



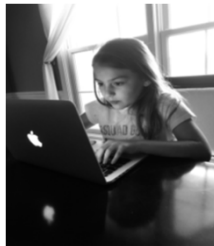
## COVID-19 Impact on Pediatrics

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THE OHIO STATE UNIVERSITY  
HEALTH SERVICES CENTER

## Kids COVID Experience: Beyond the Disease, Understanding Children's Well- being during the COVID-19 Pandemic



Source: Own image

## Objectives

- Describe the well-being of children and adolescents during the COVID-19 pandemic
- Discuss socio-ecological factors related to the well-being of children and adolescents during the COVID-19 pandemic
- Review children's perceptions early during the COVID-19 pandemic
- Discuss changes in well-being overtime in children and adolescents during the COVID-19 pandemic

### Pandemic Effects

- Physically ill
- Emotional
- Social
- Mental well-being



Source: Pixels

### Pandemic by the Numbers\*

Cumulative # of child cases	Cumulative % of all cases	Cumulative % hospitalizations	Cumulative % Deaths
15,578,985	18%	0.08%	0.00%-0.27%



Source: Pixels

\*as of 4/27/2023. The American Academy of Pediatrics. Children and COVID-19: State-Level Data Report (aap.org). Accessed 5/2/2023

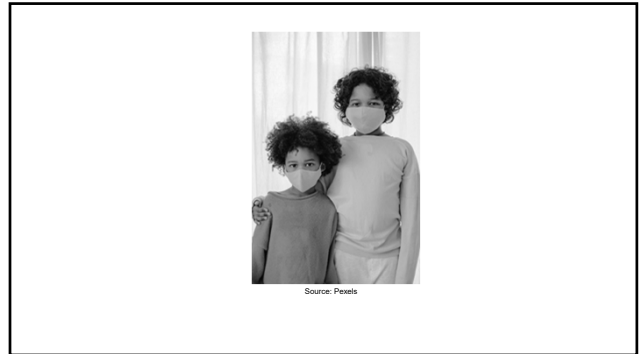
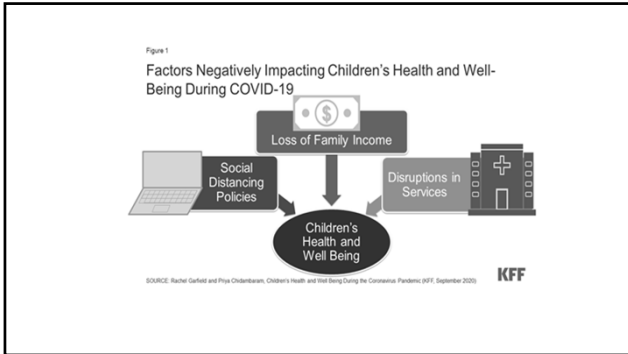
### Impact on Children

"At this time, it still appears that severe illness due to COVID-19 is rare among children. However, there is an urgent need to collect more data on longer-term impacts of the pandemic on children, including ways the virus may harm the long-term physical health of infected children, as well as its emotional and mental health effects."

- AAP, Children and COVID-19: State-Level Data Report  
May 2021

### Factors Influencing Effects

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>• <b>Child Factors</b> <ul style="list-style-type: none"> <li>- Social isolation</li> <li>- Family stress</li> <li>- Routine changes</li> <li>- Virus related anxiety</li> <li>- School closures/remote learning</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>• <b>Family Factors</b> <ul style="list-style-type: none"> <li>- Job/Income Loss</li> <li>- Financial Instability</li> <li>- Child care</li> <li>- Loss of family member d/t virus</li> </ul> </li> </ul> |
|--|--|



### Background

- Canadian and Chinese children reported decreased rates of physical activity during COVID-19 pandemic
- Chinese children during the COVID-19 pandemic
  - increased distraction
  - increased irritability
  - more fear

Source: Pexels

### Background

- > 25% worse mental health
- 14% worse behavioral health
- Single parents and parents of young children most affected
- Overall, quality of life and psychosocial functioning of children in the U.S. early in the pandemic was less known

Source: Pexels

Patrick et al. 2020. Pediatrics, 146(4).

### Study Aims

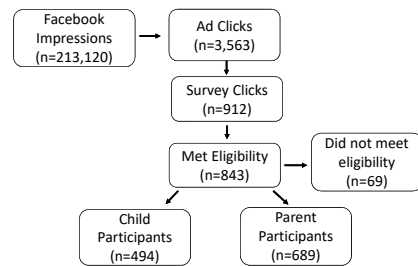
- **Aim 1:** To characterize the well-being of children and adolescents during the COVID-19 pandemic
- **Aim 2:** To examine socio-ecological factors related to the well-being of children and adolescents during the COVID-19 pandemic
- **Aim 3:** To qualitatively explore children’s perceptions of the COVID-19 pandemic through open-ended, written responses



### Measures

Measure	Time 1	Time 2
COVID Exposure and Family Impact Scale (CEFIS)		
PEDSQL		
PROMIS Family Relationship		
NIH Toolbox Loneliness Scale		
Qualitative Interview (optional)		
CD-RISC10		

### Overall Study Enrollment



## Demographics\_Time 1

Table 1. Parent/child dyad demographic characteristics (N=461)

	Mean (SD)	n (%)
Child Age in years (SD)	7.65	(2.75)
Gender (Child)		
Male	250	(51.4%)
Female	211	(45.6%)
Race (Child)		
White	416	(90.2%)
Non-White	45	(9.8%)
Ethnicity		
Hispanic	43	(9.4%)
Non-Hispanic	415	(90.6%)
Income		
Under \$25,000	31	(6.8%)
\$25,001-\$50,000	57	(12.4%)
\$50,001-\$75,000	54	(11.8%)
\$75,001-\$100,000	109	(23.7%)
\$100,001-\$150,000	137	(29.7%)
More than \$150,000	85	(18.7%)
Other	4	(0.9%)
Current Employment Status		
Working full-time (>40 hrs/week)	264	(57.6%)
Working part-time (<40 hrs/week)	76	(16.6%)
Unemployed	118	(25.8%)



Source: Pexels

Skeens, M. A., Hill, K., Olsavsky, A., Ralph, J., Udaipuria, S., Akard, T. F., & Gerhardt, C. A. (2023). Family Functioning Buffers the Effects of the COVID-19 Pandemic on Children's Quality of Life and Loneliness. *Frontiers in Psychology*, 13, 8660.

## COVID Exposure\_T1

COVID Questionnaire Part- 1 (COVID Exposure):

	No	Yes
We had a "stay at home" order	15 (3.27%)	444 (96.73%)
Our schools / child care centers were closed	1 (0.22%)	458 (99.78%)
Our child/ren's education was disrupted	23 (5.01%)	436 (94.99%)
We were unable to visit or care for a family member	99 (21.57%)	360 (78.43%)
Our family lived separately for health, safety or job demands	405 (88.24%)	54 (11.76%)
Someone moved into (or back into) our home	425 (92.59%)	34 (7.41%)
We had to move out of our home	455 (99.13%)	4 (0.87%)
Someone in the family kept working outside the home (essential personnel)	158 (34.42%)	301 (65.58%)
Someone in the family is a healthcare provider/first responder providing direct care	332 (72.49%)	126 (27.51%)
We had difficulty getting food	392 (85.40%)	67 (14.60%)
We had difficulty getting medicine	430 (93.68%)	29 (6.32%)
We had difficulty getting health care when we needed it	392 (85.59%)	66 (14.41%)
We had difficulty getting other essentials	338 (73.64%)	121 (26.36%)
We self-quarantined due to travel or possible exposure	372 (81.05%)	87 (18.95%)
Our family income decreased	277 (60.48%)	181 (39.52%)
A member of the family had to cut back hours at work	262 (57.33%)	195 (42.67%)
A member of the family was required to stop working (expect to be called back)	332 (72.33%)	127 (27.67%)
A member of the family lost their job permanently	437 (95.83%)	19 (4.17%)
We lost health insurance/benefits	446 (97.38%)	12 (2.62%)

## COVID Exposure\_T1

COVID Questionnaire Part- 1 (COVID Exposure) (cont'd)

	No	Yes
We missed an important family event or it was canceled (e.g., wedding, graduation, birth, funeral, travel [including vacation], other)	60 (13.07%)	399 (86.93%)
Someone in the family was exposed to someone with COVID-19	384 (83.84%)	74 (16.16%)
Someone in the family had symptoms or was diagnosed with COVID-19	403 (87.99%)	55 (12.01%)
Someone in the family was hospitalized for COVID-19	446 (97.59%)	11 (2.41%)
Someone in the family was in the Intensive Care Unit (ICU) for COVID-19	450 (98.68%)	5 (1.32%)
Someone in the family died from COVID-19	453 (98.91%)	5 (1.09%)



Source: Pexels

Mean (SD)  
COVID-19 Exposure Score 8.00 (2.54)

## COVID Impact-Parent\_T1

COVID Questionnaire Part- 2 (COVID Impact):

	Made it a lot better	Made it a little better	No Change	Made it a little worse	Made it a lot worse
Parenting	24 (5.26%)	88 (19.30%)	133 (29.17%)	175 (38.38%)	36 (7.89%)
How family members get along with each other	28 (6.11%)	116 (25.33%)	140 (30.57%)	144 (31.44%)	30 (6.55%)
Ability to care for your child	44 (9.73%)	87 (19.25%)	213 (47.12%)	87 (19.25%)	21 (4.65%)
Ability to care for other children in your family	23 (6.07%)	64 (16.89%)	187 (49.34%)	77 (20.32%)	28 (7.39%)
Ability to care for older adults or people with disabilities in your family	10 (3.12%)	7 (2.13%)	112 (34.58%)	90 (28.04%)	103 (32.69%)
Your physical wellbeing - exercise	30 (6.59%)	75 (16.48%)	86 (18.90%)	138 (30.33%)	126 (27.69%)
Your physical wellbeing - eating	21 (4.58%)	72 (15.69%)	101 (22.00%)	160 (34.86%)	105 (22.88%)
Your physical wellbeing - sleeping	26 (5.71%)	51 (11.21%)	96 (21.10%)	160 (35.16%)	122 (26.81%)
Your emotional wellbeing - anxiety	9 (1.98%)	14 (3.08%)	72 (15.86%)	173 (38.11%)	186 (40.97%)
Your emotional wellbeing - mood	13 (2.86%)	28 (6.17%)	67 (14.76%)	217 (47.80%)	129 (28.41%)
	Mean (SD)				
Overall, how much distress have you experienced related to COVID-19?	6.20 (2.07)				
	COVID-19 Impact Score				
In general, across all your children, how much distress have your children experienced related to COVID-19?	5.97 (2.21)				
	45.20 (9.44)				

### COVID Impact- Child\_T1

COVID Questionnaire Part-2 (COVID Impact) - CHLD

	Made it a lot better	Made it a little better	No Change	Made it a little worse	Made it a lot worse
How family members get along with each other	27 (6.2%)	105 (24%)	141 (32.3%)	131 (30%)	32 (7.3%)
How I got along with my brother or sister	22 (5%)	84 (19.1%)	108 (24.5%)	117 (26.6%)	42 (9.5%)
Your physical wellbeing – eating	30 (6.8%)	89 (20.3%)	208 (47.5%)	87 (19.9%)	22 (5%)
Your physical wellbeing – sleeping	38 (8.6%)	60 (13.6%)	149 (56.1%)	132 (30%)	57 (13%)
Your emotional wellbeing – worry	13 (3%)	30 (9.8%)	137 (31.1%)	181 (41.1%)	74 (16.8%)
Your emotional wellbeing – mood	15 (3.4%)	44 (10.1%)	130 (29.7%)	185 (42.3%)	59 (13.5%)

	Mean (SD)
Overall, how much distress have you experienced related to COVID-19?	5.05 (2.45)
In general, how much distress have your parents experienced related to COVID-19?	6.17 (2.48)

### Child QoL & Loneliness\_T1

Table 2. Comparison of parent and child reports of child quality of life to norms

	Normative Sample M(SD)	Current Sample M(SD)	df	t-value	Pr >  t	95% CI
<b>PEDS-QL Child Report</b>						
Total Functioning	82.87 (13.16)	75.35 (15.12)	6431	11.69	<.0001	6.26-8.3
Physical Functioning	87.88 (12.38)	80.97 (15.47)	6421	4.93	<.0001	4.84-7.1
Emotional Functioning	78.21 (18.54)	63.41 (21.18)	6420	16.26	<.0001	13.01-17.1
Social Functioning	84.04 (17.43)	82.20 (17.77)	6407	2.18	.03	0.18-3
School Functioning	79.92 (16.93)	71.91 (18.57)	6367	9.71	<.0001	6.39-9
<b>PEDS-QL Parent Report</b>						
Total Functioning	81.34 (15.92)	74.12 (16.16)	10319	7.09	<.0001	5.22-8.9
Physical Functioning	83.28 (13.98)	78.06 (15.17)	10300	4.13	<.0001	2.76-7.1
Emotional Functioning	80.28 (16.99)	59.83 (21.45)	10294	18.74	<.0001	18.31-2
Social Functioning	88.22 (16.06)	86.78 (17.49)	10282	0.46	.645	-0.84-1.7
School Functioning	76.23 (16.19)	71.29 (18.19)	9722	16.60	<.0001	12.25-2
Loneliness Score	50.00 (10.00)	56.12 (11.27)	460	11.66	<.0001	5.09-7

Skeens, M. A., Hill, K., Olsavsky, A., Ralph, J., Udayapuria, S., Akard, T. F., & Gerhardt, C. A. (2023). Family Functioning Buffers the Effects of the COVID-19 Pandemic on Children's Quality of Life and Loneliness. *Frontiers in Psychology*, 13, 8669.

### Potential Covariates\_T1

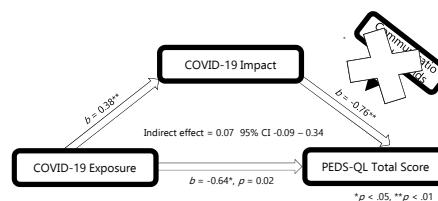
Table 3. Correlations between demographic characteristics and child report of QoL and loneliness

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. PEDS-QL Total Functioning									
2. Loneliness	-.60**								
3. Family Relationships	.36**	-.49**							
4. Communication with Friends	.19**	-.13**	-.01						
5. Child Age	-.07	.16**	-.15**	.21**					
6. Child Sex	.03	.11*	.03	.15**	-.01				
7. Child Ethnicity	.13**	.03	-.01	.08	-.02	-.06			
8. Prior Income	.21**	-.01	-.12*	.13**	.03	-.06	.17**		
9. COVID Exposure	-.29**	.06	-.05	-.09*	-.06	.02	-.16**	-.26**	
10. COVID Impact	-.30**	.25**	-.18**	-.09	-.06	-.05	.11*	-.06	.14**

\*p < .05, \*\*p < .01

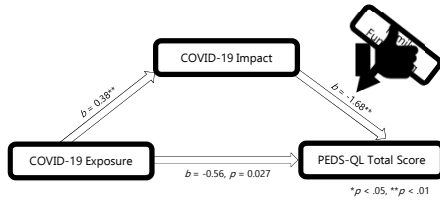
Skeens, M. A., Hill, K., Olsavsky, A., Ralph, J., Udayapuria, S., Akard, T. F., & Gerhardt, C. A. (2023). Family Functioning Buffers the Effects of the COVID-19 Pandemic on Children's Quality of Life and Loneliness. *Frontiers in Psychology*, 13, 8669.

### Do Friends Help?



R<sup>2</sup> = 0.18; controlling for age, sex, ethnicity and prior family income of which income and ethnicity were significantly associated with PEDS-QL total score.

### Does Family Help?



R<sup>2</sup> = 0.26; index of moderated mediation = 0.01, 95% CI [0.001, 0.02]; controlling for age, sex, ethnicity and prior family of which income and ethnicity was significantly associated with PEDS-QL total score.

### Qualitative Sample

- Recruitment
  - 340 agreed to interview
  - 140 contacted
  - 55 interviewed
- Children
  - Equal distribution of sex
  - Mean age 11.97 (SD = 2.81)



Source: Pixabay

### Qualitative Interviews



Source: Pixels

### 6-Month Follow-Up\_T2

T2\_Parent/child dyad characteristics (n=195)

- ~ 200 families completed 6-month follow-up
- Attrition analysis
  - No differences in demographics, but non-participating parents had lower family functioning and higher loneliness scores

	Mean (SD)
Age in years (SD)	32.50 (2.59)
Gender	
Male	107 (54.87%)
Female	88 (45.13%)
Race	
White	172 (88.00%)
Non-White	23 (11.94%)
Ethnicity	
Hispanic	11 (5.67%)
Non-Hispanic	183 (94.33%)
Income	
Under \$15,000	9 (4.69%)
\$15,001- \$50,000	17 (8.82%)
\$25,001- \$75,000	28 (14.58%)
\$75,001- \$100,000	35 (18.23%)
\$100,001- \$150,000	49 (25.28%)
More than \$150,000	52 (27.09%)
Other	4 (2.05%)
Current Employment Status	
Working full-time (>30 hrs/week)	122 (62.48%)
Working part-time (<30 hrs/week)	24 (12.31%)
Unemployed	39 (20.00%)

### COVID Exposure/Impact\_T2

- Fewer children with restrictions, but 52% had family member exposed, 29% sx's or infected, 8% hospitalized, 3% death

Measure	T1_Score	T2_Score
COVID Exposure	8 (2.54)	7.65 (3.21)
COVID Impact_Parent	45.20 (9.44)	48.03 (8.04)
COVID Distress_Parent	6.20 (2.07)	6.64 (1.93)
COVID Distress_Child	5.05 (2.45)	5.48 (2.34)

### QoL & Loneliness\_T2

- Total QoL & loneliness unchanged
- Associated with COVID exposure, impact, family functioning
- No change over time except school function
- Older children and lower income had greater decline in Total QoL
  - physical & school in older children

Source: Pixabay



### Resilience\_T2

- CD-RISC 10
  - Parent reported scores 36.2 (6.54)
  - Child reported scores 34.19 (7.57)
- Between 50<sup>th</sup> and 75<sup>th</sup> percentile

Source: Pixabay





### Summary

- Results suggest early negative effects of the pandemic on children’s QoL and loneliness
- These remain relatively stable over 6 months
- Opportunities to identify families at risk
  - Lower income, older age, and worse family r/s
- Research is needed with more diverse families



Source: Pixels

### COVID & Social Determinants of Health

- Inequity & Disparity related to;
  - Income
  - Immigrant background
  - Language barrier
  - Parental education level
  - Access to health care



Image by Freepik

### Racial Differences, COVID and Well-Being



Source: Pixabay

Paolin, Z. (2021). Months COVID-19 pandemic reveals clear racial differences in health-related and well-being. An introduction to the Special Issue: Race and social problems, 1(2), 14.

### Racial Differences, COVID and Well-Being



Source: ioc.gov



Source: Pixabay

### COVID and Quality of Life

- QOL was worse than normative samples but did not change significantly over time.
- Global data is mixed
  - Some reflect decreased QOL from pre-pandemic samples
  - Some no change
  - Spain & Germany had improved scores



Source: Pixabay

### COVID and Mental Health Outcomes

Children and adolescents experience;

- Depression
- Anxiety
- Fear
- Concern for pandemic impact on life



Source: Pixabay

### Youth and the Pandemic

According to a November 2020 article in the Washington Post:

**“Since the coronavirus arrived, depression and anxiety in America have become rampant.** Federal surveys show that 40 percent of Americans are now grappling with at least one mental health or drug-related problem. But young adults (ages 18 – 24) have been hit harder than any other age group, with 75 percent struggling.”

### Factors and Worse Mental Health Outcomes

- Older adolescent age
- Female
- Rural areas
- Low socioeconomic status
- Family health care worker
- Chronic physical conditions



Source: Pixabay



Source: Pixabay

Etharika, et al (2022). *Child Psychiatry & Human Development*, 1-13.  
Samji, H et al (2021). *Child and adolescent mental health*

### Factors and Better Mental Health Outcomes

- Physical exercise
- Positive family relationships
- Social support
- Access to entertainment



Source: Pixabay

Samji, H et al (2021). *Child and adolescent mental health*

### Interventions

- Sparse interventions to prevent and manage mental health outcomes
- Mix of parents/child specific interventions (4 – child only)
- Digital interventions to reduce emotional symptoms or improve emotional well-being
- Two remote recess and exercise interventions

Boldt et al. (2021). *International journal of environmental research and public health*, 18(5), 2361.

### Limitations

- Cross-sectional – lack of longitudinal data
- Lack of validated measures
- Research including minorities and underserved populations is missing



Source: Unplash

### Clinical Implications

- Address pandemic related effects during routine visits
- Begin to address cumulative effects on school performance and outcomes
- Increase mental health services
- Close attention and future intervention development for those with known factors contributing to worse outcomes

### Thank you

- Cynthia Gerhardt PhD
  - Terrah Foster-Akard PhD  
FAAN
  - Kathy Vannatta PhD
  - Anna Olsavsky PhD
  - Kylie Hill BS
  - Skeens Lab
  - Marketing team
  - Children and Families
- Funding acknowledgement:  
Nationwide Children's  
Intramural Grant




Source: NCH

### References

- Boldt, K., Coenen, M., Movsisyan, A., Voss, S., Rehfuess, E., Kunzler, A. M., ... & Jung-Sievers, C. (2021). Interventions to ameliorate the psychosocial effects of the COVID-19 pandemic on children—a systematic review. *International journal of environmental research and public health*, 18(5), 2361.
- Elharake, J. A., Akbar, F., Malik, A. A., Gilliam, W., & Omer, S. B. (2022). Mental Health Impact of COVID-19 among Children and College Students: A Systematic Review. *Child Psychiatry & Human Development*, 1-13.
- Jiao, W. Y., Wang, L. N., Liu, J., Fang, S. F., Jiao, F. Y., Pettoello-Mantovani, M., & Somekh, E. (2020). Behavioral and Emotional Disorders in Children during the COVID-19 Epidemic. *J Pediatr*. doi:10.1016/j.jpeds.2020.03.013
- <https://youngminds.org.uk/about-us/reports/coronavirus-impact-on-young-people-with-mental-health-needs/>

### References

- Parolin, Z. (2021). What the COVID-19 pandemic reveals about racial differences in child welfare and child well-being: An introduction to the Special Issue. *Race and social problems*, 13(1), 1-5.
- Patrick, S. W., Henkhaus, L. E., Zickafoose, J. S., Lovell, K., Halvorson, A., Loch, S., ... & Davis, M. M. (2020). Well-being of parents and children during the COVID-19 pandemic: a national survey. *Pediatrics*, 146(4).
- Samji, H., Wu, J., Ladak, A., Vossen, C., Stewart, E., Dove, N., ... & Snell, G. (2021). Mental health impacts of the COVID-19 pandemic on children and youth—a systematic review. *Child and adolescent mental health*.
- Xiang, M., Zhang, Z., & Kuwahara, K. (2020). Impact of COVID-19 pandemic on children and adolescents' lifestyle behavior larger than expected. *Progress in cardiovascular diseases*, S0033-0620(20)30096-7. Advance online publication. <https://doi.org/10.1016/j.pcad.2020.04.013>

  
**Pediatric Long-COVID:  
What are pulmonologists seeing?**

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Disclosures

- None


Objectives

<b>1</b>	<b>2</b>	<b>3</b>
Know the definition of "long COVID" in the pediatric population	Review pulmonary post COVID clinic – population we are serving, testing	Discuss what we have found so far regarding persistent symptoms and lung function changes

**Where are we at with COVID?**

- Declared no longer a public health emergency by the WHO
- “The emergency phase is over, but Covid is not.”
  - Dr. Maria Van Kerkhove, WHO technical lead on COVID
- No longer the same level of danger
- Learning more and more about long term symptoms even with mild infections
- Some similarities to other respiratory viruses, but also many differences

<https://www.nytimes.com/2023/05/05/health/covid-who-emergency-end.html>



### COVID19 in Pediatrics: General Infection

- Overall for most children is usually mild
- Symptoms similar to other respiratory viral infections, though this has fluctuated with the different variants
- Mild symptoms include fever, cough, rhinorrhea, sore throat, dyspnea
- Dyspnea and respiratory distress more common in infants <12 months
- GI complaints (nausea, vomiting, diarrhea) more common in older children and teens
- Anosmia and Ageusia seen with early strains, less so with recent omicron wave
- Recovery within 1-2 weeks

### COVID19 in Pediatrics: MIS-C

- Multi-system inflammatory syndrome in children (MIS-C)
  - First described in the UK in case report of 2 children with Kawasaki like symptoms in Pediatrics, August 2020 - 12 year old and 7 year old
  - UK reported similar as early as April 2020
- Occurs in <1% of confirmed COVID cases
- Initially described in the US in 2 patients (aged 9 and 12) as what seemed to be late phase reaction to SARS COV2, no real pulmonary symptoms, but elevated inflammatory markers, diarrhea and abdominal pain

### COVID19 in Pediatrics: MIS-C

- Now known to generally occur in older children and adolescents
- Occurs 2-4 weeks after COVID infection
- Usually previously healthy children
- Treatment standard, require inpatient treatment
  - IVIG recommended
  - +/- glucocorticoids depending on severity
  - Can use glucocorticoids alone if no access to IVIG
  - ICU support as needed with fluid resuscitation, pressors or inotropes

### Post Acute Sequelae of COVID19 or PASC: What we know in adults

- "Long haulers" or long-covid
- Similar symptoms were reported for SARS outbreak of 2003 and MERS outbreak of 2012
- Persistence of symptoms at least 4 weeks after initial infection
  - 2 categories
    - Persistent subacute COVID (still having symptoms more like acute infection) in the 4-12 week timeframe
    - Post COVID syndrome, often persisting beyond 12 weeks after initial infection

### COVID19 in Pediatrics: PASC

- World Health Organization (WHO) definition
  - At least 2 months of persistent symptoms 3 months after initial diagnosis
  - Not explained by any other diagnosis
- AAP similar but must have physical symptoms that impact daily function
  - May relapse and fluctuate over time.

### COVID19 in Pediatrics: PASC

- Most common symptoms reported
  - Headache
  - Fatigue
  - Myalgias
  - Chest Pain
  - Dyspnea
  - Concentration impairment (brain fog)
- Several studies comment on whether some of these could be related to effects from lockdown – isolation, depression, etc

### PASC: What we know in adults

- As many as 30% of hospitalized adults report persistent symptoms
  - Dyspnea being the most common (22%) as well as continued cough
  - Fatigue common as well
- Pulmonary specific – decreased diffusion capacity with restrictive physiology
  - Ground glass opacities
  - Potential fibrotic changes
  - Limited literature on bronchospasm or bronchodilator response (although decreased FEV1 is reported)

### Development of Post-COVID Clinic

- Questions regarding this population
  - Common respiratory symptoms?
  - Do they have changes in lung function? In lung imaging?
  - How long after infection do these symptoms seem to persist?
  - Does it matter if patients are vaccinated or not with regards to PASC?
  - Does prior history of pulmonary disease (mostly asthma) increase likelihood of persistent pulmonary symptoms?
  - Are there other risk factors that make PASC more likely?

### COVID19 in Pediatrics: PASC

- Dutch study from August 2021 (retrospective, observational)
  - 89 children
  - Dyspnea reported by over half of those surveyed
- Radiology study out of Germany published 2023 looked at MRIs and ventilation perfusion scans
  - Healthy controls had best V/Q match
  - Lowest V/Q match in patients with shorter time period to study participation from Covid infection
  - More likely if <180 days since COVID infection

### Other pediatric literature

Small cohort (N=29) out of Philadelphia (CHOP) – described long term reported symptoms post COVID – dyspnea, cough, exercise intolerance

- Had 6 minute walk data on 9 patients, did see significant heart rate elevation and no change in oxygenation, no follow up data
- Demonstrated 28% of their cohort with bronchodilator response on spirometry

Prospective study out of Russia published in European Respiratory Journal

- Looked at long term symptoms for children after hospitalization
- Found that risk factors for persistent symptoms were older age (12-18) and history of allergic/atopic diseases

### Development of Post-COVID Clinic

**Objective:** Comprehensively evaluate post-acute COVID-19 syndrome (PASC) pulmonary symptoms in adolescents (Long-COVID pulmonary symptoms).

**Candidates:** Pediatric patients >8 years with PASC pulmonary symptoms for at least 1 month after initial infection date. Athletes and non-athletes welcomed.

• Over 8 years old because of need to participate in fairly extensive lung function testing

**Symptoms:** Typical PASC pulmonary symptoms include shortness of breath (resting or with activity), cough, wheezing, chest/throat pain, and decreased exercise capacity.

### Development of Post-COVID Clinic

- **Evaluation:** Testing includes
  - Six-minute walk
  - Chest xray (if not obtained within the last month)
  - Spirometry (both pre and post bronchodilator)
  - Plethysmography (lung volume measurements)
  - DLCO testing (diffusing capacity)
  - Other imaging or testing determined by evaluating physician (think exercise testing, chest CT, etc)










### So, what have we seen?

- Aimed to describe long term subjective and objective pulmonary abnormalities
- Initially observed 82 adolescents, mostly previously healthy and largely NOT requiring hospitalization
- Saw 3.5 months after infection (on average)
  - Although some patients referred in that subacute time frame of 4-6 weeks after initial infection

### Initial Cohort

	Initial visit (n=71)	Follow-up (n=31)
Female sex	57.8%	64.5%
Caucasian	81.7%	81.3%
BMI	23.8 ± 6.7	22.9 ± 5.7
Age at diagnosis (y)	15.5 ± 2.2	15.4 ± 2.6
Time to pulm eval (mo)	4.3 ± 3.1	7.0 ± 3.1
Co-morbidities		
Obesity	19.7%	22.6%
HTN	4.4%	0%
Asthma	28.6%	22.1%
Mild intermittent	21.4%	25.0%
Mild persistent	5.7%	0
Moderate persistent	1.4%	3.1%
Anxiety	26.1%	23.3%
COVID vaccinated	24.3%	19.4%
Vaping exposure	11.3%	12.9%
Tobacco exposure	14.1%	6.4%
Private Insurance	76.1%	87.5%
Hospitalized for COVID	7.0%	6.5%
Competitive athlete	80.3%	77.4%

Symptoms commonly reported at presentation

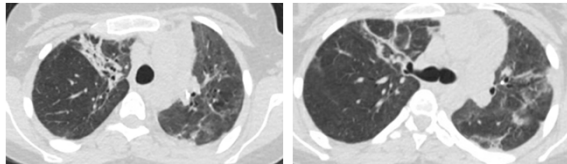
-  Cough (30%)
-  Chest pain (61%)
-  Dyspnea at rest (51%)
-  Exertional dyspnea (90%)
-  Around 80% presented with 2 or more symptoms

### Any imaging abnormalities?



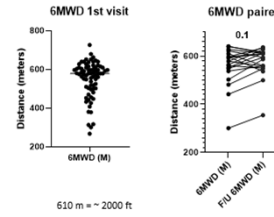
- Vast majority normal
- 8% abnormal – hyperinflation usually
- 16% had chest CT scans, generally normal

### Fibrosis and Bronchiectasis in an 18 yo female after COVID related ARDS



• IMPRESSION: 1. Evolution of fibrosis throughout the lungs with decreased volumes and progressive bronchiectasis bilaterally, as detailed above. Fibrotic changes are more discrete and consolidated compared to prior study.

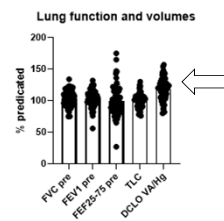
### Functional limitations – evaluation with 6MWT



### Lung function testing

Measure (% predicted)	Pre-bronchodilator	Post-bronchodilator	% Change
FVC	103.4 ± 13.1	104.2 ± 13.5	0.38 ± 3.6
FEV1	102.4 ± 13.3	107.0 ± 13.9	4.1 ± 6.7
FEF 25-75	99.4 ± 24.7	113.5 ± 23.4	16.2 ± 20.4
TLC	98.4 ± 12.7		
RV/TLC	20.4 ± 10.0		
Diffusing capacity	118.0 ± 17.1		
Normal spirometry	83%		
Bronchodilator positivity	31%		

### Lung function testing



## Diagnostic Phenotypes

- Bronchodilator responsiveness (an "asthma" phenotype)
- Paradoxical Vocal Fold Motion Disorder (previously VCD)
- Persistent functional limitations
  - Fatigue, persistent dyspnea with normal lung function testing, no diagnosis of VCD

## Bronchodilator responsiveness

- What are we doing for these patients?
- 43% of these patients were prescribed and ICS or ICS/LABA combo
  - 10% just ICS and 33% ICS/LABA combo
- At follow up
  - 85% reported clinical response
  - Due to mostly normal lung function testing initially, most patients did not have repeat spirometry and response documented based on clinic symptoms


## Paradoxical Vocal Fold Motion Disorder

- VCD
- Treated in conjunction with ENT and speech therapy
- This was 13% of the 82 individuals initially seen in the clinic
- One patient diagnosed with a laryngeal sensory neuropathy
  - Treated with a superior laryngeal nerve block

<https://www.annalrhp.org/article/53081-12063639522-3?fulltext>

## Persistent functional limitations

- Almost all patients presenting with fatigue and dyspnea
- About half had no abnormalities on imaging, on lung function testing or exam
- Deconditioning?
- Pulmonary rehab (13% of our initial cohort)
  - Improves endurance and strength
  - Mental health support



### What factors help predict outcomes?

- Multivariable models adjusting for age, sex, race, and insurance status
- **Obesity, anxiety, cough and dyspnea** were associated with **decreased 6MWT** distance
- **Female sex and initial dyspnea** were associated with **higher Borg Dyspnea and Fatigue** scores
- There were no significant factors associated with heart rate alterations during 6MWT or bronchodilator responses during spirometry.

### What factors help predict outcomes?

- Other studies have seen risk factors for overall long COVID include
  - Older age (adolescents vs young children)
  - Female gender
  - Poor mental or physical health prior to COVID infection

### Role of mental health

- Since initial collection of data we have also brought in help of our mental health coordinators
- Doing screening each visit for anxiety and depression
- So far we do have many patients with h/o mental health diagnoses
  - Many who already are on medication or have providers
- Recent article American Psychological Association
  - Reality of Pediatric Long Covid

### Sources

- Brackett, Caroline L., et al. "Pediatric Long-covid: An Overlooked Phenomenon?" *Pediatric Pulmonology*, vol. 56, no. 8, 2021, pp. 2495–2502, <https://doi.org/10.1002/ppul.25521>.
- Center for Disease Control and Prevention. COVID Data Tracker. [https://covid.cdc.gov/covid-data-tracker/#demographicsovertime\\_2022](https://covid.cdc.gov/covid-data-tracker/#demographicsovertime_2022); <https://covid.cdc.gov/covid-data-tracker/#demographicsovertime>. Accessed 4/13/2022
- Heiss, Rafael. "Pulmonary Dysfunction after Pediatric COVID-19." *Radiology*, 2023, <https://doi.org/10.1148/radiol.221250>.podcast.
- Leftin Dobkin SC, Collaco JM, McGrath-Morrow SA. Protracted respiratory findings in children post-SARS-CoV-2 infection. *Pediatr Pulmonol*. 2021.
- Licciardi F, Prucçoli G, Denina M, et al. SARS-CoV-2-Induced Kawasaki-Like Hyperinflammatory Syndrome: A Novel COVID Phenotype in Children. *PEDIATRICS*. 2020
- Michelen, Melina, et al. "Characterising Long Term Covid-19: A Living Systematic Review." *BMJ Global Health*, 2020, <https://doi.org/10.1101/2020.12.08.20246025>.
- Nalbandian A, Sehgal K, Gupta A, et al. Post-acute COVID-19 syndrome. *Nat Med*. 2021;27(4):601-615.
- Osmanov IM, Spiridonova E, Bobkova P, et al. Risk factors for long covid in previously hospitalised children using the ISARIC Global follow-up protocol: A prospective cohort study. *Eur Respir J*. 2021.
- Palacios, Sabrina, et al. "Long-term Pulmonary Sequelae in Adolescents Post-sars-cov-2 Infection." *Pediatric Pulmonology*, vol. 57, no. 10, 2022, pp. 2455–2463, <https://doi.org/10.1002/ppul.26059>.
- Pellegrino, Roberta, et al. "Prevalence and Clinical Presentation of Long Covid in Children: A Systematic Review." *European Journal of Pediatrics*, vol. 181, no. 12, 2022, pp. 3995–4009, <https://doi.org/10.1007/s00431-022-04600-x>.
- "Post-Covid-19 Conditions in Children and Adolescents." *Home*. [www.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/clinical-guidance/post-covid-19-conditions-in-children-and-adolescents/](https://www.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/clinical-guidance/post-covid-19-conditions-in-children-and-adolescents/). Accessed 10 May 2023.
- Skevaki C, Karsonova A, Karasulov A, Xie M, Renz H. Asthma-associated risk for COVID-19 development. *J Allergy Clin Immunol*. 2020;146(6):1295-1301. <https://doi.org/10.1016/j.jaci.2020.05.010>.
- Yasuhara J, Kuno T, Takagi H, Sumitomo N. Clinical characteristics of COVID-19 in children: A systematic review. *Pediatr Pulmonol*. 2020.