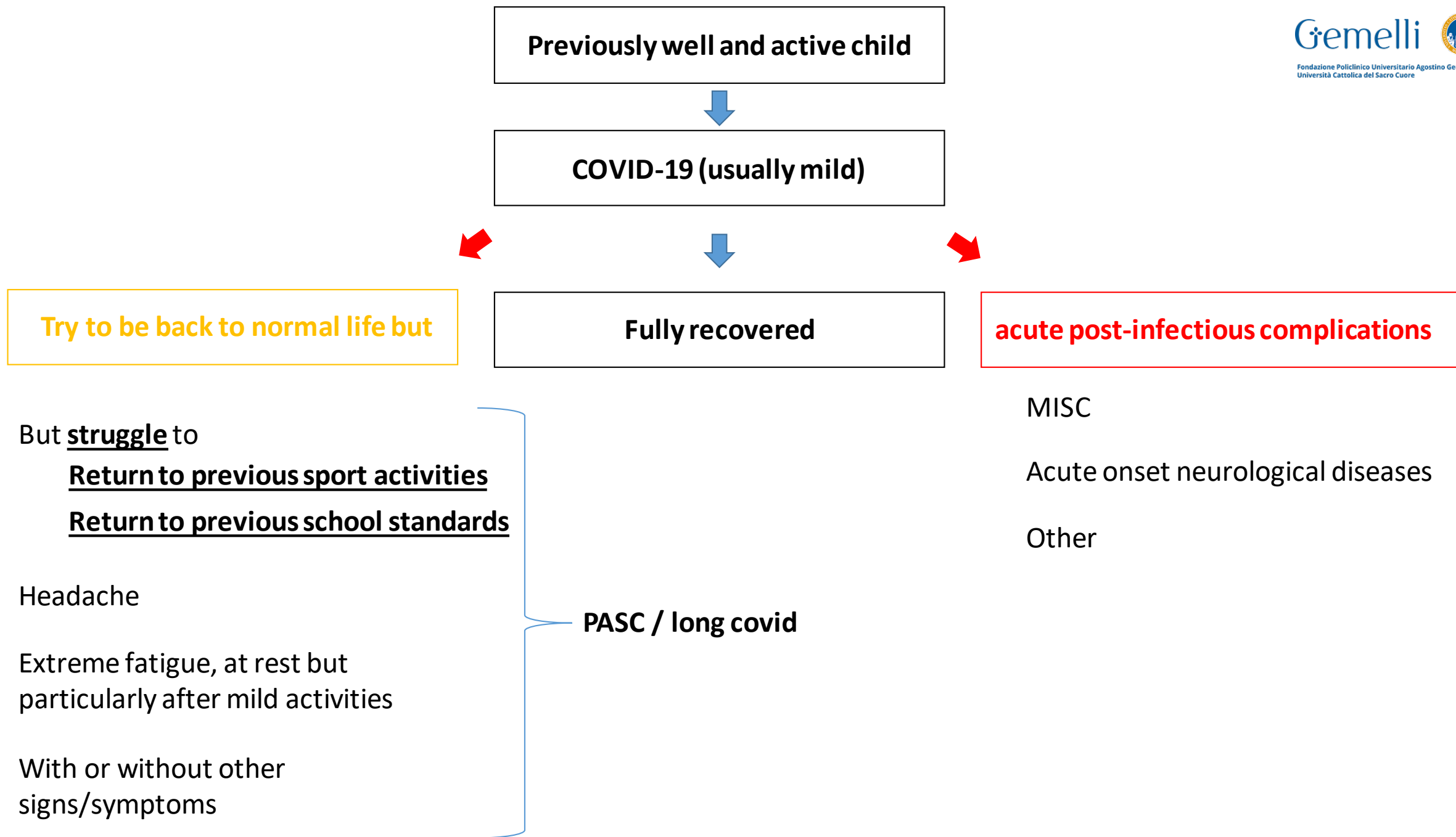


Fig. 2 Brain [^{18}F]-FDG PET hypometabolism in paediatric patients with long COVID. In comparison to paediatric controls, children with long COVID exhibited hypometabolism in bilateral medial lobes, the pons and cerebellum ($p\text{-voxel} < 0.001$, $p\text{-cluster} < 0.05$ FWE-cor-

rected), and also in the right olfactory gyrus after small volume correction ($p\text{-voxel} = 0.010$ FWE-corrected; not shown in these slices). Findings are presented in axial MR slices (the left hemisphere is on the left side, anatomical convention)



CHALLENGES AND BARRIERS

< 18 years old

Children or parents' reported symptoms led mainly to

psychological symptoms due to lockdown (??)
psychological symptoms due to lack of social activities (??)
psychological symptoms due to parents' anxiety (??)

- Do you see any biological reasons for adults suffering of Long Covid but not children (at least adolescents)?
- WE MUST NOT OVERESTIMATE NOR UNDERESTIMATE IT, but need to understand Long COVID in children as well

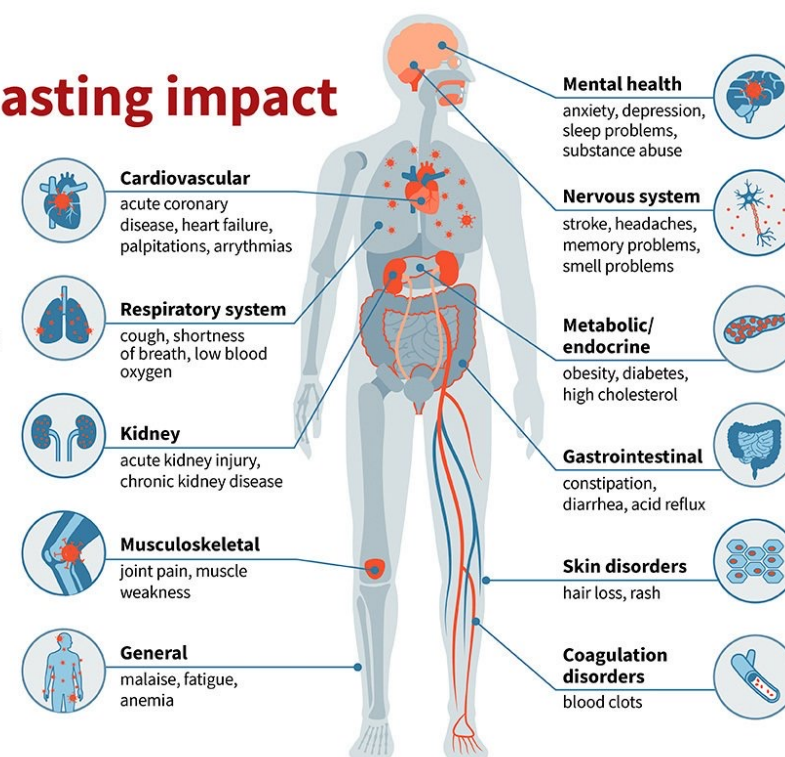
> 18 years old

Adults' reported symptoms led to the recognition of
LONG COVID by the WHO

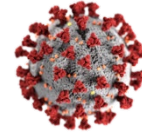
COVID-19: Lasting impact

Even those survivors with mild initial cases can have wide-ranging health issues for six months or more.

WashU researchers link many diseases with COVID-19, signaling long-term complications for patients and a massive health burden for years to come.



Strategies for the Next Phase



A child-focused
strategy

**Recognize &
Count
PASC / Long Covid as an
Outcome of pediatric Covid-19**

**STOP indiscriminate
closure of childhood activities
(eg. SCHOOLS)**

Hosp (0.1-1.9%)
Deaths (0-0.3%)
MIS-C (0.0005%)
PASC (1-10%?)

Funds for
Clinics &
Research

Better assessment
of Benefits/Risks
Of Vaccines

**Immunize eligible
Children/adolescents**

Reduce
Acute and
long term sequelae

Contribute to
Reduce transmission

Equitable
access

Harms >>>> benefits
(on all society levels)

Consider children (and parents')
Needs for policy decisions

**Other
Preventive measures
In childhood close
'environments'**

Masks
(at least school age)

ventilation

hygiene

Better students/teachers
Ratio (better education?)

Theoretical role in
Reducing morbidity/mortality
From other infections

Conclusions

- Increasing evidence of children with Long Covid worldwide
- Long Covid in adults living with children can potentially impact their ability to care for their children
- Importance of consider and count long covid for funds, better care and research, and more appropriate risks/benefits analyses (eg. vaccinations for children and adolescents)
- Better partnerships with patients/parents
- Hopefully, shared protocols worldwide
- Indirect benefits: better understanding of other post-viral/infectious conditions

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