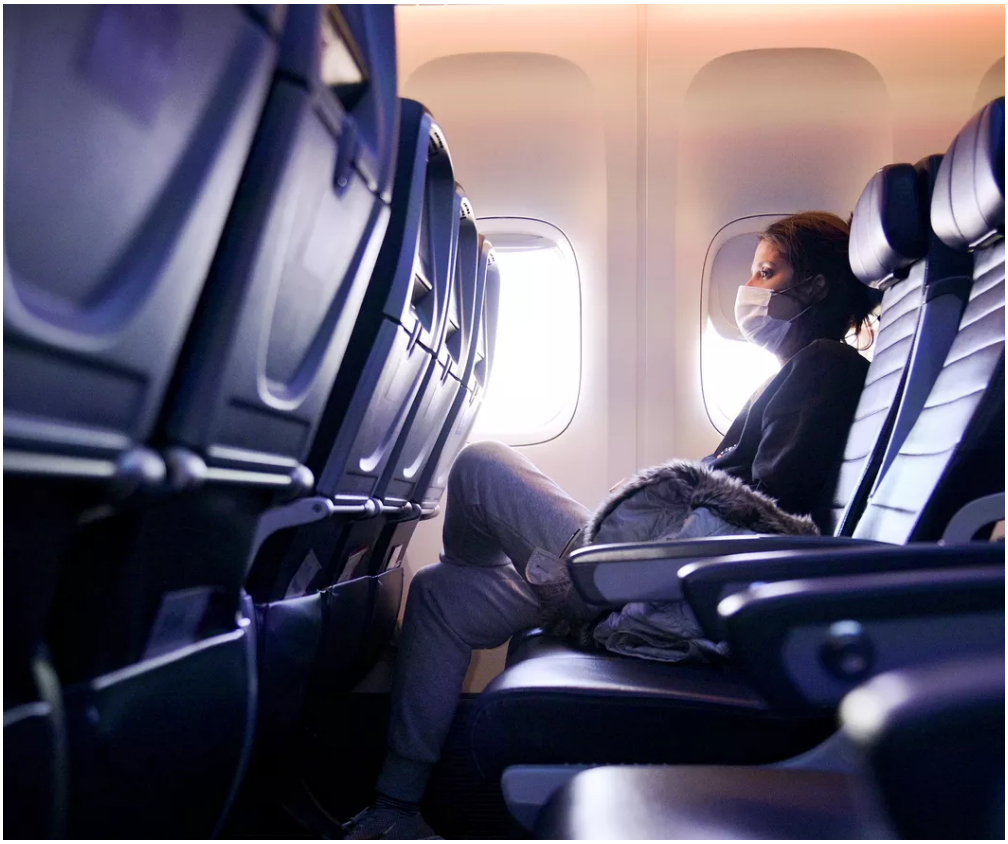
Vox

How risky is air travel in the pandemic? Here’s what the science says.

The airline industry says getting on a plane is safe. But nothing is perfectly safe when it comes to Covid-19.

By Julia Belluz and Brian Resnick | Nov 12, 2020, 12:40pm EST



A passenger on a flight from San Francisco to Newark, New Jersey, on October 27. | Michael Loccisano/Getty Images

According to the airline industry, it's safe to fly during the **Covid-19** pandemic. United Airlines **boasts** that the "risk of exposure to Covid-19 is almost non-existent on our flights." Southwest Airlines has opened up middle seats for passengers, saying the **odds** of catching the coronavirus on a plane are "similar to the odds of being struck by lightning."

Airline companies clearly have an interest in selling more tickets. But should we buy their confidence?

At the beginning of the pandemic, people who were infected with the virus **boarded planes and rapidly seeded** outbreaks all over the world. But whether planes themselves are a dangerous place to become infected, and infect others, has been more of an open question.

The truth is we don't really know the answer yet. There are few high-quality studies on transmission on airplanes, and they all come with important caveats and uncertainties.

But the best research available provides some clues.

Here's where things stand: Flying is not the most dangerous activity during the pandemic. It's safer than, say, **going to a crowded bar for drinks**. But safer does not necessarily mean safe. There have been credible instances of transmission on planes, particularly on longer flights and earlier on in the pandemic (when the current guidelines for masking and other risk-reducing actions weren't in place).

In ideal conditions — for example, everyone wears a mask, there's staggered seating, and the aircraft's ventilation system runs all the time — yes, flying is a relatively low-risk activity.

But there are many gray areas — situations that arise in an airport and on a plane — that probably increase the chance of virus spread but aren't well understood. For example, while scientists have looked at the risk of viral transmission in flight, they haven't studied the transmission dangers posed by crowding during boarding or deplaning.

Flying may be a relatively low risk, but we must ask ourselves: Should we really be traveling in the first place? Getting on a plane might not even be the most dangerous part about travel — it could be the new exposure potential when you get to your destination.

Even though there isn't one simple answer here, there are many, many ways both passengers and airlines can reduce risk.

Let's dive in.

Flying is generally safer than going to a crowded bar for drinks. But the related travel it enables may not be. | Kent Nishimura/Los Angeles Times via Getty Images

A ground crew sanitizes a plane in San Francisco before it departs for Hawaii on October 15. | Paul Chinn/The San Francisco Chronicle via Getty Images

Why we don't know exactly how risky flying is

"How safe is air travel during the Covid-19 pandemic?" sounds like a simple question, but it's deceptively hard to answer scientifically.

To know with reasonable certainty, you'd need to run a study that involves something like isolating passengers for weeks before a flight and then testing them to make sure they do not have Covid-19, while also blinding them to the reason they're submitting to testing. Then you'd put them on a plane with another passenger or crew member (or both) who is infectious. **David Freedman**, an infectious disease specialist at the University of Alabama at Birmingham, told Vox it's the flight crew members who are most likely to be infected via air travel. They're the ones spending a lot of time interfacing with the public. "The airlines don't like to talk about this," Freedman said.

Of course, no ethics review board would ever approve such an experiment — and the level of risk is different on a plane with zero or two cases versus five or 10.

"[A] long-haul flight is more risky than short-haul flights, since there's more passenger and crew movement. A full flight is more risky than a half-full flight, where hopefully they space you," said Anthony Harries, a senior adviser at the International Union Against Tuberculosis and Lung Disease who authored a **review of the research on the safety of flying** during the pandemic.

We don't have comprehensive real-world data on these travel scenarios because public health agencies and airlines don't track down every passenger to see if they became sick after a flight.

And it's not just the planes, either. Airports are also potentially dangerous places for swapping microbes. "They're closed in, no open windows. You don't know what the ventilation is like, if they've got decent filters like on airplanes," Harries added.

What we have instead is imperfect research evidence that's mostly taken one of two approaches.

The first is an engineering approach: using controlled experiments or mathematical modeling to try to figure out the likelihood of the virus spreading in the airplane environment.

The second involves detective work: using contact tracers to track a cluster of cases involving one or more infected people who were on a plane and spread the virus to others. The best of these studies also use genome sequencing to confirm the virus is genetically linked in the passengers who became ill.

Modeling and experimental studies show that airplanes are pretty safe — under ideal conditions

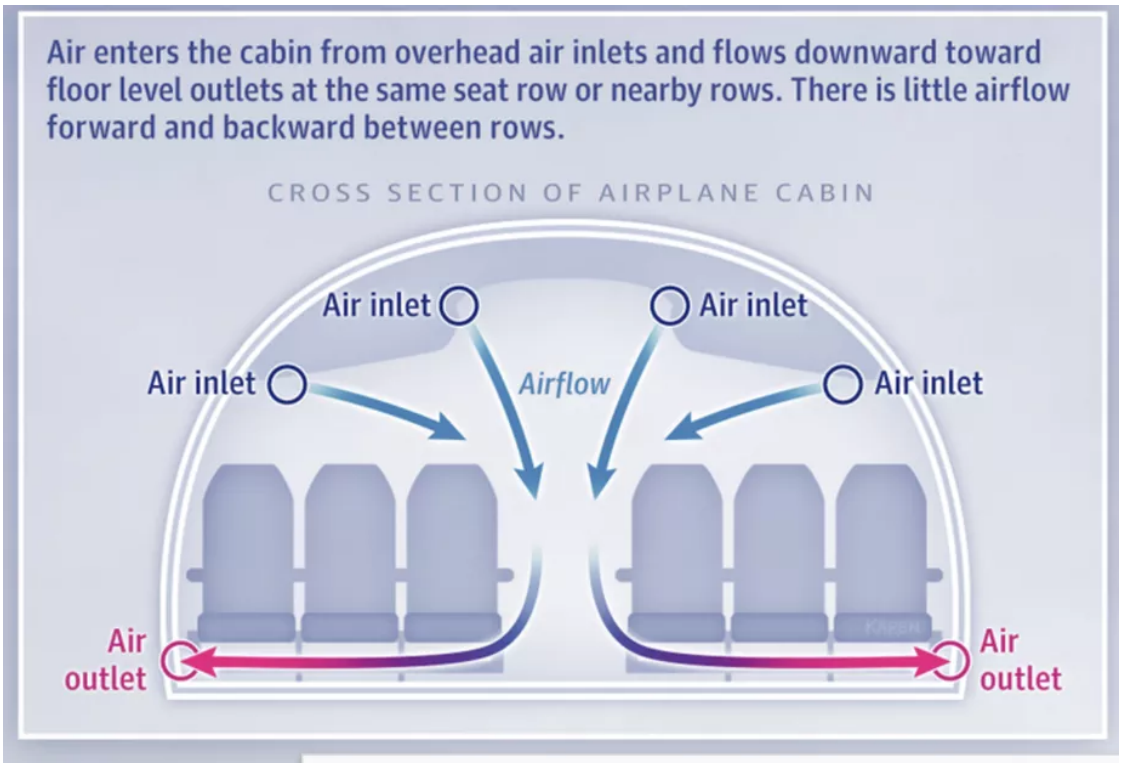
Let's first look at the modeling studies.

Planes have an important built-in safety measure when it comes to the spread of respiratory viruses: air filtration and ventilation systems. To help stop the spread of infectious diseases like the flu, air quality experts have long recommended that air in an indoor space be filtered — where it's passed through a membrane that catches virtually all of the tiny aerosols or droplets that might contain the virus — or replaced by fresh air **around six times per hour**. In practice, planes have an air exchange rate closer to **20 or 30 times per hour**. (Federal Aviation Administration regulations **require** each passenger be provided 0.55 pounds of fresh air per minute.)

The airflow in the plane is also designed to keep any droplets spewed by a passenger from floating around the cabin. The air flows from the top of a passenger's head and is collected down by their feet, which keeps whatever we exhale from spreading too far horizontally.

In ideal circumstances, this air filtration system should work very well. One **study from the Department of Defense** (which was, in part, sponsored by the airline industry, so take that into consideration), fitted an **aircraft with mannequins** equipped with nebulizers to mimic real human breathing. In the experiment, the "breath" from the mannequins was marked with a fluorescent tracer so that researchers could see what happened in real time.

The study concluded that due to the high air-circulation rate, the risk of being infected even while sitting next to an infectious person was very, very low: According to the test results, it would take 54 hours for someone sitting next to an infected passenger to be exposed to an infectious dose of the virus.



Courtesy of JAMA

This number sounds precise — and encouraging — but the study had numerous limitations. The researchers assumed only one person aboard the plane was infected, that everyone was wearing masks at all times, and that the infected passenger never turned their head and sat facing forward for the entire flight.

The study also looked at only the spread of aerosolized particles that can linger in the air — it didn't consider the spread of the larger viral-laden droplets that fall to the ground more quickly. If you're sitting next to a person who's coughing out lots of big droplets, that could still be a problem.

A final caveat: The study makes an assumption about what constitutes an infectious dose of the coronavirus, though virologists haven't determined that yet.

Meanwhile, **researchers at Harvard** also developed a mathematical model on Covid-19 transmission risk on airplanes, based on what's known about ventilation systems. They arrived at similar conclusions: The risk of infection while flying is very low because of those ventilation systems. (The Harvard study, published independently by the university and not in a peer-reviewed journal, was partially funded by Airlines for America, an industry trade association.)

But the authors of the study acknowledge they can't account for all the behaviors that may occur on a plane, including walking up and down the aisles, eating, and drinking. And they can't account for the behaviors of other passengers, either.

"All these systems can be defeated if people are not wearing masks," **Ed Nardell**, a professor of immunology and infectious diseases and a co-author of the Harvard analysis, said during a press call. He pointed to other gray areas as well, like the risk of people standing less than 6 feet apart while boarding, waiting to use the bathroom, and deplaning. "That's going to be an important thing, that people are not ganged up … on the bridge, or standing in the aisles for a long period of time," he said.

These models also account for the plane's ventilation systems running at full speed mid-flight. But the ventilation systems aren't always turned on at full blast while a plane is being boarded, taxiing, or sitting at the gate — again, the precise moments during a flight when people are most likely to crowd together.

"We made a recommendation that the ventilation system be turned on when planes are on the ground," **Lenny Marcus**, another co-author of the Harvard paper, said on the press call. But they're not guaranteed to be. In the worst-case scenario, you could be stuck for hours at the gate, stewing in less than perfectly filtered air.

Planes have an important built-in safety measure when it comes to the spread of respiratory viruses: their air filtration and ventilation systems. | Michael Loccisano/Getty Images

If you do decide to fly, wear a mask, stay away from other people as much as possible, and consider shielding your face. | Andrew Lichtenstein/Corbis via Getty Images

In contact-tracing studies on flights, there are several documented examples of coronavirus spread

Even better than modeling studies is the evidence we have from real-world examples where Covid-19 (almost certainly) spread on planes. Freedman, the infectious disease specialist, co-authored **one of the most comprehensive papers** on the subject — a review of studies looking at flights with possible transmission, published in the *Journal of Travel Medicine* in late September.

He and co-author Annelies Wilder-Smith studied peer-reviewed research and public health publications from January to September to identify instances of Covid-19 spread on flights, then ranked them by the certainty with which we could trust the results.

Let's look at the four strongest case studies, all of which were considered "mass transmission events," or flights that generated at least two additional Covid-19 cases.

Two of those studies used the "genetic detective" approach mentioned previously: whole-genome sequencing to tease out whether cases that seemed to originate in flight were, in fact, genetically linked.

1) In the first paper, published in the journal ***Emerging Infectious Diseases***, 11 people were PCR positive and symptomatic on a March flight from Sydney to Perth, Australia — nine of them having recently disembarked from a cruise ship where there was an outbreak. They infected 11 others on the flight — none of whom had been on the cruise ship — with a strain of the virus that hadn't yet been identified in Australia. Masks weren't mandatory at the time, and in interviews, passengers said mask-wearing was rare (though two passengers who got the virus in flight did wear masks, though not for the entire journey).

2) In another genetics study, also published in ***Emerging Infectious Diseases***, researchers traced **four Covid-19 cases** recorded in Hong Kong backward to an international flight from Boston in early March (when masking wasn't required). Not only were these four cases on the same flight, the authors of the paper concluded that each case had a virus with a genetic sequence that had never been documented in Hong Kong before. The researchers deduced that two of the passengers on the flight must have acquired the virus with this particular genetic sequence in North America, then boarded a plane where they likely transmitted the virus to two flight attendants.

In both of these studies, it's very difficult *to* prove that transmission happened in flight. But the whole genome sequencing linking the cases with a strain of the virus — that wasn't circulating in the places the passengers boarded the flights — tells us that's very likely.

3) Two of the other four highest-quality papers didn't use genetic sequencing, but they also offered compelling evidence of virus spread on planes. In one, also published in the journal ***Emerging Infectious Diseases***, a symptomatic business-class passenger with Covid-19 boarded a London-Hanoi flight and appears to have infected 15 people (12 in business class, two in economy, and one flight attendant). The authors reasoned that at the time of the flight — March 2 — neither the UK nor Vietnam had more than a handful of Covid-19 cases, so it's very likely the transmissions occurred in the air.

4) The final example was essentially a slightly pared-down real-world version of the unethical experiment described earlier. Since April in Hong Kong, air travel passengers are required to submit to PCR testing upon landing and then quarantine for 14 days. The information on cases can tell us how many people on a flight are positive when they arrive at a destination, and how many go on to develop Covid-19 — suggesting they probably picked it up in the air.

The flight described in the paper was a virtual hotbed of Covid-19: An astonishing 27 passengers had the virus upon arrival in Hong Kong from Dubai, meaning they were

probably already infectious when they got on the plane. The researchers determined that they likely passed the virus on to two other people (both people were negative upon landing but tested positive by day 14). Notably, this was a flight where mask-wearing was mandatory, which may explain why the 27 index cases only generated an additional two cases.

Given all the flying that's happened during the pandemic and these relatively few well-documented examples of virus spread, the **airline industry has been arguing** that this means there's a "low incidence of inflight COVID-19 transmission."

Freedman sees it a different way: "The absence of evidence is not evidence of absence." Since the burden of proving a Covid-19 case was generated in the air — and not through contact just before getting on the plane or just after — is really high, and not all passengers are followed up with, there's probably a lot we're missing, he reasoned.

Mask-wearing seems to reduce the chance of catching the virus in flight. | Sandy Huffaker/Getty Images

"When you're traveling, I think you're more at the hands of those around you in terms of how safe are they being," says Saskia Popescu, an infectious disease epidemiologist and assistant professor with George Mason University. | Sandy Huffaker/Getty Images

What this suggests about the risk of flying in the pandemic

Together, the modeling studies and contact tracing studies tell us a few things about flying in the pandemic: Covid-19 definitely spreads on planes, seemingly mostly to passengers who are seated near index cases, though it's not clear how often this happens. And there's some good news: Masks seem to help.

So what does this mean for the people who want to go home for the holidays or visit loved ones across the country? There are a few things we can take away from the research.

1) **Mask-wearing probably reduces your risk of catching the virus**. Three of the mass transmission events — where more than one person got infected — Freedman's study uncovered happened on flights early in the pandemic, when masking wasn't mandatory. In contrast, in the flight from Dubai to Hong Kong, which carried 27 passengers who were coronavirus positive, there was universal masking in place and only two people got infected. (One of them was seated in a row with five people who tested positive for the virus on arrival.)

"The circumstantial evidence is extremely strong that these [mass transmission] incidences we know about really stopped happening after the airlines started implementing some form of masking," Freedman said. Wearing glasses or a face shield to

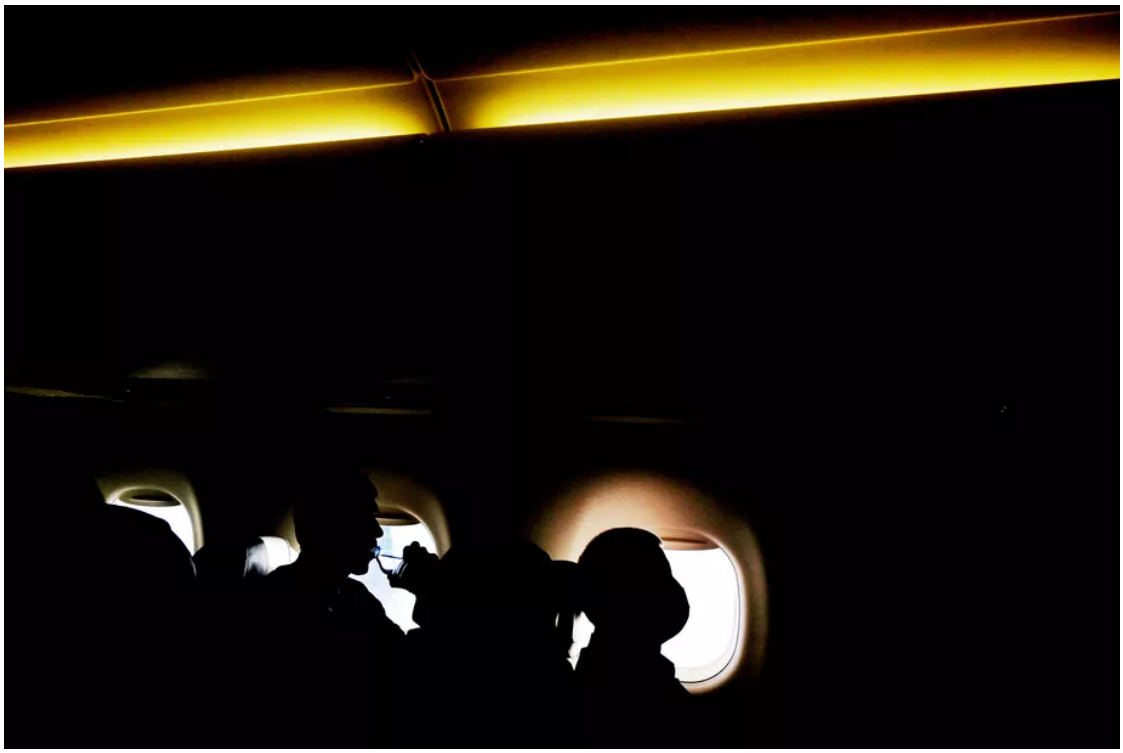
cover your eyes too is probably even more protective (though **face shields are not a substitute for masks**).

2) **Proximity matters.** In all four real-world examples mentioned above, most of the cases were clustered near the person who was sick — and a minority happened more than three rows away from an index case. According to the **Harvard report authors**, when more than 60 percent of seats on a plane are occupied, "it is no longer possible to rely on physical distancing alone to mitigate the risk of virus transmission."

3) **You're subjected to other people's behaviors on a flight in a way you can't escape.** Even with universal mask-wearing, people might remove their mask to eat or talk. Or they might not wear their mask properly. And flying is different from other activities we do that involve some coronavirus risk: If someone started coughing in a meeting or restaurant, you could simply walk away, but the same isn't true for an airplane. People "don't want to take a chance on being a prisoner in a circumstance they can't control," Freedman said.

Overall, the risk of getting the virus on a plane is probably low, he noted, lower than going to a crowded bar or restaurant. But it's not zero. What's more, "Travel is a process that is more than just the flight itself. Passengers need to weigh their tolerance of risk in this context." You may wind up in a line for boarding or the bathroom, where it's harder to distance.

"When you're traveling, I think you're more at the hands of those around you in terms of how safe are they being," said **Saskia Popescu**, an infectious disease epidemiologist and assistant professor with George Mason University. "And that kind of leaves you in a bit of a vulnerable position. So there's only so much we can control when we're traveling. And that's the first step in really understanding the risks at hand."



Overall, the risk of getting the virus on a plane is probably low, but it's not zero. | Sergei Gapon/AFP via Getty Images

Passengers onboard a Qantas flight take photos as they fly over Uluru-Kata Tjuta National Park in Australia on October 10. | James D. Morgan/Getty Images

So: Should you fly?

Even if flying is perfectly safe — and, by now, we know it's not — it's worth being really cautious about travel. "Travel is one of the things, ideally, we'd be trying to minimize right

now," said **Julia Marcus**, an epidemiologist at Harvard, while recognizing that's not going to be possible for a lot of people who have to travel for work or a family emergency.

But think hard: Do you really need to go? Because travel, overall, is how this disease spreads between regions. "Airplanes are certainly vectors of disease, efficiently transporting infectious people around countries and the globe," Joseph Allen, a public health researcher at Harvard, **wrote** in the Washington Post. "This is obviously critical in terms of outbreak control for Covid-19."

The Covid-19 outbreaks grew to pandemic proportions because of air travel, but it's not necessarily because of the planes themselves — it's because of travelers' behavior once they arrived at their destinations. You might, for example, end up at a gathering in a friend's home with people who aren't wearing masks.

So be especially cautious if you're flying from an area with an uncontrolled or rising outbreak to an area with lower levels of infection, or vice versa. You run the risk of exposing a community to the virus, or catching the virus yourself.

There's also your individual risk profile and tolerance to consider. Someone flying home to see a beloved family member perhaps for the last time simply has a different risk calculus than someone whose family members are all likely to be around for years to come. People who are in **higher-risk groups** for serious Covid-19 illness might also be more hesitant than people who aren't.

It is "helpful to think somewhat long term because we are in a long-term situation here," Marcus said. "One of the ways that we can adapt is to have some flexibility around our traditions and rituals that are really important in our lives."

If you decide to fly, how can you minimize your risk?

First and foremost: Check the airline's policy before you go. Some airlines are still practicing physical distancing and spacing out passengers, but others aren't.

Harries, who co-wrote a **review of the research on the safety of flying**, had some useful advice to reduce your risk of getting sick on the plane or transmitting to anyone else.

- Wear a mask and bring extra masks in case the one you're wearing gets dirty or breaks.
- Consider shielding your eyes with sunglasses, goggles, or a face shield.

- Do all the usual pandemic hygiene things you've gotten used to: Take alcohol-based sanitizers on the flight and wipe surfaces around you, regularly wash or sanitize your hands, and don't touch your face.
- Stay away from other people as much as possible — so don't congregate in the bathroom, or in a lineup to board or deplane.
- Try not to talk or yell (that's how droplets spread).
- If you're near someone who is coughing, ask to be moved away.
- Snag a window seat (since people seated in window seats have less contact with other people).
- Minimize eating or drinking, since you have to de-mask to do these things.
- Minimize going to the bathroom on the plane (again, where you'll have contact with others and their germs).
- If **there's an air nozzle** above you, keep it on maximum and point it at your head to keep air flowing from above you to your feet.

Harries also suggested thinking about how you get to the airport — taking a taxi or your own car instead of a crowded bus, for example. And, of course, distancing while at the airport, boarding, or deplaning, too.

So, if you have to travel, do everything you can to reduce your risk of catching or spreading anything, and that'll go a long way even if you can't control what others on the plane are doing.

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