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What makes for the best COVID-19 mask?

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Photo illustration of paper and cloth masks. Credit: Alyssa Stone/Northeastern University

The great mask debate is back. With the highly contagious omicron variant driving a surge in infections around the globe this winter, many people are trying to figure out how to best protect themselves—without returning to the isolation of the pandemic's early days. In addition to

vaccines, masks have been touted as an important tool to shield ourselves from spreading or being exposed to the coronavirus.

But not all masks are created equal. Must we don N95 masks for every social interaction or shopping trip? Or do cloth face masks offer enough protection in some situations?

The answer, says Neil Maniar, professor of public health practice, associate chair of the department of health sciences, and director of the master of public health program at Northeastern, is that it depends.

"There are three things you want to think about with a mask: Fit, filtration, and function," he says. "With omicron, all three of these are important. But what's vital is fit and filtration."

Those two pieces can go hand-in-hand, Maniar says. The poor fit of a mask can negate its ability to filter out harmful stuff, like viral particles.

And it's not just a slight difference, according to research by Loretta Fernandez, associate professor of civil and environmental engineering at Northeastern. Fernandez and colleagues have tested many different kinds of masks—cloth and medical grade alike—to see how many particles of a similar size to those of the coronavirus could make it through to a wearer's mouth and nose.

To test the effect that fit had on filtration, the researchers pulled a nylon stocking over their heads, on top of a mask, to eliminate gaps. With the nylon, many masks performed about 25% better, and a few masks even performed nearly 50% better.

Fernandez isn't suggesting that you cut up stockings to wrap around your head. But the lesson is clear. "Improving the fit of a mask is going to protect you better," she says. It gives the mask a better chance of

removing the particles that might otherwise sneak through the gaps.

Those gaps can easily be identified, she says. Notice whether you can feel your breath on your cheeks, nose, or neck outside your mask when you breathe out heavily.

The concept of layering might still be helpful, Fernandez says, even if you're not using a stocking. "That's where double-masking comes in. If you put something else on top that's going to seal up the gaps, that is going to improve the particle removal in most cases," she says.

"In the cases where it doesn't improve the removal, it's because the material itself isn't blocking the stuff."

And that's where filtration matters.

The goal of a mask is to be a barrier, Maniar says. But a mask through which we must also breathe can't block absolutely everything. So researchers hunting for the best masks to mitigate coronavirus particles are studying whether particles of the same size can make it through the material.

Viral particles are just 0.1 microns in size. A micron is one-millionth of a meter. So they are tiny.

Certified N95 or similar respirators are considered the gold-standard face coverings for blocking viral particles. Fernandez's research found that a N95 that was properly fitted was about 99% effective at keeping out particles of the same size as the coronavirus particles.

But not everyone has access to a N95 mask that fits properly and can be worn every day. So what's the next best thing? What makes one mask better than another?

While medical masks are often considered better filters of viral particles, Fernandez found that some cloth masks can actually rival the looser, ear-loop-style disposable procedural masks that many people wear—removing anywhere from 50% to 75% of particles. But cloth masks have a lot of variability.

It may seem as though a tighter weave makes for a better mask. And that's true, Fernandez says. But it's not the whole picture.

Think of a mask as if it's a maze that a viral particle has to navigate in order to infect the wearer. The more obstacles it encounters, the better for that person.

In addition to fit and weave, the shape of the mask's fibers can matter, too. Cotton, for example, Fernandez says, has bristly fibers, whereas synthetic fibers are quite smooth. The rough surface and extra filaments of cotton provide more impediments against the viral particles.

"It's making the particles have to travel a more tortuous path," she says. "So if you have more fibers, you have more chances of removing the particles."

What it comes down to is surface area on that microscopic level, says Steve Lustig, associate professor and the associate chair of research in chemical engineering at Northeastern.

Lustig also conducted experiments with nanoparticles to see which household materials might be used to make a mask that approaches the effectiveness of a N95 respirator. Two layers of terry cloth from a towel, he found, could do the trick.

"The terry cloth made a lot of sense to me," he says. As part of Lustig's research, in addition to testing how readily nanoparticles moved through

different household materials, he and his colleague explored the different fabrics under magnification. "If you look at the pictures of the terry cloth, there are all these loops in the fabric," he says. "It's more surface area to get in the way."

Layering up is also crucial, both Lustig and Fernandez found in their studies. Additional layers of material in a mask added even more obstacles and surface area to block out viral particles.

Another way to use layering to improve a mask's filtration is simply to double-mask.

It's kind of like Swiss cheese, Maniar says. "If you have one layer of Swiss cheese, you're going to have a bunch of holes, right? So you're going to have some degree of permeability. If you have two layers of Swiss cheese, then you're kind of stalling up some of those holes and you have a better layer of protection."

Maniar suggests wearing a surgical or procedural mask underneath a cloth mask.

Another aspect to consider, Lustig says, is whether your mask has waterproof properties. And that's not just because it's uncomfortable to wear a moist scrap of fabric all day.

"When you get sprayed, because someone sneezes on you or someone coughs, or you cough, you're loading this mask material with all this liquid," he says. "And if that liquid permeates all the way across the mask, well, then you could be imbibing the virus just because it flows by liquid."

Waterproof material isn't the only way to avoid that damp disaster, however. The researchers found that duckbill-shaped masks—masks that

are shaped and stiff enough to stay away from touching your mouth—are more effective, too. And you're also much less likely to accidentally lick the inside of those masks.

Although fit and filtration are key in preventing exposure to SARS-CoV-2, the coronavirus that causes COVID-19, Maniar says it is still important to consider the third factor, function.

"Masks offer an important barrier between us and the virus, both in terms of transmitting the virus and in terms of catching the virus," Maniar says. But when choosing a mask, he adds, it's also important to ask, "How well does it work for you? You want something that's also going to allow you to be able to comfortably engage in whatever activities you're doing while wearing the mask. And that's why there are different options for different scenarios."

More information: www.masktestingatnu.com/findings

Provided by Northeastern University

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