Transcript

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Patrick Ahearn:

So once again, hello and welcome everyone to today's session of the R3 seminar series, Social Determinants of Health and Long COVID: Insights from the RECOVER Observational Studies. My name is Patrick Ahearn with RTI, and I'll be helping out with the virtual room today.

So just a few quick housekeeping notes before we get started. Note that when you log in, your microphone and web camera are automatically muted and turned off, but if you have any questions for presenters today, please submit those into the Q&A window at any time. And if you run into any technical issues, please let me know in the Q&A window as well. Closed captions are available during today's webinar. Just click on the "show captions" button on your main Zoom toolbar to turn those on.

So, at this time, I'll turn things over to my colleague Quinn to introduce us to today's session.

Thank you.

Quinn Barnette:

All right. Good afternoon and welcome everyone to the RECOVER Research Review or R3 Seminar. My name's Quinn Barnette. I'm an epidemiologist with the RECOVER Administrative Coordinating Center, and I'll be your moderator for today's session.

The goal of the R3 seminar series is to share the RECOVER Initiative's research findings with researchers and the public. These seminars accelerate scientific discovery by allowing experts to share their latest insights on Long COVID and related conditions. In today's seminar, the panelists will present their research on how various social factors impact a person's risk for developing Long COVID. These findings further our understanding of how conditions in a person's daily life may contribute to Long COVID outcomes. I want to start by thanking everyone who submitted questions in advance and remind everyone that you can submit questions during today's presentations using the Q&A feature in your Zoom menu. After today's panel, our speakers will answer as many questions as possible.

The Q&A document will also be posted with the recording of the seminar on recovercovid.org. This document will include the answers for submitted questions relevant to today's presentations and questions about other scientific topics will be addressed in future seminars, and answers to broader questions about RECOVER will be available in the FAQs found at recovercovid.org.

As a reminder, we cannot answer questions about individual clinical care.

I'm pleased to share that our panelists today are Dr. Candace Feldman, Dr. Kay Rhee, and Ms. Brittany Taylor, and our discussant will be Dr. Beth Karlson.

Dr. Feldman is a practicing clinical rheumatologist and social epidemiology researcher at Brigham and Women's Hospital and Harvard Medical School. Her research focuses on risk factors for adverse outcomes and interventions to address barriers to care among individuals with chronic rheumatic conditions. She holds national leadership roles across the lupus and rheumatology communities.

Dr. Rhee is a professor of pediatrics at UC San Diego School of Medicine, Vice Chair of Equity, Diversity and Inclusion, Chief of the Divisions of Child and Community Health and Adolescent Medicine, and the Medical Director of the Inpatient Eating Disorder Unit at Rady Children's Hospital San Diego Medical Behavioral Unit and the UCSD Center for Healthy Eating and Activity Research. She has special interests in childhood eating and weight-related disorders and has multidisciplinary training in family-based behavioral therapy, parenting skills training, motivational interviewing, epidemiology, and social psychology.

Ms. Taylor is a public health practitioner with 15 years of experience overseeing and implementing projects focused on health equity, chronic disease management and prevention, infectious disease control, tobacco cessation, and women's health. She's a leader in public health practice and community engagement and is deeply committed to health equity and community through inclusive service. Ms. Taylor has held leadership positions with the RECOVER Initiative, the CEAL Alliance, National Million Hearts Initiative, Deloitte CDC [Canadian Delivery Centre] Diversity and Inclusion Team, and the National Association of Chronic Disease Directors, and was previously appointed to serve as an inaugural co-chair for the National Community Engagement Group on the RECOVER Initiative. Currently, Ms. Taylor is among the inaugural global health equity PhD cohort in the nation's first School of Global Health at Meharry Medical College.

Finally, Dr. Karlson is professor of medicine at Harvard Medical School, vice president of Mass General Brigham Personalized Medicine, and a rheumatologist and epidemiologist at Brigham and Women's Hospital. Dr. Karlson has leadership roles in numerous multi-institutional research projects, including the eMERGE Clinical Center at MGB, the *All of Us* Research Program, New England Consortium, and the post-acute sequelae of SARS-CoV-2 Data Resource Corps. Dr. Karlson has expertise in longitudinal cohort studies, disease epidemiology in genetics, biobanking, and the use of bioinformatics to define phenotypes and electronic health records.

The topic of today's seminar is Social Determinants of Health and Long COVID: Insights from the RECOVER Observational Studies. Today's speakers will present findings from the RECOVER Adult Observational Cohort studies about the effect of social risk factors or conditions in a person's daily life and a person's risk for developing Long COVID. They'll also present ongoing work from the RECOVER Pediatric cohort on the relationship between social risk factors and a child's risk of Long COVID.

Please welcome all of our speakers, and with that, I'll turn it over to our first speaker, Dr. Feldman.

Dr. Candace Feldman:

Hi, everyone. Thanks so much for this opportunity to present to all of you today. As mentioned, I'm going to talk a bit about social determinants of health and Long COVID, with a specific focus on the adult RECOVER population. So, I have a couple of goals for the next 25 or so minutes. First, I'll present a framework to understand social determinants of health. Then I'll discuss a bit about the role of social determinants of health on COVID-19 infection burden and severity. And then I'll describe associations that we found between social determinants of health and Long COVID in the RECOVER adult prospective cohort. And finally, I'll present to you some limitations and potential implications of our study findings.

So first, I'd like to start with some definitions. Social determinants of health are defined as the non-medical factors that influence health outcomes. They're the conditions in which people are born, work, live, and age, and the wider set of forces and systems that shape the conditions of daily life.

What you'll see on this side of the screen here is a wheel that is part of the CDC Healthy People 2030 description of social determinants of health. And what they present are five domains, four social determinants that include healthcare access and quality, neighborhood and built environment, social and community context, economic stability, and education access and quality.

Social risk factors or adverse social determinants of health, such as lower educational attainments, financial food and housing insecurity, to name a few, are associated with poorer health and poor health outcomes. What we know across many studies and across many different fields of medicine and public health are that social risk factors contribute to differences in the burden and distribution of acute and chronic conditions.

There have been a number of studies that have looked at the impact of social determinants of health on COVID-19 infection. Studies have shown that poverty, difficulty accessing food, and working in essential occupations were associated with a greater burden of COVID-19 infection, as well as with more severe disease. In addition, we've learned that where you live also contributed to COVID-19 infection and outcomes, and living in neighborhoods with concentrated poverty and also in more crowded households contributed to a higher risk of COVID-19, as well as to poor outcomes. We also know that individuals who experienced poverty suffered more from the pandemic. They had greater unemployment, a greater loss of health insurance, more housing instability, food insecurity, and more difficulty recovering following infection. What we also saw were that Black and Hispanic individuals experienced poorer COVID-19-related outcomes, and this was oftentimes associated with the greater social risk factor burden that existed in these populations.

So, what are the mechanisms behind the association between social risk factors and COVID-19 infection and infection severity? Well, a key factor has thought to be related to poor access to care, whether it's from lack of English proficiency, lower health literacy, or technological barriers; all of these factors as well as others impacted a person's ability to get care when sick.

Adverse environmental exposures likely also play a role, whether we think about those exposures from where a person lives or where they work. We know that infections spread more rapidly in people who lived in more crowded living conditions, and we also know that experiences of discrimination contribute to mistrust in healthcare, which reduces healthcare-seeking behavior and also reduced uptake of COVID-19 vaccinations.

Finally, we also know that there's biological embedding of adverse lived experiences and exposures. And we know that individuals with more chronic conditions had a higher likelihood of having poor outcomes from COVID-19 infection. We know that experiencing discrimination across generations, living in neighborhoods of higher poverty all contribute to persistent adverse lived experiences, increased stresses, persistent exposures, and a higher likelihood of all chronic conditions that have really been studied.

So, what about social determinants of health and Long COVID? So, to date, there are a couple of studies that look at these factors. In the United Kingdom, a study found a higher risk of Long COVID among individuals who lived in areas of high compared to low neighborhood deprivation. A US-based study found a greater risk of Long COVID–related organ involvement among individuals who lived in ZIP codes with higher levels of air pollutants, as well as in neighborhoods with greater deprivation and poorer food access. However, there are a few studies to date that prospectively, so looking forward over time, examine these factors at both the individual and the neighborhood level.

So, with this in mind, we aim to determine whether social determinants of health are associated with risk of Long COVID. We hypothesize that individuals with versus without social risk factors and adverse area-level exposures at the time of acute COVID-19 infection would have a higher risk of developing subsequent Long COVID. To do this study, we included individuals who were enrolled in the NIH-funded US Research and COVID to Enhance Recovery Initiative, known as RECOVER. Our focus for these specific analyses was on individuals 18 and over who were enrolled between October 2021 and November 2023 from 33 US states plus Washington, DC, and Puerto Rico.

We specifically focused on this prospective cohort, which means these were individuals who enrolled within 30 days of an active COVID-19 infection and were followed going forward or prospectively for at least 6 months after that date, and at that 6-month mark, completed a set of surveys that included symptoms that could be consistent with Long COVID.

For our outcome, we used the research definition of Long COVID, which was a published index that was based on symptoms collected 6 or more months following the acute COVID-19 infection date. And this initial definition was revised and published in *JAMA* in 2025, and we used this revised definition.

What this study found was that symptoms were more common in people who had COVID than in people who never had COVID, and scores greater than or equal to 11 were considered to meet the research definition of Long COVID. Well, the scores came from the factors that you can see in the table here, so loss of smell or taste, post-exertional malaise, chronic cough, brain fog, thirst, palpitations, chest pain, fatigue, dizziness, shortness of breath, and snoring or sleep apnea with different points given to different factors. Scores less than 7 were considered Long COVID indeterminate, meaning that these individuals could have some symptoms but didn’t have a high-enough score to meet the research definition.

Our primary exposure was presence or absence of specific social risk factors, and we used that CDC social determinants of health framework that I presented to you a few slides back that was based on questions that were collected as part of the RECOVER surveys that were completed at the time of acute COVID-19 infection. So, these included questions within a number of domains. So first, within economic insecurities, these included questions related to financial hardship, poverty, housing, and food insecurity and unemployment, questions related to healthcare access challenges, including discrimination and healthcare, difficulty with healthcare access, loss of insurance during the pandemic, and being uninsured or publicly insured. Education and literacy access challenges included less than college, a college degree, and primary language other than English, social and community challenges, including lack of social support, lack of neighborhood togetherness or cohesion, experiences of discrimination in the everyday setting, and not being married or living with a partner. And finally, we use the ZIP code where a person lives to approximate a neighborhood, and within those neighborhoods, we linked their data to US census data to calculate the percent of people in the ZIP code where they lived who lived in poverty and the percent in the ZIP code who lived in crowded households.

For our methods, we estimated marginal probabilities and risk ratios for each specific social risk factor and ZIP code exposure, and all of our models were adjusted by a number of factors, including age, sex, race, ethnicity, disability status, number of chronic conditions at the time of acute infection, receipt of COVID-19 vaccinations, hospitalization for COVID-19 as a marker of disease severity, and pregnancy status to determine the relationship between social risk factors and Long COVID over and above these other factors. So, the focus for the rest of my talk today is specifically going to be on those social risk factors with the idea that in our models, we held the other factors constant to look specifically at the association of these social risk factors with Long COVID.

So, for our results in this cohort, we identified 300—sorry, excuse me—3,787 individuals who met our inclusion criteria. And of those individuals, 418 or 11% met that Long COVID research definition at 6 months. The mean age was 49; 69% were female; 60% were White; 14% Black or African American; 13% Hispanic, Latino, or Spanish; 7% Asian; and 4% identified as more than one race. Six percent were pregnant at the time of infection, 7% had high school or less education, and 69% had at least one other chronic health condition at the time of their acute infection.

So, in this table, you'll see the distribution of social risk factors using those domains from the Healthy People 2030 social determinants of health schema. And what I want to highlight are just a couple here. So, what you can see here is in the overall cohort, about 29% indicated that they experienced financial hardship.

And when we look among those who met the research definition for Long COVID, 53% of those individuals had experienced financial hardship compared to 26% of individuals who did not meet the criteria for Long COVID.

There were about 28% of people in the cohort who had less than a college education. Among those who met the definition for Long COVID, 44% had less than a college education, compared to 26% who did not meet the definition. Overall, about 18% of the cohort indicated that they had experienced medical discrimination, 37% of individuals who met the definition of Long COVID compared to 16% among those who did not. And just to pick one of these lack of community or social support factors as an example, 38% of the cohort indicated they were not married or living with a partner, and 47% of individuals who developed Long COVID indicated this compared to 37% among those with Long COVID, who were unlikely to have Long COVID. And you can see here that that distribution of these factors really tracks with a number of these other factors as well, where there's a higher percentage of individuals who experienced these social risk factors among those who developed Long COVID compared to those who did not.

This figure here shows the distribution of social risk factors by racial and ethnic groups within the social risk factor domains that I described before. The light blue bars represent Black individuals who identified as Black or African American. The light turquoise indicates Hispanic, Latino, or Spanish, and the darker green more than one race. And one thing that's important to note from this figure is that if you look at each of these domains, you can see a higher burden of nearly all of these specific social risk factors among individuals who identified as Black or African American, Hispanic, Latino, or Spanish, or more than one race compared to White, which are these hatched lines here. And this really held true for nearly all of the economic instability measures, for the healthcare access and quality challenges, for the education and language barriers, as well as for the lack of social and community support domains.

Now going to our models, what I'm going to present now are each of the specific categories and the specific risk factor and association between that risk factor and the risk of Long COVID. All of the data that I'm presenting here are what we call adjusted marginal risk ratios, which means that each of these specific models are adjusted for all of these factors that you see in blue, which I had mentioned previously. So, what you can see here is that each of these specific factors, so presence of housing insecurity, presence of financial hardship, presence of food insecurity, or living below the federal poverty line, all were associated with significantly higher risk of developing Long COVID. So, for example, financial hardship was associated with over 2 times higher risk of developing Long COVID. Similarly, individuals who were food insecure compared to individuals who were not food insecure had more than a 2-fold greater risk of developing Long COVID.

We found a similar finding among those who had less than a college education compared to those with greater than college education, with more than 1.5 times greater risk of Long COVID. Among individuals who experienced healthcare access and quality challenges, we similarly found very strong associations with Long COVID. So individuals who experienced medical discrimination had nearly a 2.4-fold higher risk of Long COVID, those who lost insurance during the pandemic, nearly 2.3 times higher risk, those who skipped care or medical care specifically due to the cost of the care, had almost a 3-fold higher risk of developing Long COVID, and being Medicaid insured or uninsured was also associated with a significantly higher risk.

Similarly, lack of social or community support factors were associated with a greater risk of Long COVID. Here, you can see the strongest association among individuals who had poor social support compared to those who had greater social support with a nearly 1.8 times higher risk of Long COVID, and each of these factors similarly were associated. So, it's those who experienced discrimination compared to those who did not frequently experience discrimination, those who lived in neighborhoods that did not have strong togetherness, had nearly 1.4 times higher risk.

In terms of the area-level metrics, we found a trend towards a potentially higher risk of Long COVID among individuals who lived in areas with more concentrated poverty. However, that risk was not statistically significant. We did find a statistically significant increased risk of Long COVID among those individuals living in neighborhoods that had higher household crowding with about 1.4 times higher risk.

So, we did do a couple of additional analyses that I'll briefly mention. One of the things that we were interested in is we know that each individual social risk factor was associated with a higher risk of Long COVID, but we wondered whether having more social risk factors was associated with even higher risk. And what we found was that that in fact was the case. So, we found a dose-dependent, higher risk of Long COVID associated with greater social risk factor burden, meaning that individuals who, for example, had two, three, or four healthcare access and quality challenges had even greater risk of developing Long COVID compared to individuals who had one risk factor.

We also examined models where we did not adjust for race/ethnicity, and we found persistently significant associations between social risk factors and Long COVID, but the orders of magnitude were slightly less robust, so the risk ratios were a little bit lower. We also examined models that were stratified by racial and ethnic group, meaning we wanted to see whether there was a difference in the association between social risk factors and Long COVID for, for example, individuals who identified as Hispanic compared to individuals who identified as Black compared to individuals who identified as White.

And what we found were really similar estimates across most social risk factors between each of the racial ethnic groups, but slightly stronger associations between homelessness and Long COVID and between food insecurity and Long COVID among individuals who identified as Hispanic.

It's important to note that all studies are with limitations, and ours certainly did have some as well. So, one important thing to mention is that while great efforts were taken to have as representative a study population as possible, no study population that I know of can ever really be fully representative, and there were some significant factors in this population that I think are important to highlight. So first, this population really did have a very high educational attainment with really only 7% of individuals who had a high school education and less, so over 90% with greater. In addition, over 90% of the population enrolled in this study were English speaking.

While we did have a robust set of social risk factors that were collected as part of the RECOVER questionnaires, they did not, certainly, include every single social risk factor that a person could be exposed to. So, for example, because, in order to protect patient confidentiality, we didn't have full addresses, we only had ZIP codes, we weren't able to link to more granular environmental exposure data or neighborhood exposures.

It's also important to note that we used a research definition of Long COVID, which certainly may not include all individuals who had related symptoms but didn't have the specific symptoms that were part of that index.

And finally, with all studies like this that are observational longitudinal studies, our findings demonstrate associations but don't necessarily say that the exposures that we examined caused the outcome.

In conclusion, we found strong and consistent associations between the presence of economic, social, educational, and healthcare access and quality-related challenges and a higher risk of Long COVID in the adult RECOVER cohort. For most social risk factor exposures, we observed dose-dependent associations, meaning that for more risk factor exposures, there was even higher risk of developing Long COVID, and these persisted after accounting for all of the covariates that we included in our models, all of which had previously been shown to be related to the risk of Long COVID.

So, as we think about the implications of our findings, one important thing to remember is that this study is an observational study where we looked at associations between risk factors and outcomes, but it isn't a mechanistic study. So further studies are needed to really understand what's driving this. What's driving the strong associations that we see between presence and burden of social risk factors and Long COVID?

We, as I mentioned, used a very specific definition of Long COVID, but using different definitions, and possibly broader definitions, may reveal additional associations.

Further, while we did have a quite representative cohort, additional studies are needed, both in our country and also internationally, that look at other social determinants of health and other populations to determine if the findings that we see here replicate.

It is also important to think about what to do with the findings that we have, and what I would argue is that, at this point, interventions are needed to address disparities in social risk factor distribution, knowing that improving access to care and the overall health of populations disproportionately affected likely has the potential to affect Long COVID, but also a number of other chronic conditions.

And finally, as we think about all of our rules, advocacy is needed to think about the upstream drivers of these differences that we observed in this study that have also been shown in other studies of chronic conditions.

So, I'd finally like to thank the National Community Engagement Group, NCEG, all patient, caregiver, and community representatives, and all of the participants enrolled in the RECOVER Initiative without which this study would not have been possible. I'd like to acknowledge the really important contribution of the RECOVER Social Determinants of Health Writing Committee, all of whom were integrally involved in every aspect of the design, the analysis, the implementation, and the synthesis of the findings I presented to you today. I'd like to acknowledge the RECOVER Adults and Pregnancy Cohort participants and teams that also contributed to this work and also our funding source, which is the National Institutes of Health. Thank you.

Dr. Kay Rhee:

Great. Let me share my screen and I will continue on. Okay. So, thank you, Candace, for setting me up really well, actually, for talking about the Pediatric Cohort and what we have found. So we, similarly, were looking at the risk and resiliency factors associated with Long COVID in pediatrics, and Candace did a very nice job describing the social determinants of health. Unbeknownst to us, we actually picked the similar framework in the Pediatric Cohort that the Adult Cohort did, so I won't be going into all of these details again, because it is pretty much the same as what Candace just presented. And in the pediatric world as well, there are lots of historical literature talking about the impacts of adverse social determinants of health and many pediatric outcomes as well, poor child health status, family conditions as well, so I won't be going into that at this point.

But one of the things I wanted to bring up with this concept of looking at social determinants of health, in the pediatric world, this concept really fits very well into the concept of adverse childhood events. And within that framework, all of these factors are considered to be stresses in the child's life, in the family's life, and they are either acute or chronic. And so, when you think about all of these adverse social determinants of health, they are essentially adding stress to a person's life.

And so, if you look at the left-hand side with acute stress responses, we see in the brain hypothalamic-pituitary-adrenal gland axis, the HPA axis, we see that when there are stressors, we have increased CRH [corticotropin-releasing hormone], ACTH [adrenocorticotropic hormone], glucocorticoids. Our body is responding in this fight or flight manner. But in that response, once you get high-enough levels of glucocorticoids and things, you start to trigger a negative feedback loop. So, you turn off some of these responses, these hormone levels start to go down, and you get back to what we would call a steady state or a normal state, not a stressed state.

But when we think about the adverse social determinants of health that Candace so nicely described, a different mechanism potentially is occurring here. And so, the initial acute response happens, but over time, as these responses continue to go on, the hypothalamus and the brain stop reacting to some of these signals. And so, you continue to get elevated ACTH, glucocorticoid stress responses, which then lead to things that will contribute to the poor health outcomes that we see and have been associated with things like weight gain, high blood pressure, risk for type 2 diabetes, and poor immune function, which is something I wanted to highlight.

Because when we think about Long COVID, Long COVID is essentially a post-viral syndrome, and so if we are in a state, if our body is in a state of increased susceptibility to outside forces, then the risk of potentially developing something like Long COVID could be higher. And that is why the Adult Cohort, the Pediatric Cohort really wanted to examine what are some of these outside forces that may increase the risk of developing something like Long COVID.

If you haven't seen this article before, this article really talks about hypothesized mechanisms of Long COVID, and some of them that are really pertinent to what we're talking about is this idea that there is some immune dysregulation that occurs. And so, if our bodies or our patients' bodies are more susceptible to getting disease, then there is potentially an increased likelihood of them developing Long COVID.

So similar to the Adult Cohort, our study aim was to examine whether adverse social determinants of health factors were associated with increased odds of Long COVID in school-aged children and adolescents. And similarly, we hypothesized that there would be several adverse social determinants of health factors that could be associated with increased odds of Long COVID. So, for us, we also used a RECOVER Cohort to look at this question.

For all of the surveys that were completed in the Pediatric Cohort, I just wanted to point out that a lot of these surveys were completed by the parents or the caregivers. And so, when I talk about what we've done, a lot of it is looking at the parent–child dyad, but the outcome is for the child. Is it the child that develops Long COVID? So, we recruited from 60 sites around the United States and Puerto Rico. We also tapped into the Adolescent Brain Cognitive Development Study that had an existing cohort of about 11,000 teens to recruit from that cohort as well.

We looked at caregivers who completed surveys between the time of March 2022 to August 2024, and we only included surveys that were completed at least 90 days after the reported SARS-CoV-2 infection so that we could see if the symptoms had existed for at least 90 days. We also excluded any participants who had a reinfection within 30 days of completing the survey because we didn't want to sort of confound the symptoms between another infection versus Long COVID.

For this analysis, we also only looked at children between the ages of 6 and 17. We've published a couple of manuscripts at this point looking at the different symptoms that occur across the life course. And so, for that reason, we just focused on children and adolescents, with the idea of potentially looking at them separately, but I'll say in a few slides that we actually were able to combine them because of the similarity of the results.

In terms of exclusion criteria, if they did not complete a symptom survey, they could not be included. If there was an unknown date of first infection, and if they had something called multisystem inflammatory syndrome in children, or MIS-C, they were also not included in this analysis.

Similar to the Adult Cohort, we also used the Long COVID Research Index. This was published in 2024. And because of the differences in symptoms that parents of younger children would report and what parents of teenagers would report, we actually developed two research indices. And similar to the method that Candace described, our cutoff for the school-age index was 5.5 and the index for the adolescents was 5. And you can see on the slide here, some of the list of symptoms that were prevalent in the school-age cohort and those in the adolescents, which are on the right.

If you notice, just quickly looking at the adolescent list of symptoms, they map on a little bit closer to what the adults are reporting in terms of Long COVID. They have the loss of smell, muscle and joint pain, fatigue, brain fog, headaches, those sorts of symptoms. The school-aged children, though, were a little bit different and they were reporting more GI symptoms, so stomach pains, nausea, vomiting, and then there were more skin symptoms as well, trouble sleeping, things like that. So, because of that reason, we looked at both indices separately.

And then for our social determinants of health factors, we actually had, depending on which measures you wanted to include, anywhere from 23 to 30 measures of social determinants of health factors, and we clustered them into the five domains that were described before. And because there were so many, we ended up doing a different kind of analysis, which I'll talk about in a second.

But I just wanted to mention first here that we also did similar methodology that the Adult Cohort did where we looked at each of the measures within the five domains and tried to report the frequency of having Long COVID if they had one of these adverse social determinants of health factors. For simplicity of the analyses, we also dichotomized these results into, "Was there a hardship present or not?" And then we reported odds of Long COVID for each of these factors. And so, you can see here a lot of these factors overlap with what the Adult Cohort looked at, but we were able to just look at a little bit more, a few more economic stability factors as well as the social and community context factors.

One of the things we did because we had so many measures here and we were concerned about the collinearity or the correlation between some of these factors with each other, we did something called latent class analysis. And I don't want to get into all the details of what this methodology is, but essentially, it's a procedure that helps us identify subgroups within a population that may share outward characteristics with each other.

And so, if you think about all of the factors in, let's say, the economic stability factors, you could have somebody who had a household income less than 120% of the federal poverty line, had difficulty covering household expenses, but were not food insecure or were not having trouble getting to where they needed to or finding childcare. And so, these different clusters of people within the cohort, we try to characterize and put them together into clusters. And that's what latent class analysis tries to do. And so, there's an assumption that there are observed and unmeasured factors within each class that can explain patterns of scores across these different domains.

And so, we created a latent class within each of the five social determinants of health domains, and then similar to the Adult Cohort, we also controlled for additional factors such as age, sex, time of infection, and method of recruitment and race/ethnicity. Just as a reminder, during this time, vaccination was not as available in the pediatric world as it was in the adult world, so vaccination status is a little bit more tricky for us.

So unfortunately, I will just be talking about some of our demographics and preliminary findings. We are in the middle of revising our manuscript and hopefully it'll get published soon, but for that reason, I can't go into all of the details. But I did want to show the demographics of our population. I'm breaking it up here into the school-age cohort, the adolescent cohort, and the last column shows, overall, what this cohort looked like. And there was a pretty even split between males and females. And similar to the Adult Cohort, we had a fairly representative population to the US population in terms of diversity of our families. You can also see here that if you look overall, only about 40% of our population were vaccinated during the time of this study.

Because there have been differences reported in the severity of outcomes based on what strain of SARS-CoV-2 you were infected with, we also looked at whether or not you were infected before Omicron or after Omicron. We just cut it in half like that because it was getting complicated to look further into that. And then you can see here overall, about 17% of the Pediatric Cohort met criteria for Long COVID using the Long COVID Research Index.

Again, without going into too much detail, we created a heat map. And if you look at the middle column, this is the column that reports the percent of people with Long COVID who had some of these social determinants of health factors, and the darker the color, the more prevalent this factor was for this cohort. And you can see here, medical discrimination was pretty common in those with Long COVID compared to those without, unmet medical needs, as well as food insecurity, transportation difficulties, childcare difficulties, and report of government assistance.

Unfortunately, that's as much as I'm going to be able to talk about. Hopefully we can have some Q&A and maybe we can talk a little bit more about some of these implications. But one of our main next steps is to publish these outcomes so that we can talk a little bit more about what we found. With these social determinants of health latent constructs now that we've created, we are hoping that we would be able to use these constructs within other analyses that can really look at the interaction between clinical risk factors and social risk factors to see how they play with each other and affect the risk of Long COVID.

We're also hoping now that once these factors are out there, that other pediatric cohort studies will be able to use these and adjust for these factors in their analyses as well. And like Candace said, I think it is really important to think about what are the implications of these findings and how can these results potentially inform interventions and policymakers to think about what we can do to address some of the upstream disparities and social environmental conditions that our families and our adults and children in this country are experiencing that may help to mitigate some of these risks.

I also wanted to acknowledge the National Community Engagement Group, all of our cohorts, the families, the caregivers, the children who participated in our studies, as well as the writing groups, the Pediatric and Pregnancy Cohort participants and teams as well, as well as our ABCD participants and the NIH for their funding support.

Quinn Barnette:

All right. Thank you so much, Dr. Rhee and Dr. Feldman, for those great presentations. I'm now going to turn to Brittany to hear some of her reflections about this work. Brittany, I know you served as both the co-author and a community representative on the first paper that was discussed today, so you have a bit of a unique perspective. I wonder if you could just start off by sharing a little bit about the roles that you've played on RECOVER thus far.

Brittany Taylor:

Sure. Thank you, Quinn. And thank you also to Dr. Kay and Dr. Candace for sharing findings and research thus far from our papers. I am Brittany Taylor. I have served as an inaugural co-chair for the National Community Engagement Group, which you've heard both Dr. Candace and Dr. Kay acknowledge. The National Community Engagement Group is a small working group of patient, caregiver, and community representatives within RECOVER that helps shape the research and also communicate information out to the public.

In addition to that, I am a former member of the Observational Consortium Steering Committee. I now serve as a member of the Clinical Trials Data Safety Monitoring Board, and recently, I had the opportunity to participate on one of the long-term follow-up working groups that are helping to shape the next phase of RECOVER. And lastly, my involvement with RECOVER led to me now being involved on another initiative called Reverse Long COVID, and that work is being incorporated into RECOVER-TLC, or RECOVER Treating Long COVID. And so those are the roles I played on RECOVER thus far.

Quinn Barnette:

And can you talk a little bit about the reasons this topic was important to you, specifically as a community representative?

Brittany Taylor:

Sure. So, I'm very passionate about health equity, very passionate also about eradicating health disparities. And so, when I saw this topic listed, immediately I was enthusiastic about submitting my name to participate and contribute to the science, right? Because we understand that it's important to examine the social determinants of health and the social drivers that influence the determinants and these adverse determinants towards reducing barriers to care, towards accessing services, so that patients can get access to the care that they need and advance the science for recovery. And this paper does that. And so, I immediately wanted to participate on this. I also was excited because this paper provided an opportunity to delve further into the adverse determinants of the disparities that amplified COVID-19, especially at the height of the pandemic and the subsequent evolvement of Long COVID.

Quinn Barnette:

And can you talk a little bit about your role as a co-author on this paper, the adult cohort paper, and including the importance of the community voice in that process?

Brittany Taylor:

Sure. So, let me just say that I'm excited that I was selected to be a co-author and serve as a community representative for this paper. The community voice is so important, period, but especially with RECOVER, because when patients are tired or when caregivers have too much on their plate, community representatives are able to step in and elevate the voices of those patients. And so, during the process of writing this paper, Dr. Beth and Dr. Candace were very collaborative, they were very inclusive. They always solicited input and feedback from the representatives in addition to everyone else on the writing group. It was definitely a collaborative process. And additionally, they made sure that they practiced meaningful community engagement. And so, ensuring that we are interacting with the voices of community members, of patient members. We're also getting feedback and opinions from the different communities that have knowledge and lived experiences and have been impacted adversely by Long COVID and COVID-19.

So, Dr. Candace and Dr. Beth made presentations to several different groups to ensure we were aligned with experiences and feedback. And so, they provided a presentation to the NCEG, the National Community Engagement Group. They also presented to RECOVER investigators. And additionally, they presented to the Boston COVID Recovery Cohort, which is an advocacy group in Boston. And they are focused on health equity, really focused on advocacy and elevating what Long COVID is, what are the impacts across communities, especially marginalized communities, and what can be done to advance recovery in addition to the science around Long COVID. So, it's been a very rewarding experience to serve as a community representative and elevate the community voices for RECOVER and beyond.

Quinn Barnette:

And from your perspectives, what would you say are the key takeaways from this study that are important for communities and for healthcare professionals to understand?

Brittany Taylor:

I think there are a lot of key takeaways. I think Dr. Candace did a very good job of highlighting them. But for me, I think one unique thing this paper or this research did was to capture diverse perspectives. Right? So, in addition to using the Healthy People 2030 definition of the social determinants of health, we were intentional on including the World Health Organization criteria around the acute definition of SARS-CoV-2 as well. I think another thing that not every other paper has done was incorporate the discrimination variable that we did. So, both on the medical and everyday discrimination variables and analyzing how that impacted communities, how that impacted participants experiencing Long COVID and what that looks like for RECOVER participants. Another takeaway is the highlight on structural barriers and inequities that we touched on in this manuscript and addressing the need to address and dismantle structural inequities that perpetuate these disparities that prevent some, not all, patients from receiving the care that they need or access to even getting the care that they need.

I think, when I think about healthcare professionals, I want them to consider these adverse social risk factors and that they impact participants and patients differently, especially in marginalized communities. Patients are not a monolith, and so they all have different experiences, and they also experience different levels of disease severity. And that needs to be incorporated when they’re conducting their visits with their patients. I think our findings underscore the importance of incorporating social risk factors and the social determinants of health in future studies. And as future research is being conducted and developed, those things should continue to be incorporated, right? So, they can serve and inform different research topics forever.

And then lastly, I’ll say it’s important for communities and community members to remember that this is still a novel disease. It’s evolving, it’s ever changing, and it affects everyone differently. But as we think about ways to increase awareness of Long COVID and diverse communities, we have to also remember that these communities speak different languages and understand terminology around Long COVID differently. And so that in turn impacts them recognizing if they have Long COVID and how to treat it going forward. And so, pathways will begin to open on treating Long COVID, once they are more aware of what it is.

And I think I kind of have covered the overarching takeaways from the working group and the paper, other than to say it’s really important, to just remember that you’re always inclusive of everyone that’s contributing to being a member of the writing group and ensure you’re elevating what they can bring to the research.

Quinn Barnette:

All right, that’s great. Thank you so much, Brittany. I think I will turn it over now to our discussant, Dr. Karlson, to share some additional reflections and a few questions for our entire panel.

Dr. Beth Karlson:

Excuse me. Thank you very much. Those talks are really fascinating, and I thought it was really interesting to hear how the analysis in the adult cohort compared to the analysis in the pediatric cohort. I wanted to bring up a few questions that we received before we started the seminar, from people who were planning to attend, just to talk about those first, and then go to some specific questions for the presenters.

So, one question which we received was, do we have any plans for making the research datasets publicly available? And I thought I would just answer that as one of the principal investigators for the Data Resource Corps. We manage the data from the program. And the answer is yes, and the data is actually publicly available. There, you can look on the internet for it at BioData Catalyst, and the study is actually called RECOVER@BDC, BioData Catalyst, and people can register for access to that data.

Now, registering for access is somewhat complicated. So, what RECOVER has done is made something called Open PIC-SURE, which is available to everybody, where you don't have to go through a fancy registration process. You just go into Open PIC-SURE and you can look at some of the statistics and the characteristics of the cohorts and the questions are that are asked and so forth, and you can find that also on the internet. So, if you are working in, say, a research area and you have the ability to do computer programming with using languages like R or Python, you could actually run your own analysis in this RECOVER@BDC. If you don't have the talent or the skill to do that kind of analysis, you can do what we call queries in Open PIC-SURE.

And so, every 3 months, the data from the program is fully de-identified. So, we take out any sort of identifiers such as dates, birthdates, name, address, et cetera. And so, all the de-identified data is released to this publicly facing website, the Open PIC-SURE website, and then it's put onto the RECOVER@BDC for analysis. The second question is, I think this would be one that might be nice for Brittany to address. Through your work, have you found that there are disparities in Long COVID awareness among different demographic groups? And how do you think those disparities might affect our statistics and our analyses? Could we address these gaps?

Brittany Taylor:

Yeah, I do think that there were some disparities in who participated and that subsequently affected our findings and results. So, when you think about what our research found, was that we have a higher educational attainment level for RECOVER participants. And so, three-fourths of our participants have a college degree, and that is not always the case when you're looking at research studies and when you're working in populations for studies. And so, diversifying maybe ways that we are recruiting patients. What communities are we going into? So, I know that we made concerted efforts like working with the Boston COVID cohort, but integrating ourselves into maybe more community-based settings, maybe showing up in areas where we know more trusted messengers are located and communicating with those trusted messengers in religious settings, or you might want to check out your local soccer league, things of that nature where we can communicate with individuals that might not have that level of education.

And when we're raising awareness in those areas and in those venues, then we'd be able to recruit a bit of a more diverse population. So, there are a couple of disparities, but in changing the way we recruit and communicate about Long COVID would help to diversify participants and subsequent results.

Dr. Beth Karlson:

Wonderful. And hopefully seminars like this will be attended by more people. We can send out links to people we know to listen to the recorded seminar and so forth. Absolutely. So, in terms of the study in the children, the pediatric study, I wondered if, Kay, if you could describe what's unique about assessing social determinants in children. So, it seemed that you had a lot of caregiver factors. Did you have questionnaires that were designed specifically to assess social determinants among the caregivers?

Dr. Kay Rhee:

Yeah. So, it's always trickier, I think, in pediatrics to try to get at what is the child experiencing. When you have a 6-year-old, a 7-year-old, you do have to rely on somebody else to report those. So, a lot of the SDOH factors that we assessed were family, house, environmental, the social environment around the child, as well as, as best as we can, what the child was experiencing. So, we didn't develop any surveys ourselves, we used preexisting validated measures. But we did get at things like, is the child experiencing discrimination or is the parent experiencing discrimination? We were also looking at access to childcare, things like that. We also included a lot of measures around the parents' mental health status and social support. Because, for a child, their family environment is the most proximal to the child in determining a lot of outcomes: academic outcomes, social emotional development, health outcomes.

And so, we actually included a lot of parent measures as well for that but did not include it in this analysis. And we are actually finding some interesting things there as well, which hopefully will be a different manuscript. But yeah, it is a little bit trickier, I think, to tease this apart for the child. And I don't know if...

Dr. Beth Karlson:

Go ahead.

Dr. Kay Rhee:

Well, I was thinking, I think I mentioned—well, in my talk, I mentioned something about ACEs and I see in the chat here that there was a question asking about ACEs, and did we assess ACEs specifically? And so, for this person and anyone else who is wondering, in pediatrics, we often use the PEARLS tool, which asks about things like abuse, sexual abuse, physical abuse, neglect, things like that. But there is a part two of the PEARLS questionnaire, which asks about social determinants of health. And so, in ACEs, the concept of ACEs actually does include these adverse social determinants of health factors. I think a lot of people think about ACEs as just the abuse part of it or parent divorce or things like that. But the other part of ACEs are things like, has your child experienced challenges with housing? Do you not have enough food to eat?

Have you been separated from your parent or caregiver? Does your parent or caregiver have a serious physical illness? Have they been incarcerated? So, we actually did ask some of those questions, which are part of the PEARLS assessment, but we didn't ask everything. And so, when we think about ACEs and social determinants of health, there's a lot of overlap in those two concepts. But unfortunately, in the RECOVER surveys, we didn't specifically ask about abuse and neglect. So, I don't know if that helps answer that question.

Dr. Beth Karlson:

Thank you. So, Candace, it seems that you tried also to get at the social environment with some of your questionnaires. So, for example, you asked about marital status, and that's also asked in the pediatric study, but you had some other measures like social support. Can you describe for us what kinds of things you measured in that domain? So, were you getting at the sort of household environment the way that pediatrics surveys were getting at the household environment?

Dr. Candace Feldman:

Yeah, it's a great question. I think there were definitely some questions that related to those concepts of household support and neighborhood support, less so about the inter-household or intra-household dynamics. The social support questionnaire that we use was similar to what Kay was describing in pediatric. The pediatric space, all questionnaires that we used were validated questionnaires that had been studied in other populations. The social support questionnaire included questions about, do you have someone who can take you to the doctor if you need someone, who could help you if you couldn't get out of bed? It also asks about, do you have somebody who understands your problems to love or make you feel wanted? So, there's questions related to that. So, they do get at, again, that social support, not necessarily requiring that those are directly in the household though.

The other sort of questions that we asked in that domain, as you mentioned, was the marital status question, as well as a broader neighborhood support question, which is, do you live in a neighborhood where people help each other out? Are there people in your neighborhood that you feel that you can count on? So, again, just the, within close-knit support and then the neighborhood support.

There was an interesting question just to highlight in the chat as well, that I responded to directly, but just to highlight it more, which was asking about, if I'm reading the question correctly, about triangulation of different factors. Right? And so, the question was, did you look at the combination of people living in poverty with social support or without social support or people who lived in poverty and did have household crowding or did not? And I think it's a really interesting question. And the answer is, we unfortunately didn't look at those specific permutations, but I do think one of the ways that I sometimes think about social support, or household support, or neighborhood support, is to what degree could these be buffering factors?

So, if you are, for example, experiencing poverty, but you have strong social support or neighborhood cohesion, does it in some way mitigate the effect of living in poverty on an adverse outcome? So, not something we studied here, but something that I'm very interested in a broader sense and to what degree are modifiable social factors able to reduce effects of, for example, poverty on health?

Dr. Beth Karlson:

Wonderful. So, one final question. Kay presented some really intriguing hypotheses about the biologic underpinnings of social determinants and how social determinants on a chronic basis can lead to changes in the immune system. And I know there are some biomarker studies. RECOVER has collected a lot of blood samples for both the pediatric and the adult cohort. So, just for Kay and Candace, maybe Kay first, do you anticipate that you could try to understand the biologic underpinnings of these findings by using these samples?

Dr. Kay Rhee:

That's the hope. I really would love to do that. I think, also in the chat, somebody asked about the acute phase of the infection and about the viral titers and the immune response. Unfortunately, at least in pediatrics, we were not always enrolling participants at the time of their infection. So, we were often enrolling them after the infection and having them report on some of these things, and that was also the time of the blood collection. So, unfortunately, I think, as Candace had mentioned before, you really need a prospective study where you're able to catch that at the moment of infection, to look at those titers.

But that said, I do think there's a lot of potential with the biosamples that we have, to look at some of the immune function, the cytokines, hopefully. I'm not involved in those work groups right now, so I don't know what tests they're planning to do, but it would be really important, I think, to understand the mechanisms of why some people are at risk and are there the families and adults and children who have experienced more stressors, is there something different about their biology that makes them more susceptible to, one, getting the infection, and then two, potentially not clearing the infection and having the post-viral syndrome that just persists?

And it's unfortunate. And I think, for this reason, the advocacy that's needed to help people understand that these social factors are not just, I hate to say the word "fluff," they're not just social factors that have no importance on physiologic, biologic, and mental health outcomes. They're very linked. And if we can help people understand that, I'm hoping we can make some changes on multiple fronts, the biologic front as well as the social-political front.

Dr. Beth Karlson:

So, Candace, what do you think about using the adult cohort that you used for your analysis? Because your cohort, you limited it to the prospective arm, the people who were acutely infected. Do you think it's worth looking at biomarkers, say during acute infection, and then maybe at the early time points? And how might that lead to understanding biology and maybe understanding treatment?

Dr. Candace Feldman:

Yeah. I think as a rheumatologist, the biomarkers are the reactants that we think a lot about are these acute phase reactants, so these markers, these cytokines that show inflammation. And there have been a number of studies among people who have experienced extreme stress that show significantly higher biomarkers or markers of inflammation in the body. The challenge is that it's oftentimes harder to tease apart what the cause of that is. We certainly know that people who live in chronic stress oftentimes have at baseline higher markers of inflammation, or at least that's been shown in a number of studies. And having an infection actually also does that too. I think one thing, and Kate alluded to this, and Beth as well, is that I think what's interesting, or at least would be very interesting in my mind is, is there a difference in the pattern of these biomarkers over time in people who are exposed to acute infection and then live in social situations that contribute to chronic stress? And I would argue that we would, or at least I would hypothesize that we would find a potential difference, and that would be one mechanism to think about.

The other two things that came to my mind too—there's a great deal of interest in understanding the microbiome and the way that that could play a role here. And we know that poverty and food insecurity and housing instability contribute to those factors, to the microbiome and the dynamics between different cytokines and biomarkers as well. And so again, this is something thinking longitudinally as well could be very interesting. And then the last point I'd make too is something that's been studied a lot less in this specific field and less as a rheumatologist are the biological mechanisms by which adverse environmental exposures like air pollution may impact susceptibility to chronic conditions and autoimmune conditions as well. [We] studied [it] a bit, but [it] definitely could use some more study. And I think being able to think about the role that might play, knowing that where a person lives does matter in terms of their risk, might help us understand a piece of this as well.

Dr. Beth Karlson:

Terrific. Thank you so much. And I just want to say thank you to Brittany. I was part of this working group for the adult cohort's social determinants paper, and Brittany and her other colleagues from the community advisory and community advocacy groups contributed so much to our discussion over several years of working on this. So, thank you, Brittany, and all of your colleagues. And I wanted to point one thing out, which is that they really emphasized looking at crowded households, and we figured out how to do that through the area-level measures that you can get from ZIP code. And what ended up being a really strong risk factor was living in crowded households. So, it wasn't obviously on the top of our list for hypotheses when we started the project, but by talking to the patient representatives, the community representatives, we really started to focus on that in the analysis, as well as many of the other social risk factors, but that one really stuck out in my memory of interactions. So, thank you to everybody who worked on these projects, and thank you all for the presentations. And I think now we open it up for questions where Quinn is going to take the lead on other questions.

Quinn Barnette:

Yes, thanks everyone. I think we'll keep this discussion going with some Q&A from our audience, a lot of which we've already been able to cover, which is great. So, we'll start with some questions that we got in advance and then move into some questions we got in the Q&A chat. And just as a reminder to the audience, we'll also be posting the Q&A document on recovercovid.org following this seminar. The first question I have asks, "Are there disparities in Long COVID awareness among different demographic groups, and could this further affect our statistics and how can we address these gaps?" I think this is open to the panel, but maybe I'll start, Candace, with you.

Dr. Candace Feldman:

Sure. So, Brittany did comment a bit to the answer, and an answer that I very much agree with a bit earlier for this. The one thing that I would add to what Brittany had mentioned is that while we didn't ask as our outcome, "Have you been diagnosed with Long COVID?", where you could imagine that there would be differences between populations from language differences or cultural differences. We did ask about a number of different symptoms, and people may perceive symptoms and describe symptoms differently depending on their experiences with healthcare in the past, their cultural backgrounds, their language, their lived experiences. And so, it's possible that the symptoms that were used and the way that they were asked may not have captured everybody's symptoms the same way. And so, it's possible that it may not represent everybody equally.

Dr. Kay Rhee:

I just wanted to add to that. I think that issue of making sure that we got a broad demographic in both our cohorts was something that would hopefully help us reach a diversity of groups so that we could get different perspectives and different experiences. And the fact that we... So, we also used the Long COVID Research Index, and so we asked about symptoms. So, whether or not somebody thought they had Long COVID, we were collecting a compilation of symptoms that we then created a research index for. And so, it's a pro and a con, right? It helps to maybe more objectively look at clusters of symptoms that are prevalent, but it doesn't capture everything. And there may be people who didn't fit the research index because they didn't have enough symptoms, or they only had one very severe symptom. So, pros and cons of using that method.

But I think one of the best ways to get around this issue of, "Were there people who didn't realize they had Long COVID? Or were we not reaching populations that may have experienced Long COVID differently?" I think our effort to try to decrease that impact as much as we could was to really recruit from diverse areas of our country. And one thing we haven't mentioned too much is the rural population and the medically underserved population. And in the pediatric cohort at least, I think we recruited about 30%, 40% of our cohort was medically underserved. Not rural. Rural was more difficult to recruit, which in all national studies that's the case. But by getting the medically underserved population, we are hoping also to get people who may not have been accessing healthcare as much and still capture what their symptoms were.

Quinn Barnette:

All right. Thank you. I guess somewhat building off of that question, we got a question that asks if there will be future research that discusses access to not only healthcare, but healthcare that's knowledgeable of Long COVID. This person indicates that they often had to travel far to access clinicians for their specialty care. I wonder if that's something that is possible at this point to analyze, or if there are any plans for that in the future? Maybe Kay, I'll start with you for that one.

Dr. Kay Rhee:

So basically, they're asking about greater dissemination of this work, and really to clinicians I think, right? So that they understand that this is a condition that exists and how to find it. I mean I think that is one of the missions of the RECOVER Initiative, to help define what is Long COVID and then help educate the community, the healthcare community, the community at large, the public health community, what this is. I think the challenge with this, and I'm sure there are other people in the audience who are expert in this, is that this cluster of symptoms... Because this is a post-viral syndrome, it falls into the category of some of these other post-viral syndromes that are a little bit more nebulous. And the ability to do a test and say, "Yes, you have X" is much more difficult when it's a post-viral syndrome than when it's that you have the infection. You have a virus, I can test for the virus, and it's there.

So, I mean this is one of the goals of the RECOVER Initiative, and so I am hopeful that that is something that we'll be able to do. I think I hinted at this a little bit in our pediatric study, what the symptoms were varied by age group. And I didn't talk about the infant and preschool age group, but their Long COVID symptoms were different than the school-age group, from the adolescent group, from the young adult-adult group. And so that in and of itself makes it very difficult for pediatricians to know is this post-viral Long COVID, or is this gastroenteritis from rotavirus? So, I think these are the complexities for a clinician, and I'm hoping we can help them. It's a work in progress.

Quinn Barnette:

All right, thank you. I think my next question is for Candace, and asks, "Are there any insights gleaned from the pregnancy subgroup?"

Dr. Candace Feldman:

Great. Yeah, interesting question. So, I'll mention first to say that there were about 200, so 209 to be specific, women who were pregnant in this cohort. But there's a separate body of literature and set of studies that's happening in a pregnancy cohort that's going to get to the answer to your question in a much deeper way than what I can provide.

But what I can tell you in our group is we were asked two questions actually by reviewers when we were finalizing our paper. And one was, "Well, is there any chance that you're misclassifying Long COVID in pregnant women because a number of the symptoms that you have for Long COVID could very well be symptoms of pregnancy?" So, for example, post-exertional malaise or fatigue. So, we did look at a comparison of pregnant women and non-pregnant women, and men as well, and looked at each of the components of the Long COVID Research Index. And what we actually found was that overall, the percent of pregnant women who had Long COVID in this acute cohort was about 7.7%, so a little under 8%. Whereas in non-pregnant women, it was closer to 12%. So, there was a lower percentage of pregnant women who met the definition for Long COVID compared to non-pregnant women. And then similarly, there was a lower percentage of pregnant women who had each of the components of the Long COVID index. So fewer with palpitations, [inaudible 01:22:00], brain fog, et cetera.

One of the other questions we were asked was, "Well, if you removed pregnant women from your cohort, was there a stronger or weaker association between social determinants of health and Long COVID?" And so, we did this, and we really found no difference. So, it seems like the association between social risk factors and Long COVID is very similar for pregnant women compared to non-pregnant women. Because of the small numbers of pregnant women with Long COVID in this specific subcohort, so there were only 16 pregnant women who ended up with Long COVID in this cohort, we couldn't look at direct associations between social risk factors and development of Long COVID. But I could say when we excluded these individuals, there really was no significant or even remotely significant difference with the overall population. So, we think associations are similar and that the prevalence, at least in this sub-cohort, was a little bit lower of Long COVID among those who were pregnant. However, I would direct you to the pregnancy studies for a much more in-depth understanding. And I know they are also looking at social risk factors in that specific cohort too.

Quinn Barnette:

Thank you. Back to Kay. Our next question is, "What were the reasons behind the difference in the sample size between the school-age and adolescent age groups?"

Dr. Kay Rhee:

Yeah, thank you for bringing that up. So, in the adolescent cohort, we were able to recruit from the Adolescent Brain Cognitive Development Study, the ABCD national study, which had been going on since 2019. And so, from that point prior to COVID, they had recruited 11,000 children or teens at that point into their study and were following them. And so, because we partnered with ABCD, we were able to recruit a lot of adolescents very quickly because they were an already existing cohort. And then overall with the 30-plus sites, we were recruiting children and adolescents. And so, it was just more difficult to get children, and so that's why you see a lot of discrepancy in our numbers between grade-school children and adolescents.

Quinn Barnette:

Mm-hmm. All right, thank you. I think we have time for one more question, and this one is perhaps for both Kay and Candace. And it asks... Well, they know that reinfection is a risk factor for Long COVID and more severe Long COVID. So, they ask, "If there's any plans or if it's possible to look at those repeat infections, and what social determinants of health might be associated with reinfection?"

Dr. Kay Rhee:

Yeah, I'll start. We haven't done that yet. I think it's an interesting question. I'd have to go back and see how much information we've gathered about the repeat infections, because there's a cohort of people that moved into tier 2, and we're gathering serial questionnaires from them. It would be that group of people that we would want to look at. So yeah, it's a great question.

Dr. Candace Feldman:

Yeah, I agree. We haven't looked at it yet, but I think it is a very interesting question. There was another question right above it as well that I also think is really interesting, and I actually think factors into this question too, which is the ability for people to have recovery time from infection and the degree to which that may contribute, and how social risk factors play a role there. And I think that's an interesting question, and I think also relates to re-infection risk too. Can you minimize your exposure after your first infection? My hypothesis is that individuals with higher burden of social risk factors would have less rest time post-infection, would have higher risk of subsequent infection, but we haven't studied it. But both are very interesting, and I think important, questions.

Quinn Barnette:

All right. Well, thank you so much everyone. I think we have gotten through all of my questions and we're coming to the end of our session, so I'll go ahead and wrap up. But thank you so much to all of our panelists, and thank you to our audience again for attending this seminar and engaging with the Q&A. As a reminder, a recording of today's seminar will be available on recovercovid.org in about a week or so. And then later we'll also post a recap of this seminar, as well as a Q&A document that has responses to the questions we received today, including some that we did not have time to address. Our next seminar is going to be on October 28, and it'll be entitled, "Long COVID in older adults: Insights from the RECOVER adult observational cohort," and we'll put a link in the chat for you to register for this seminar as well.

Finally, you'll see a short survey come up on your screen right now, which asks for feedback on this seminar. We'd appreciate if you could take just a minute to fill out this brief survey with some feedback. And with that, thank you again to our panelists for these great presentations. Thank you to our audience for engaging today, and I hope you have a great rest of your day.