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THE UNIVERSITY OF ARIZONA  
MEL & ENID ZUCKERMAN COLLEGE OF PUBLIC HEALTH  
**Center for Rural Health**

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THE UNIVERSITY OF ARIZONA  
MEL & ENID ZUCKERMAN COLLEGE OF PUBLIC HEALTH

Center for Rural Health



# Kristen Pogreba-Brown, PhD, MPH

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The Arizona CoVHORT: Study Design and Early Findings



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MEL & ENID ZUCKERMAN COLLEGE OF PUBLIC HEALTH

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# The Arizona CoVHORT: Study Design and Early Findings

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# Land Acknowledgement

The University of Arizona sits on the original homelands of Indigenous Peoples who have stewarded this Land since time immemorial. Aligning with the university's core value of a diverse and inclusive community, it is an institutional responsibility to recognize and acknowledge the People, culture, and history that make up the Wildcat community. At the institutional level, it is important to be proactive in broadening awareness throughout campus to ensure our students feel represented and valued.



# CoVID-19 in AZ: The Good, The Bad and The REALLY Ugly



<https://s2.dmcn.net/v/SIZ1X1WU3eY6f9--B/x360>

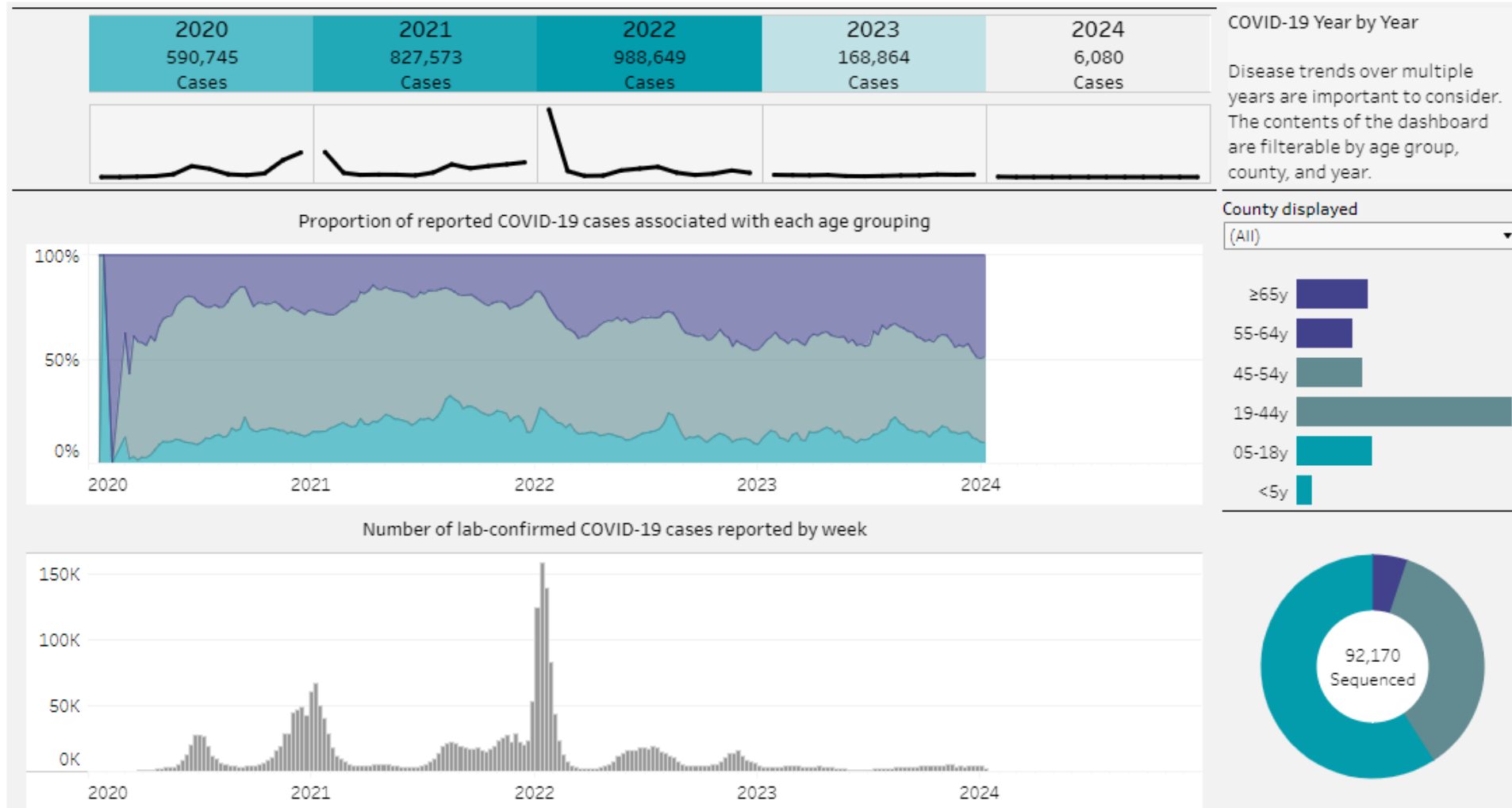


# COVID-19 Surveillance in Arizona

(New dashboard on AZ Dept of Health Services website)

<https://www.azdhs.gov/covid19/data/index.php>

Data pulled 1/23/24





# Where are we at today?

- ❖ Over 2.5M cases reported to the state health department
  - ❖ This is guaranteed to be highly under-reported because it only counts cases that were tested in a laboratory
    - ❖ Does not include results of home tests which have increased dramatically in the last year
    - ❖ Does not include people who were sick and never tested



[www.pima.gov](http://www.pima.gov)



# Vaccination in AZ



Photo: [https://www.cdc.gov/coronavirus/2019-ncov/images/vaccines/covid-19-vaccine-vial.jpg?\\_=65166](https://www.cdc.gov/coronavirus/2019-ncov/images/vaccines/covid-19-vaccine-vial.jpg?_=65166)

- \* Percent of people vaccinated AZ~77% (unclear if this is partial or fully)
  - \* Pima County: ~85%
  - \* Mohave ~47%
  - \* Take those numbers with a little grain of salt – Santa Cruz is reporting 185% of their population vaccinated
- \* Vaccinations in children (under 20) are still pretty abysmal (38.4%)
- \* Vaccination rates go up with increasing age (good news)
- \* Omicron booster uptake has been hovering around 16% (nationally) increasing susceptibility over time



# We're #1...oh wait...

- \* A recent analysis in the Lancet showed Arizona had the highest adjusted death rate in the US during the pandemic
- \* AZ: **581 deaths/100k people**
  - \* (lowest: Hawaii 147/100k or New Hampshire (215/100k)
- \* AZ death rate was on par with countries hit hardest (Russia, Bulgaria, Peru)
- \* States with higher levels of poverty, less access to healthcare, and lower levels of interpersonal trust had higher rates of mortality
- \* States with high vaccination rates linked to fewer deaths (the earth is also round)

Assessing COVID-19 pandemic policies and behaviours and their economic and educational trade-offs across US states from Jan 1, 2020, to July 31, 2022: an observational analysis  
Thomas J Bollyky, JD \* • Emma Castro, MS \* • Aleksandr Y Aravkin, PhD • Kayleigh Bhangdia, MS •  
Jeremy Dalos, MSc • Erin N Hulland, MPH • et al. [Show all authors](#) • [Show footnotes](#)  
[Open Access](#) • Published: March 23, 2023 • DOI: [https://doi.org/10.1016/S0140-6736\(23\)00461-0](https://doi.org/10.1016/S0140-6736(23)00461-0) •





# CoVHORT's Beginning ([www.covhort.Arizona.edu](http://www.covhort.Arizona.edu))

## HOW YOU CAN HELP BEAT COVID-19

### Become part of the solution.

Whether you have had COVID-19 or not, we need your help! By participating in the CoVHORT study, you can help researchers gather the data we need to help better understand COVID-19.

**FIGHT THE VIRUS, JOIN THE COVHORT STUDY ▼**

THE ARIZONA  
**CoVHORT**

COVID-19 Public Health  
Research Study



# What feels like 10 Years Ago...

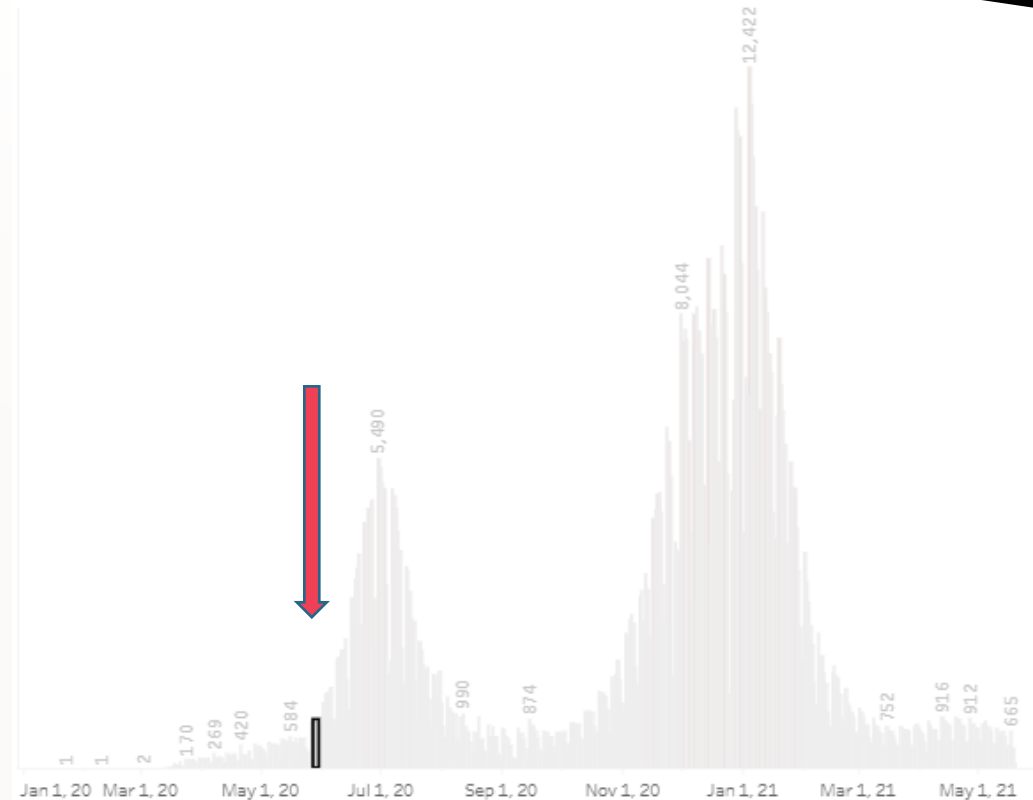
Early 2020 – while most people were focused on shedding their holiday pounds (if only we knew the 'Quarantine 15' was coming we might have tried harder) epidemiologists were getting worried...

March 2020 – UA starts working with Pima County HD to conduct surveillance interviews with people who tested positive for CoVID

April 2020 – PH Faculty start to plan CoVHORT

May 1, 2020 – Awarded seed grant from UA Bio5 Institute to initiate study and mail post cards

May 28, 2020 – CoVHORT launches first online surveys!



# CoVHORT's Overall Mission

- ❖ Determine impacts of COVID-19 in the AZ community
- ❖ Work in a way that recognizes disparities and works WITH communities to collect data
- ❖ Answer questions about a new disease, such as who is likely to contract the disease and why, who is likely to get severely ill and what can be done to mitigate these impacts on public health overall
- ❖ Create an infrastructure for a wider group of researchers to collaborate
- ❖ Work with local agencies to collaborate on research questions and dissemination of findings



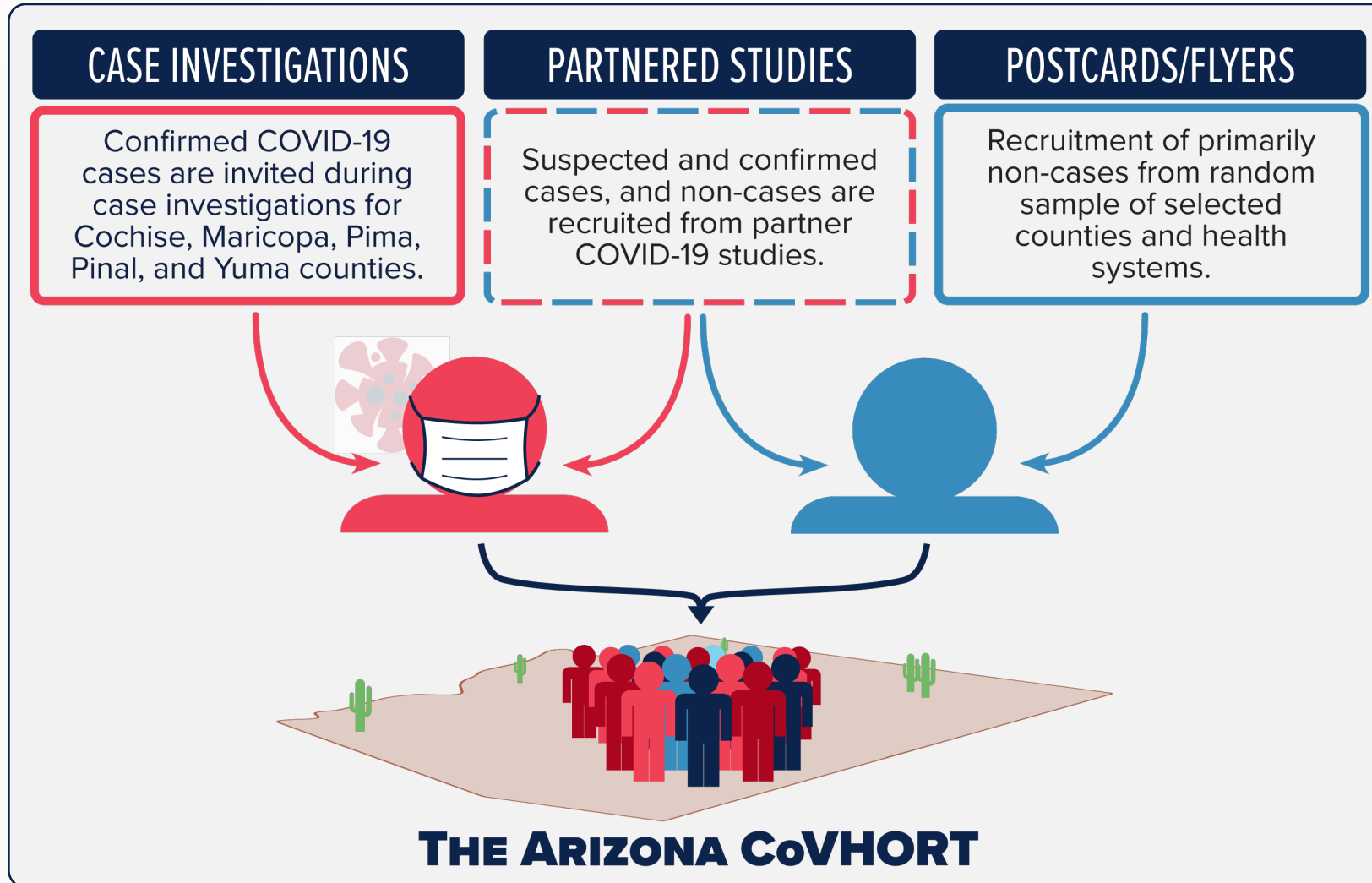


# What did we set out to study?

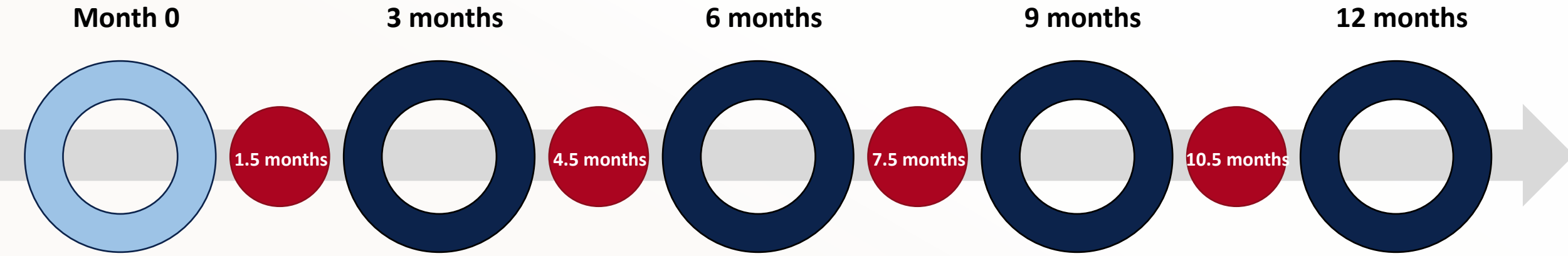
- ✿ A growing cohort of Arizona residents with and without a history of COVID-19 disease with a goal of 10,000 participants.
- ✿ Four primary objectives:
  - 1.Examine how risk factors and co-morbidities impact the severity of COVID-19 disease
  - 2.Identify post-infection chronic health conditions
  - 3.Examine the relationship of disease severity with “long-covid” and what might be done to mitigate these symptoms in people
  4. Determine the impacts of vaccines and vaccine hesitancy on the progression of the pandemic



# Recruitment



# Participant & Survey Timeline



## KEY



**Study Enrollment**  
(includes Consent & Baseline Survey)



**Follow-up survey**



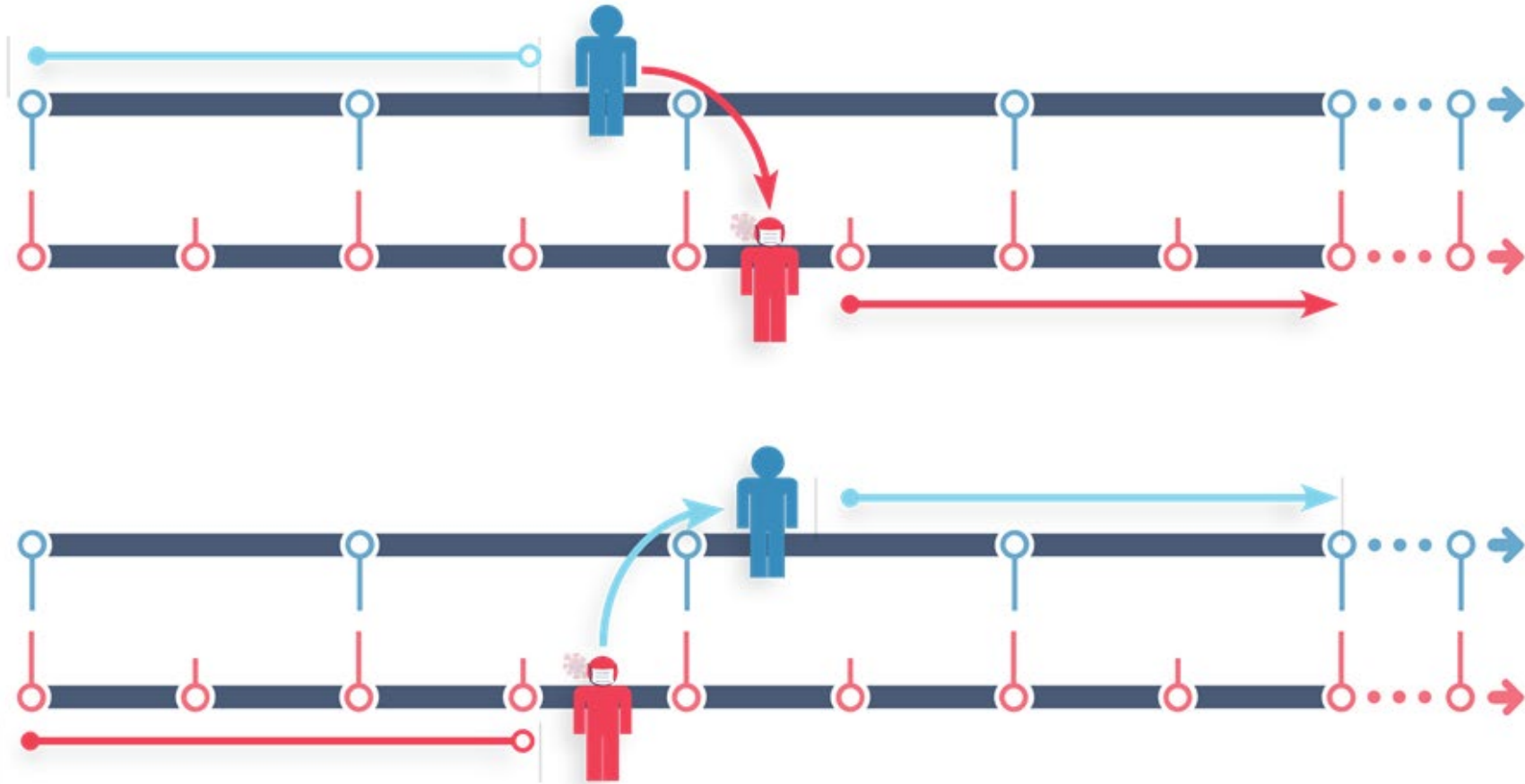
**Symptom Survey**

(completed at specified time points if  
participant reports having COVID-19 or if still sick)

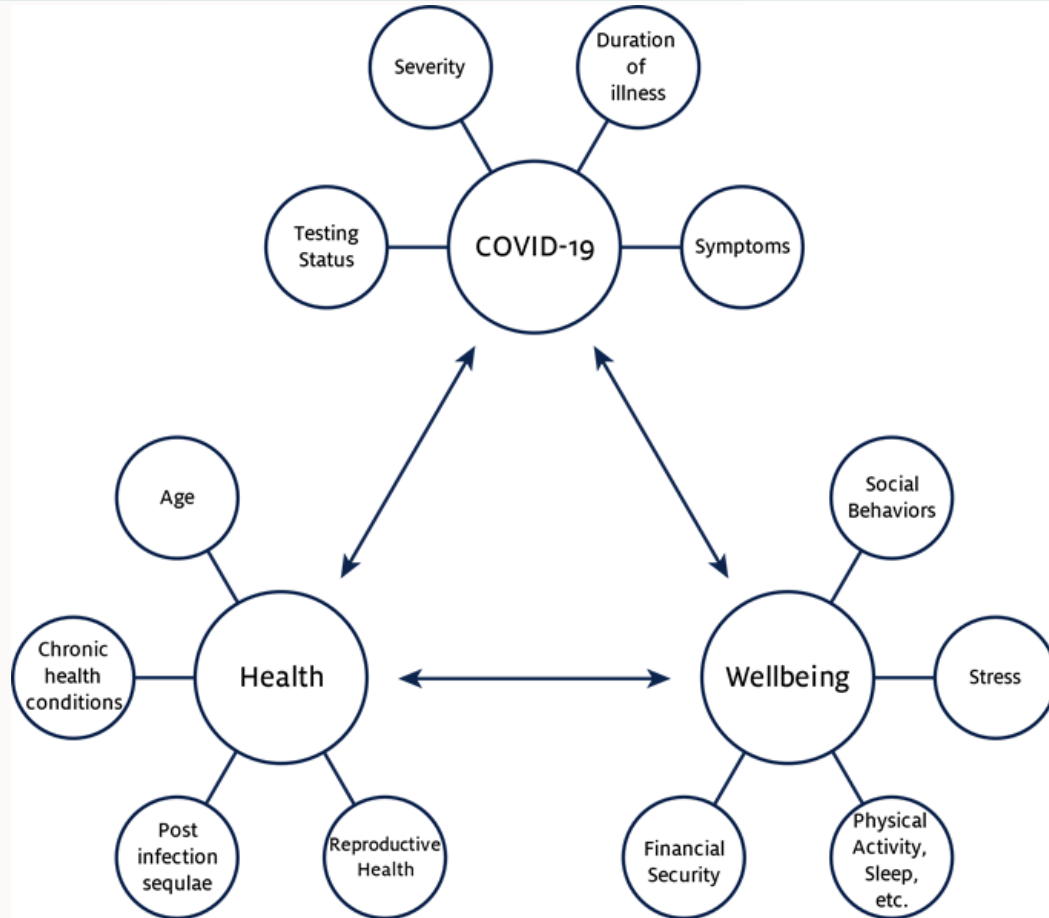




# Participant Experience



# Tell us more about \_\_\_\_\_



**Goal:** To create cohesion among many researchers on the backend so instead of being recruited to participate into a dozen studies, a dozen researchers would create a streamlined survey that covers multiple topics and research questions.

**Ancillary Studies:** Allow you to give us more in-depth information IF it's applicable to YOU and your circumstances.



# How We Protect Participants & Their Information

- ❖ All data is protected in a HIPAA compliant server (those surveys you take on your phone or computer are very well protected on the backend)
- ❖ Very limited access to personal data – If we don't need it (and we usually don't) we can't see it
- ❖ All surveys and consent forms are reviewed by all study investigators EXTENSIVELY and by the University's Internal Review Board
- ❖ Any studies that would involve additional information or samples are always an OPT IN (meaning you must consent to participate, we don't automatically enroll anyone into ancillary or new studies)

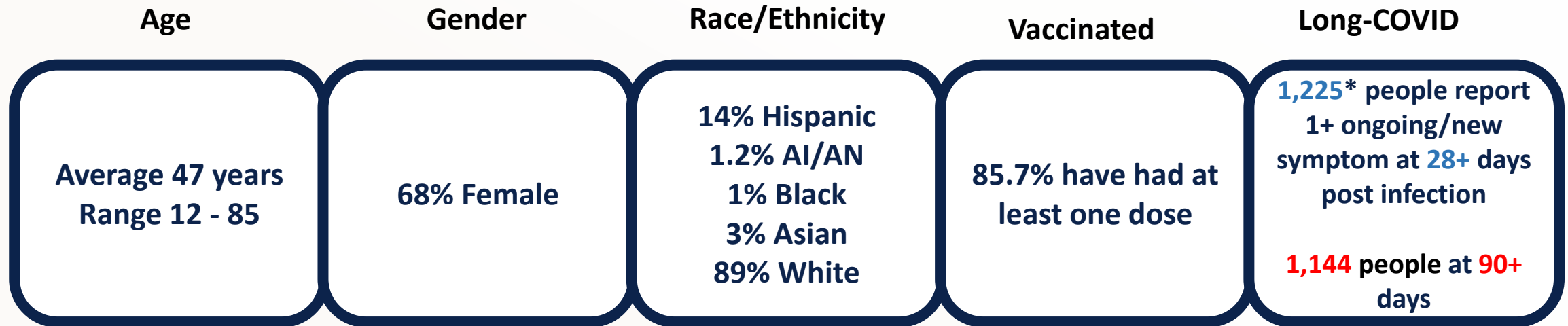


# CoVHORT – Current Enrollment Numbers

- ✱ **8,925** people have completed the Baseline questionnaire
- ✱ 4,510 people have reported testing positive at some time point of their participation
- ✱ 3,837 people have tested negative (just as important for us!)
- ✱ Participation over time
  - ✱ 3 month survey complete – 3,512
  - ✱ 6 month survey complete – 2,554
  - ✱ 12 month survey complete – 3,754
  - ✱ 24 month survey complete – 2,086
  - ✱ 30 month survey complete – 1,473
  - ✱ 36 month survey complete - 600



# Current Study Enrollment: Who's Participating?

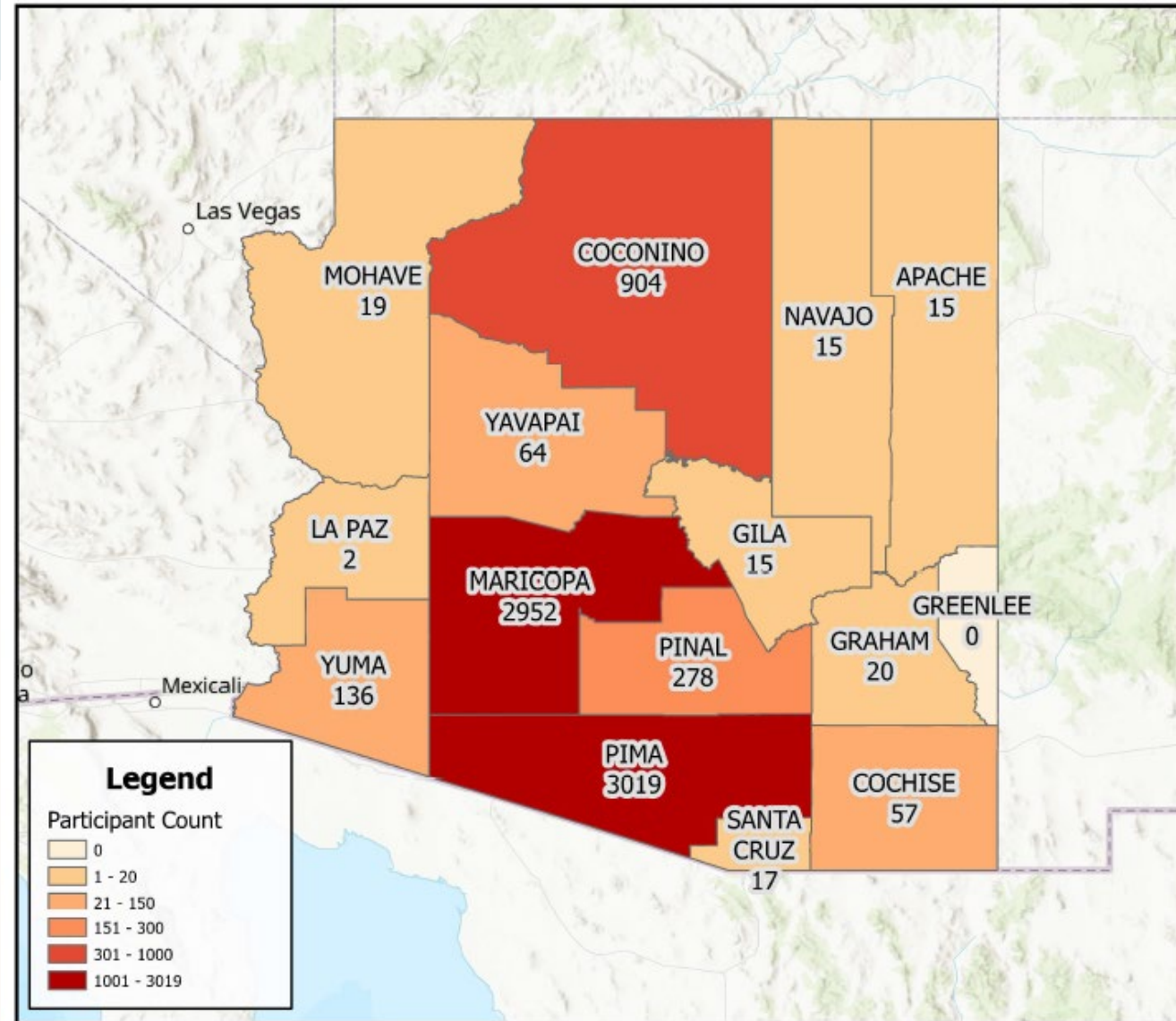


\*based on data collected through 11/28/2023





# CoVHORT Participants by County (as of Jan 2024)



University of Arizona CoVHORT,  
TIGER/line Shapefiles - U.S. Census  
Bureau 2017, County of Yavapai, Esri,  
'fom'fom, Garmin, J,AO, NOAA, USCS,  
EPA, USJ,WS, Esri, CSCS. Map create<l  
1/23/2024



# New Partners to Continue working on Long COVID

- ❖ In September 2022, CoVHORT was awarded a grant from CDC to conduct active surveillance for Long COVID
- ❖ The other half of the surveillance project includes passive surveillance (lead by Dr. Jennifer Andrews in the UA College of Medicine) collecting EHR data with participating clinics across the state linked to AZ Dept of Health Services MEDSIS data
- ❖ For the CDC project, people who are recently (past 3 months) are followed for 18 months to determine the incidence, symptoms and recovery from Long COVID.
- ❖ All Arizonans are still being recruited into CoVHORT and the original question themes remain in the study



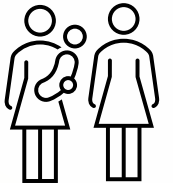
# Other Parallel and Ancillary Studies



RECOVER – NIH Study on biological mechanisms of long CoVID (Dr. Nikolich)



Reproductive Study (sub-study lead by Dr. Leslie Farland)



*CoVHORT participants are made aware of these studies if they meet the inclusion criteria and are invited to participate*



PANGS (Grief sub-study lead by Dr. Mary Francis O'Connor)



GI-PASC (IBS and COVID-19 Study by Dr. Kristen Pogreba-Brown)



# Some of our Published Papers (So Far...)

- \* Elucidating symptoms of COVID-19 illness in the Arizona CoVHORT: a longitudinal cohort study
- \* Design of the Arizona CoVHORT: A Population-Based COVID-19 Cohort
- \* CoVID-19 Infection, the CoVID-19 Pandemic, and Changes in Sleep
- \* A Rasch analysis assessing the reliability and validity of the Arizona CoVHORT CoVID-19 vaccine questionnaire
- \* Post-acute sequelae of COVID-19 in a non-hospitalized cohort: Results from the Arizona CoVHORT
- \* SARS-CoV-2 infection and subsequent changes in the menstrual cycle among participants in the Arizona CoVHORT Study
- \* Persisting gastrointestinal symptoms and post-infectious irritable bowel syndrome following SARS-CoV-2 infection: results from the Arizona CoVHORT
- \* Pre-existing conditions associated with post-acute sequelae of COVID-19



# Long COVID

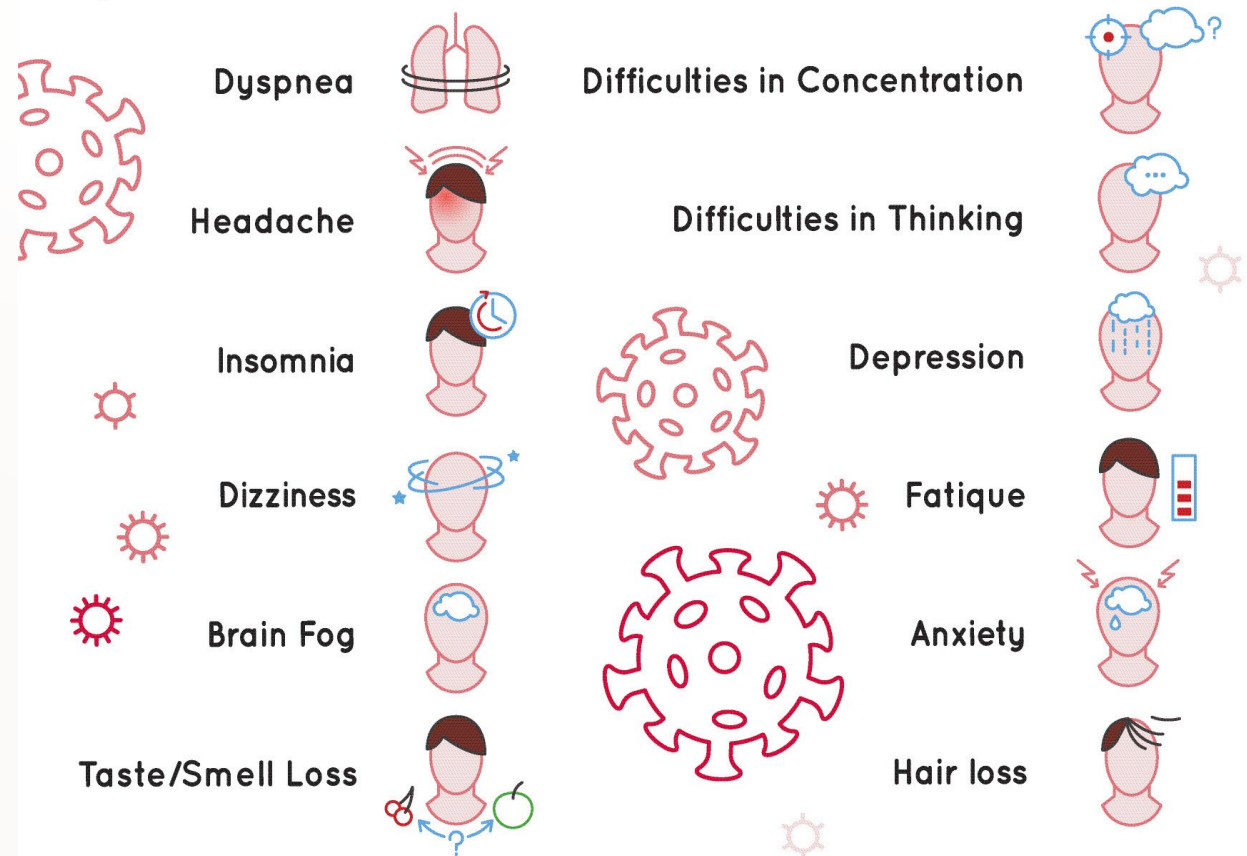
AKA

Post-Acute Sequelae  
of SARS-CoV-2 (PASC)

AKA

Post-CoVID Conditions  
(PCC)

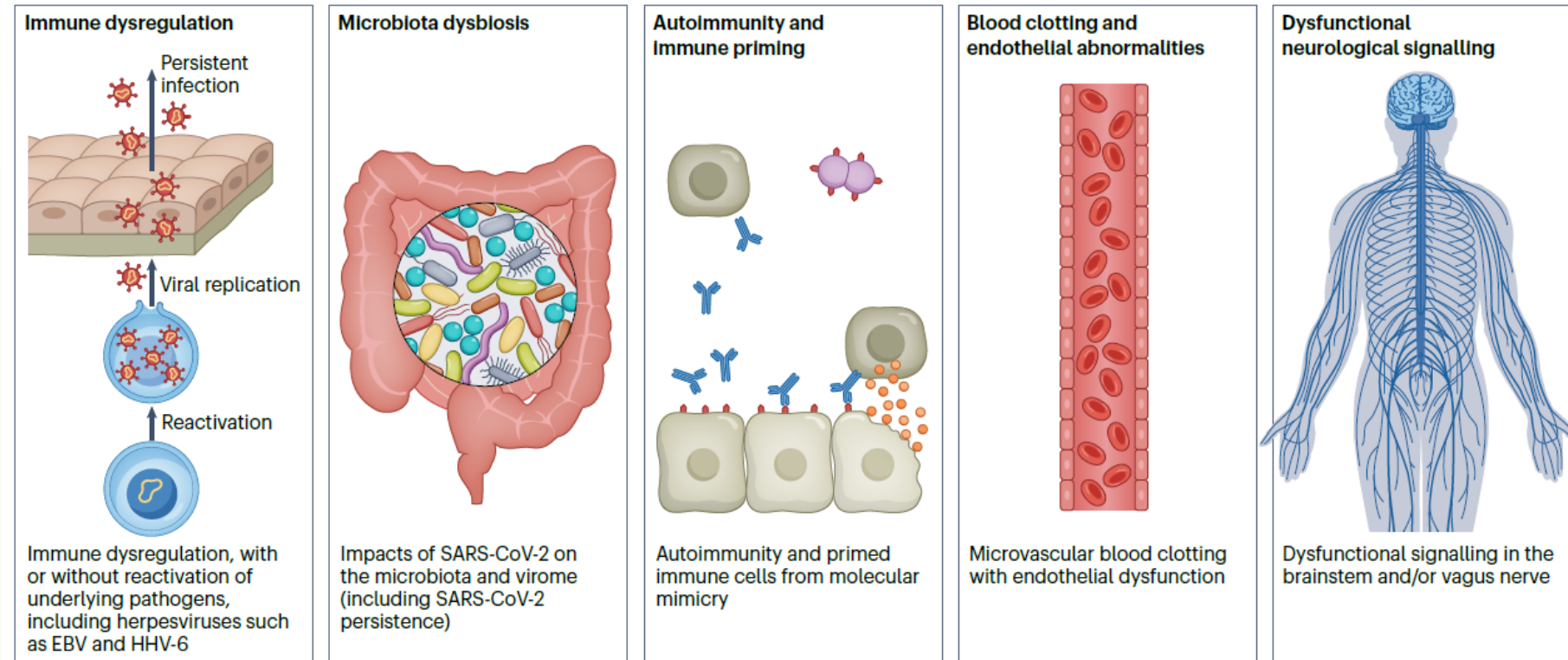
## LONG-TERM EFFECTS OF COVID-19





# LONG COVID

## Possible Mechanisms



**Fig. 3 | Hypothesized mechanisms of long COVID pathogenesis.** There are several hypothesized mechanisms for long COVID pathogenesis, including immune dysregulation, microbiota disruption, autoimmunity, clotting

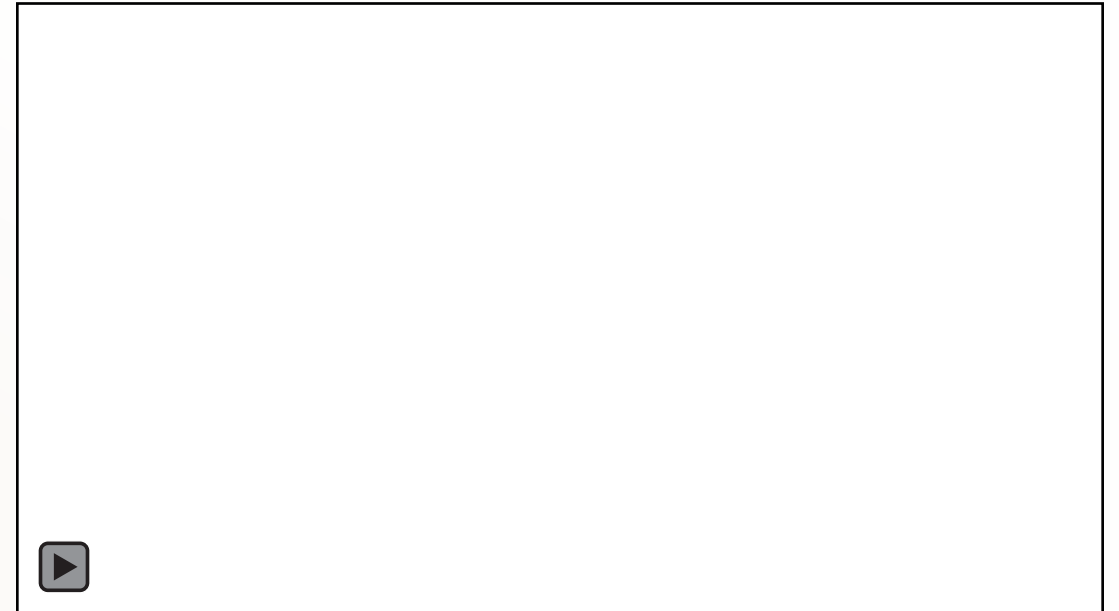
and endothelial abnormality, and dysfunctional neurological signalling. EBV, Epstein-Barr virus; HHV-6, human herpesvirus 6; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

Davis H, et al. Long COVID: major findings, mechanisms and recommendations. Nature Reviews Microbiology. <https://doi.org/10.1038/s41579-022-00846-2>



# Just *some* of the questions we have

- ❄ How many people suffer from long COVID?
- ❄ What are the main symptoms?
- ❄ How many symptoms?
- ❄ What factors are associated with long COVID?
- ❄ Do less severe cases get long COVID at the same rate as more severe cases?
- ❄ How long does it last?



# Results from early analyses (2021 data)

- \* Prevalence of long COVID at 30 days post-infection was 68.7% (95% confidence interval: 63.4, 73.9).
- \* Most common symptoms were:
  - \* fatigue (37.5%)
  - \* shortness-of-breath (37.5%)
  - \* brain fog (30.8%)
  - \* stress (30.8%).
- \* The median number of symptoms was 3 (range 1-20).
- \* Amongst 157 participants with longer follow-up ( $\geq 60$  days), long COVID prevalence was 77.1%.



# Public health implications and unanswered questions

- ❄ Public health problem of massive proportions!

100M+ cases CoVID in U.S. alone

- ❄ Further questions:
  - ❄ How long does it last?
  - ❄ How should it be treated?
  - ❄ Does getting vaccinated help?
  - ❄ Do other treatments, like Paxlovid, reduce incidence?

*Even a small percentage of a big number, is still a big number.*



# Trends in Long CoVID incidence

- Currently have ~1,300 people who have been 'tagged' as LC

People who have tested positive and report ongoing or new symptoms 6 weeks later

SARS-CoV-2 cases and PCC cases among Arizona CoVHORT participants who provided SARS-CoV-2 test dates between January 16, 2020, and January 15, 2023.

Diagnosis Dates	PCC Status			
	No PCC (n=1414)		Developed PCC (n=1168)	
01/16/2020 - 07/15/2020	32	(20.78%)	122	(79.22%)
07/16/2020 - 01/15/2021	257	(41.38%)	364	(58.62%)
01/16/2021 - 07/15/2021	77	(47.83%)	84	(52.17%)
07/16/2021 - 01/15/2022	264	(66.84%)	131	(33.16%)
01/16/2022 - 07/15/2022	604	(59.62%)	409	(40.38%)
07/16/2022 - 01/15/2023	180	(75.63%)	58	(24.37%)
1/16/2023 – 7/15/2023	157	(67.1%)	77	(32.9%)





# Pre-Existing Conditions and Long-CoVID

Out of the 1,224 participants who had COVID-19 that were included in the analyses,



**42%** currently, or previously, experienced long-COVID

Participants who had/still have long-COVID were:



**1.47** times more likely to have a respiratory condition(s) before getting infected

**1.62** times more likely to have a gastrointestinal condition(s) before getting infected



**4.38** times more likely to have an autoimmune condition(s) before getting infected



# Long CoVID and Pre-existing Conditions

**Table 3**

Adjusted ORs (95% CIs) for the development of PASC by pre-existing condition.

Pre-existing condition	n PASC/ Total	Adjusted OR <sup>a</sup> (95% CI)	Adjusted OR <sup>b</sup> (95% CI)	Adjusted OR <sup>c</sup> (95% CI)
Respiratory		1.47 (1.06–2.14)	1.33 (0.94–1.87)	1.25 (0.88–1.78)
Asthma	90/173	1.54 (1.10–2.15)	1.40 (0.98–1.99)	1.33 (0.93–1.90)
Bronchitis or Emphysema	3/5	2.72 (0.44–16.90)	1.66 (0.26–10.44)	1.33 (0.21–8.29)
COPD	6/10	0.67 (0.24–1.91)	0.42 (0.14–1.26)	0.43 (0.14–1.26)
Cardiovascular		0.99 (0.75–1.32)	0.94 (0.70–1.27)	0.89 (0.66–1.21)
Myocardial Infarction	3/6	1.33 (0.26–6.81)	1.51 (0.26–8.79)	1.41 (0.24–8.18)
Heart Disease such as Angina	6/13	1.31 (0.41–4.14)	1.22 (0.36–2.08)	1.03 (0.30–3.49)
Stroke	4/9	1.09 (0.29–4.43)	0.98 (0.22–4.38)	0.83 (0.19–3.74)
High Blood Pressure	101/220	1.10 (0.47–1.52)	1.00 (0.71–1.40)	0.98 (0.70–1.38)
High Cholesterol	85/194	0.95 (0.68–1.33)	0.93 (0.66–1.32)	0.86 (0.60–1.22)
Other cardiac/ heart disease	18/40	1.10 (0.56–2.18)	0.91 (0.45–1.87)	0.87 (0.42–1.80)

Gastrointestinal		1.62 (1.16–2.26)	1.47 (1.04–2.09)	1.32 (0.92–1.90)
Liver Disease	5/8	2.44 (0.56–10.67)	2.38 (0.53–10.77)	2.31 (0.52–10.25)
Ulcerative Colitis	3/5	2.31 (0.38–14.20)	2.29 (0.33–16.12)	1.97 (0.29–13.25)
Irritable Bowel Syndrome	39/70	1.59 (0.97–2.63)	1.40 (0.83–2.38)	1.25 (0.73–2.13)
Chronic Diarrhea	5/9	1.01 (0.25–4.16)	0.93 (0.22–3.96)	0.95 (0.22–4.12)
Chronic Constipation	11/14	4.29 (1.15–16.00)	3.12 (0.83–11.64)	2.65 (0.70–10.10)
Colitis	6/8	3.20 (0.63–16.1)	1.74 (0.34–9.00)	1.61 (0.31–8.23)
Reflux	56/102	1.54 (1.01–2.34)	1.49 (0.95–2.31)	1.33 (0.84–2.09)
Diabetes		1.31 (0.89–1.92)	1.22 (0.82–1.82)	1.10 (0.73–1.65)
Diabetes	29/61	1.15 (0.66–2.01)	0.98 (0.55–1.75)	0.87 (0.49–1.57)
Pre-Diabetes	35/67	1.25 (0.75–2.09)	1.20 (0.70–2.04)	1.06 (0.62–1.83)
Gestational Diabetes	11/17	2.14 (0.78–5.91)	2.31 (0.83–6.37)	2.23 (0.80–6.20)
Autoimmune		4.38 (1.59–12.06)	4.29 (1.49–12.39)	3.78 (1.31–10.91)
Systemic lupus erythematosus	5/5	N/A	N/A	N/A
Multiple Sclerosis	2/3	2.23 (0.20–24.48)	1.42 (0.12–16.77)	1.29 (0.10–16.10)
Rheumatoid Arthritis	13/17	3.69 (1.15–11.82)	3.20 (0.96–10.74)	2.97 (0.88–10.00)



#### Other Conditions

Seasonal Allergies	238/482	1.56 (1.22–1.98)	1.55 (1.20–1.99)	1.48 (1.15–1.91)
Valley Fever	10/16	2.33 (0.83–6.56)	2.20 (0.75–6.47)	2.14 (0.72–6.40)
Cancer	47/103	1.04 (0.67–1.61)	1.14 (0.72–1.81)	1.11 (0.70–1.76)
Kidney Disease	4/10	0.78 (0.21–2.84)	0.75 (0.20–2.84)	0.71 (0.19–2.70)
Thyroid Disease	76/146	1.34 (0.93–1.93)	1.35 (0.92–1.97)	1.30 (0.89–1.91)
Depression/ Anxiety	71/127	1.72 (1.17–2.52)	1.83 (1.22–2.74)	N/A

<sup>a</sup> Model adjusted for age (continuous), BMI (categorical; 18.5–24.9; 25.0–29.9; 30.0–39.9;  $\geq 40.0$ ); gender (ref: female; 1 = male; 2 = nonbinary); race (ref: 1 = white, 2 = Asian; 3 = AI/AN; 4 = AA; 5 = Mixed race; smoking (ref = never smoker; 1 = current smoker).

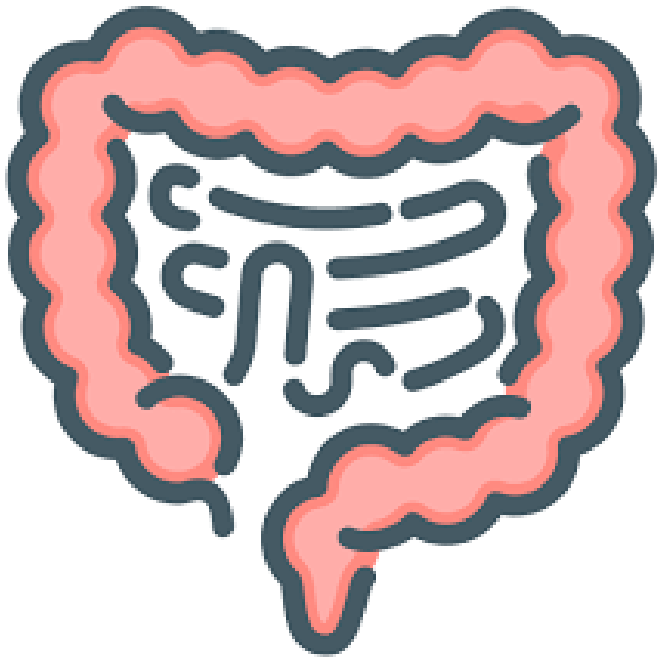


# Findings Associated with Long COVID

- ❖ Consistent with other studies, we have found the vaccination decreases the incidence of Long COVID.
- ❖ Consistent with other studies, we have found that having pre-existing chronic conditions does increase your risk of developing Long COVID. In our AZ data, autoimmune, respiratory and gastrointestinal conditions had the highest risk.
- ❖ As seen in other studies, other risk factors for developing Long COVID are increasing age, female gender, severity of acute illness and pre-existing conditions.



# Gastrointestinal Impacts of COVID-19



**4XS** - GI symptoms during infection, increased odds of having long-term GI symptoms by **FOUR**

30% had symptoms consistent with an IBS diagnosis





# GI Study – Role of Acute Symptoms on Long-Term Outcomes

**Table 2.** Logistic regression odds ratios and 95% confidence intervals for the relationship between gastrointestinal symptoms during acute infection and gastrointestinal symptoms  $\geq 45$  days post-acute infection in adult Arizona CoVHORT participants who tested positive for COVID-19 (May 2020–October 2021)

Acute infection symptoms	$\geq 45$ days GI symptoms n (%) <sup>*</sup>	Unadjusted OR (95% CI)	Adjusted <sup>a</sup> OR (95% CI)	Sensitivity analysis adjusting for missingness <sup>b</sup> OR (95% CI)	Sensitivity analysis with new GI definition <sup>c</sup> OR (95% CI)
GI symptoms ( <i>n</i> = 499)	45 (9.0)	4.04 (2.42–6.77)	4.29 (2.45–7.53)	3.63 (2.09–6.28)	4.27 (1.62–11.21)
No GI symptoms ( <i>n</i> = 976)	23 (2.3)	–	–	–	–

Abbreviations: GI, gastrointestinal; OR, odds ratio; CI, confidence interval.

<sup>\*</sup>Proportions take into account lost to follow-up: *n* = 4 for GI symptoms, *n* = 22 for no GI symptoms.

<sup>a</sup>Adjusted for age, sex and perceived stress via the Perceived Stress Scale (PSS).

<sup>b</sup>Adjusted for the same covariates. Missing perceived stress values were imputed with the subject mean for each item if less than 5 items were missing, or with the 6-week PSS if enrolment was in the original CoVHORT survey when PSS scores were not asked at baseline.

<sup>c</sup>Adjusted for the same covariates. New outcome definition of GI symptom presentation to  $\geq 180$  days post-acute infection.



# GI Study – Role of Pre-Existing Conditions

**Table 3.** Effect modification of gastrointestinal symptoms during acute infection and gastrointestinal symptoms  $\geq 45$  days post-acute infection by chronic condition status in adult Arizona CoVHORT participants who tested positive for COVID-19 (May 2020–October 2021)

	No acute GI symptoms		Acute GI Symptoms		ORs (95% CI) for acute GI symptoms within strata of chronic disease status
	<i>N</i> with/without $\geq 45$ days GI symptoms	OR (95% CI)	<i>N</i> with/without $\geq 45$ days GI symptoms	OR (95% CI)	
No chronic conditions	7/381	1.0	16/154	4.29 (2.45–7.53) $P < 0.001$	8.34 (2.91–23.94) $P < 0.001$
At least 1 chronic condition	16/550	1.18 (0.66–2.11) $P = 0.57$	29/296	4.27 (2.43–7.51) $P < 0.001$	3.18 (1.62–6.26) $P = 0.001$

Abbreviations: GI, gastrointestinal; OR, odds ratio; CI, confidence interval.

All ORs are adjusted for age, sex and perceived stress via the Perceived Stress Scale (PSS).



# Impacts of COVID-19 on Menstrual Cycle



**16%** of the participants reported changes to their menstrual cycle after infection

Irregular (60%) and infrequent (35%) menstruation (60%), increase in premenstrual syndrome symptoms (PMS) (45%)

More likely to report a greater number of COVID-19 symptoms, including fatigue, headache, body aches and pains, and shortness of breath and to identify as Hispanic



# WE'RE RECRUITING!!!

## [www.covhort.arizona.edu](http://www.covhort.arizona.edu)

### ❄️ CDC Surveillance for Long COVID

- ❄️ Recent infections of CoVID-19
- ❄️ Ages 12+
- ❄️ Surveys only

### ❄️ NIH R01 Study on GI and COVID

- ❄️ Role of pre-existing IBS
- ❄️ IBS and other GI outcomes as part of LC sequelae
- ❄️ Surveys and biospecimens

### LEARN MORE ABOUT THE ARIZONA COVHORT STUDY



Our Researchers



How Adults Can Participate



How Teens Can Participate



# Thank you to our funders!

- ✿ Arizona Biomedical Research Centre

- ✿ New Investigator Grant (2022-2025)

- ✿ National Institutes of Health

- ✿ R01 (2023 – 2027)

- ✿ Centers for Disease Control

- ✿ Cooperative Agreement (2022 – 2026)



ARIZONA DEPARTMENT  
OF HEALTH SERVICES

ARIZONA BIOMEDICAL RESEARCH CENTRE



National Institute of  
Diabetes and Digestive  
and Kidney Diseases



CENTERS FOR DISEASE  
CONTROL AND PREVENTION

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# Questions?

