

Seasonality of Common Human Coronaviruses in the United States, 2014–2021

[Announcer] This program is presented by the Centers for Disease Control and Prevention.

[Sarah Gregory] Hello, I'm Sarah Gregory, and today I'm talking with Dr. Melisa Shah, an infectious disease physician and a recent graduate of CDC's Epidemic Intelligence Service, better known as an EIS officer or disease detective. We'll be discussing the seasonality of common human coronaviruses in the United States.

Welcome, Dr. Shah.

[Melisa Shah] Thank you very much.

[Sarah Gregory] Since the emergence of SARS-CoV-2, coronaviruses obviously are getting a lot more attention these days. What exactly are they?

[Melisa Shah] SARS-CoV-2, the virus that causes coronavirus disease 2019 or COVID-19, has placed a lot more attention on the common human coronaviruses. In general, coronaviruses are named for their crown-like spikes on their surface, and the common human coronaviruses cause mild to moderate upper respiratory tract illness (like the common cold). And most people have gotten infected with one or more human coronaviruses at some point in their lives.

[Sarah Gregory] What are the different types of coronaviruses? I think there are many, correct?

[Melisa Shah] There are four main groupings of coronaviruses, known as alpha, beta, gamma, and delta. And the four common human coronaviruses include two alpha types and two beta types. They are sometimes referred to as the common cold or endemic or seasonal coronaviruses. And the names of the four types are OC43, HKU1, NL63, and 229E. There are other types of human coronaviruses, including the Middle East respiratory syndrome (or MERS) and the severe acute respiratory syndrome (or SARS), and of course COVID-19.

[Sarah Gregory] Is there one type that affects people more severely than others? Excluding, of course, SARS and MERS.

[Melisa Shah] Yes. All four common human coronaviruses, like you say, generally cause less severe disease than the types of coronaviruses that cause MERS, SARS, and COVID-19. And among these four, all of them can cause upper and lower respiratory disease. More severe disease is generally seen in infants and older adults, and one of the alpha coronaviruses (NL63) has been associated with croup in children.

[Sarah Gregory] What are the kinds of illnesses do they typically cause?

[Melisa Shah] Generally, the common human coronaviruses can cause upper respiratory tract infections. They cause one- up to one-third of community-acquired upper respiratory tract infections in adults, and they play a role in severe respiratory infections in both children and adults. They can cause things like pneumonia, bronchiolitis, croup, as well as exacerbations of existing respiratory conditions, like worsening COPD in adults and asthma.

[Sarah Gregory] Your article is on human coronaviruses in particular. Are there animal coronaviruses and if so, can they be spread to people?

[Melisa Shah] Yes. That's a great question, because sometimes coronaviruses that infect animals can evolve to become a new coronavirus that makes people sick. And examples of this are

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SARS-CoV-2, which infects many mammal species, and MERS-CoV, which infects bats and camels. Coronaviruses are important veterinary pathogens; they can infect chickens, cattle, pigs, and they can cause respiratory and diarrheal illness in those animals. As you know, coronaviruses are also found in birds and mammals, with bats being hosts to many types.

[Sarah Gregory] You focused (in your article) on the seasonality of common human coronaviruses in the US from 2014 to 2021. Why this time period, specifically?

[Melisa Shah] We started with data from 2014 because this was the second surveillance year in which data was available to us. We included data through November 2021 at that time we were doing the analysis to include as much of last year's season as possible, because we wanted to describe the changing seasonality during the COVID-19 pandemic.

[Sarah Gregory] And are there seasons for coronaviruses?

[Melisa Shah] Human coronaviruses occur primarily in the winter in temperate climates, although infections can occur at any time of year. There have been several studies that indicate that infections peak between December and March. For example, there's a study from Michigan that spanned eight seasons indicating that only 2.5% of infections with common human coronaviruses being identified between June and September. One published review suggests a relatively consistent winter peak in temperate regions, but this is likely not the case in parts of Asia and parts of Africa. One study from subtropical China indicated that human coronaviruses were most often detected between June and August there.

[Sarah Gregory] What makes human coronaviruses more prevalent in the cooler months in the US, then?

[Melisa Shah] The seasonality of human coronaviruses probably results from a combination of viral, human, and environmental factors. Many respiratory viruses show seasonal patterns that often coincide with cooler seasons, and some theories that people have is that this includes increased virus stability in colder temperatures, patients being more susceptible to infections due to drying of the airways, and changes in behavior including people spending more time together indoors.

[Sarah Gregory] Would other countries that have opposite season changes compared to the US have opposite coronavirus seasonality patterns (like Australia, for example)?

[Melisa Shah] Yes, that's very interesting. So there is much more information about the seasonality of human common coronaviruses in northern hemisphere countries. But in temperate southern hemisphere regions, following suit with other respiratory viruses, their respiratory virus season seems to also peak during their cooler months. For example, there are some data from Argentina showing that the common coronaviruses peak in April to August (which is their cooler months) in contrast to the northern hemisphere countries.

[Sarah Gregory] Are there certain types that are more prevalent during certain seasons?

[Melisa Shah] In many studies, human coronavirus OC43 was the most prevalent of the four strains. We found that as well. However, there is variability over time and by seasons, so this finding may not always be generalizable.

[Sarah Gregory] Flu changes from season to season, year to year, with the type or the strain. What makes human coronavirus predominant from one season to the next?

[Melisa Shah] We do see an every-other-year pattern emerge where one type in the subgroupings tends to alternate predominance each year. We think this could be due to population waning of immunity from season to season.

[Sarah Gregory] And what causes these patterns of change? Is it weather or viruses or just the immunity that you're talking about? Or something else?

[Melisa Shah] That's an important question to answer. Prior to 2020–2021, which was during the COVID-19 pandemic, the patterns of circulation were quite consistent. There was a clear change during the pandemic, which we can't attribute completely to climate or environmental changes. Rather, it was likely related to behavior changes and the mitigation measures during the COVID-19 pandemic, as well as possible viral interactions.

[Sarah Gregory] Let's go back to immunity here for a second. So you're saying that prior infections can maybe impact the strain or something from at least to the next year? What about vaccines? Are there vaccines for coronaviruses?

[Melisa Shah] So I'll start with your first question. For the four common human coronaviruses, immunity seems to develop soon after infection, with protection generally lasting for about one year. So it's this transient immunity that we think factors into why there's an alternating every--other-year pattern of circulation. When scientists have looked at cross-reactive antibodies among the four common human coronaviruses, they seemed to be higher among types within a particular grouping. And in general, infection with a common human coronavirus likely doesn't provide a large amount of protection against SARS-CoV-2 infection or vice versa. Despite many studies on this, the results have been inconclusive and we need more information. Additionally, I think we need more information to understand how SARS-CoV-2 vaccines may impact immunity to common human coronaviruses or other human coronaviruses.

[Sarah Gregory] In what ways did COVID-19 impact the coronavirus season onset from 2020 to 2021? You want to tell us more about that?

[Melisa Shah] Yes. The 2020–2021 seasons started 11 weeks later than usual. It was 11 weeks later than the prior six seasons and it had an extended duration. It lasted longer than the prior six seasons. And so, this may have been due to behavior changes and other factors related to the COVID-19 pandemic.

[Sarah Gregory] Tell us briefly about your study now and what you were looking for in particular.

[Melisa Shah] Our study's goal was to describe the seasonality of the common human coronaviruses in the United States and to document whether changes in seasonality occurred during the most recent seasons. We used a national surveillance system to describe the start, the peak, and the end of seven of these seasons since 2014.

[Sarah Gregory] Tell us a little bit about this system and why you used this particular one.

[Melisa Shah] The National Respiratory and Enteric Virus Surveillance System (it's called NREVSS) is a passive surveillance system established by the CDC in the 1980s. NREVSS collects respiratory virus testing from laboratories across the United States. We use this surveillance platform because it's one of the few nationwide platforms that collects PCR test results on all four of the common human coronaviruses.

[Sarah Gregory] Who has access to this system?

[Melisa Shah] So CDC shares these data with state and local health departments through a secure exchange. Researchers and other external CDC partners may also request data by contacting nrvss@cdc.gov.

[Sarah Gregory] And going back to your study, what did you find? What was the most significant finding?

[Melisa Shah] We found that in the six common human coronavirus seasons before 2020, the season onsets occurred in October to November, the season peaked between January and February, and the offsets occurred during April to June. Most (that is, over 93%) of the detections were within these defined seasonal onsets and offsets. And then in contrast, the 2020–2021 season was remarkably different. The onset was 11 weeks later than in prior seasons, and we suggest that the delay was probably associated with COVID-19 mitigation measures.

[Sarah Gregory] How do you personally hope your findings will be used?

[Melisa Shah] Our study helps provide an understanding of what is usual—what is the usual seasonality—and it allows us to contrast that to understand abnormalities or changes in future seasons. So this can help clinicians and the public health community plan for and anticipate upcoming circulation of respiratory viruses.

[Sarah Gregory] What further research on the seasonality of coronaviruses do you think is needed?

[Melisa Shah] I think more modeling studies to predict and understand the factors that determine the seasonality of the common human coronaviruses would be helpful. We describe these patterns in our study and if we could take this a step further to understand the key factors resulting in the seasonal patterns, that would be very useful.

[Sarah Gregory] As I said in the introduction, you're a recent graduate of CDC's Epidemic Intelligence Service. Tell us what drew you to this program and what was your favorite project that you worked on during your time as an EIS officer.

[Melisa Shah] EIS has been on my mind since I was an undergrad. I did a major in anthropological sciences and focused on medical anthropology. So I was very interested in public health and medicine. I ended up doing an MPH during medical school at Emory, and I was able to work with current EIS officers and meet graduates of the EIS program. And I saw all the amazing and formative opportunities they had to make a difference in population health, and that's what really drew me to the program. One of my favorite projects during EIS was this study. It brings together elements of immunity, behavior changes during the COVID-19 pandemic, and respiratory virus circulation.

[Sarah Gregory] What are some precautions that you take on a daily basis to keep yourself from getting sick as cold season is upon us in the US?

[Melisa Shah] That's right, it's coming up. Hand hygiene is incredibly important, so washing my hands with soap and water for 20 seconds is my standard practice. Equally important are avoiding touching your eyes, nose, mouth, and avoiding close contact with people who are sick. We can do simple everyday things—washing our hands, staying away from others, covering our mouth and nose—to help prevent the spread of human coronaviruses.

[Sarah Gregory] I recently learned through a podcast that *C. diff* is not susceptible to hand sanitizer (it doesn't kill the germ). I'm wondering about the common cold or human coronaviruses. We know that it works for COVID-19. Does it work for the other strains?

[Melisa Shah] Yes. Hand sanitizer should be effective for the common cold viruses and is a possible way of keeping your hands clean.

[Sarah Gregory] Well, thank you so much for taking the time out of your busy day to talk to me, Dr. Shah.

[Melisa Shah] Thank you so much for having me.

[Sarah Gregory] And thanks for joining me out there. You can read the October 2022 article, Seasonality of Common Human Coronaviruses, United States, 2014–2021, online at [cdc.gov/eid](https://www.cdc.gov/eid).

I'm Sarah Gregory for *Emerging Infectious Diseases*.

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