EPA Researchers Test Effectiveness of Face Masks, Disinfection Methods Against COVID-19

Your Guide to Masks

CDC recommends that people wear masks in public settings, at events and gatherings, and anywhere they will be around other people. Check out CDC's Your Guide to Masks webpage <https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/about-face-coverings.html> to learn how to select and properly wear a mask.

Published April 5, 2021

Face masks and other personal protective equipment (PPE) are important tools to protect the wearer and others against COVID-19. EPA scientists and others are applying their expertise in aerosol and decontamination research to study the effectiveness of various types of masks for the public and healthcare workers, as well as methods for disinfecting PPE for the public, healthcare workers, and other essential workers, including emergency responders.

Researchers are rigorously testing masks and other PPE in EPA's laboratories in Chapel Hill and Research Triangle Park, North Carolina. They want to know how effectively different materials can filter out virus particles from the air, whether popular do-it-yourself mask modifications work, and which disinfection methods work well for masks and other types of PPE, like face shields and protective suits.

This information will help health care professionals and the public better identify the most effective products and allow hospital personnel to prioritize N95 respirators and identify alternatives during shortages. Two peer-reviewed articles in the *Journal of American Medical Association* along with one EPA Report, were published in 2020.

Mask Filtration Studies

Public health experts recommend wearing face masks as tools to protect others from breathing potentially infectious particles. At the request of University of North Carolina (UNC) Hospitals, EPA scientists are working to understand the effectiveness of masks to protect the wearer against the virus through a series of projects in collaboration with UNC researchers. Researchers tested how well different masks and modifications filter out airborne salt particles, which are the same size as the smallest SARS-CoV-2 particles, but are not harmful. Members of the research team wore the face coverings to do the testing themselves.

"We were fortunate to have the lab already prepared for a different study before the COVID-19 pandemic set in, so we were able to pivot to help answer important questions UNC Hospitals and other researchers had about masks," said Dr. James Samet, a research biologist and collaborator on the projects. "We've performed hundreds of tests to provide the most useful information for decision makers and the public to help fight this virus."

In one study, the researchers sought to determine whether alternatives to high-efficiency N95 masks reserved for health care workers could offer similar protection for hospital personnel in the event of shortages. They tested the filtration ability of expired N95 masks, N95 masks that had been sterilized for reuse, and dozens of other face mask alternatives. The results show that both expired N95 masks and sterilized N95 masks provided the same level of protection as new N95 masks with greater than 95 percent filtration. Other alternatives provided less protection. For example, surgical masks with

ties provided 71.5 percent filtration, while surgical masks with ear loops only provided 38.1 percent. Knowing the relative performance of alternatives to new N95 masks will help hospital administrators make evidence-based decisions to protect their staff.

In another study, the researchers examined the filtration ability of a variety of medical procedure masks, cloth masks and coverings recommended for the public. They tested masks made from cotton, nylon, and other materials and in different styles, including masks with ear loops and ties.

They found that the effectiveness of the masks varied widely: a three-layer knitted cotton mask blocked an average of 26.5 percent of particles in the chamber, while a washed, two-layer woven nylon mask with a filter insert and metal nose bridge blocked 79 percent of particles on average. Other masks scored somewhere in between.

They also tested a variety of modifications to improve the fit of commercially available medical procedure masks, like tightening ear loops, placing rubber bands over the top and bottom of the mask to reduce gaps, and placing a cut-out piece of nylon stocking over the mask to seal the gaps. The filtration ability improved by 60.3 to 80.2 percent depending on the modification made. As the fit of the medical procedure masks improved, so did their filtration efficiency.

In their study of masks recommended for the public, the researchers emphasize the importance of mask material and fit. Their results indicate that not only are certain cloth masks effective at keeping out viral particles, but in many cases perform as well as or better than non-N95 medical masks. Fabrics with multiple woven layers and reducing gaps provide substantially more particle filtration. The team continues to explore mask performance with studies in progress on the effects of facial hair and face shape on mask fit. The results of these projects will help the public and health care professionals choose mask options that provide the greatest level of protection.

PPE Disinfection and Reuse Study

As the pandemic hit in early 2020, healthcare and frontline workers began to experience shortages of the highly effective N95 masks and other PPE, leaving fewer options available for EPA’s emergency responders and the public. To help address the shortages, EPA researchers wanted to know whether PPE could be disinfected and reused while providing the same level of protection for wearers. They designed a study

to test the suitability of six disinfection methods on an array of PPE types made of various materials. These include not only N95 masks, but full-body protective suits, face shields, face coverings, street clothes, and more.

In an ongoing research project, researchers are applying harmless viruses to the surface of small swatches of each material, then quantifying the amount of virus remaining after disinfection. As they identify which disinfection methods seem promising for each PPE type, the researchers will move to testing full-sized items. Their preliminary results, published in an EPA Report, show that certain disinfection methods may work well on some types of PPE without damaging the material.

"There is no one disinfection technique that works well for all types of PPE," said John Archer, EPA project co-lead. "There is a diversity of PPE that we are investigating low-technology methods for, to actually be effective for use in the real world."

Learn More:

Evaluating Disinfection Methods for Personal Protective Equipment (PPE) Items Intended for Reuse <https://epa.gov/covid19-research/evaluating-disinfection-methods-personal-protective-equipment-ppe-items-intended>

Evaluation of Cloth Masks and Modified Procedure Masks as Personal Protective Equipment for the Public During the COVID-19 Pandemic

Filtration Efficiency of Hospital Face Mask Alternatives Available for Use During the COVID-19 Pandemic

While N95 respirator type masks are the most effective at filtering viral particles, the CDC recommends reserving these masks for healthcare workers. The table below compares the fitted filtration efficiency (FFE)—how well a material filters out particles—for common types of masks recommended for the public.

Consumer-grade masks	Fitted Filtration Efficiency (FFE)	
2-layer woven nylon mask		
Without aluminum nose bridge	44.7%	
With aluminum nose bridge	56.3%	
With aluminum nose bridge and filter insert	74.4%	
With aluminum nose bridge, washed (no filter)	79.0%	
Cotton bandana		
Folded surgeon general style	49.9%	
Folded bandit style	49.0%	
Single-layer woven polyester gaiter	37.8%	
Single-layer woven polyester/nylon mask with ties	39.3%	
Non-woven polypropylene mask with fixed ear loops	28.6%	
3-layer knitted cotton mask with ear loops	26.5%	
N95 respirator: 98.4% FFE **Surgical mask with ties: 71.5% FFE**		

The table below compares the fitted filtration efficiency (FFE)—how well a material

filters out particles—after modifications have been made to masks.

Procedure mask modifications	Fitted Filtration Efficiency (FFE)	Image
Procedure mask with ear loops (no modifications)	38.5%	
With loops tied, corners tucked	60.3%	
With ear guard	61.7%	
With clawed hair clip	64.8%	
Fix-the-mask technique (rubber bands)	78.2%	
Nylon hosiery sleeve	80.2%	

Contact Us <https://epa.gov/sciencematters/forms/contact-us-about-science-matters> to ask a question, provide feedback, or report a problem.

Discover.

Accessibility <https://epa.gov/accessibility>

Budget & Performance <https://epa.gov/planandbudget>

Contracting <https://epa.gov/contracts>

EPA www Web Snapshot <https://epa.gov/home/wwwepagov-snapshots>

Grants <https://epa.gov/grants>

No FEAR Act Data <https://epa.gov/ocr/whistleblower-protections-epa-and-how-they-relate-non-disclosure-agreements-signed-epa-employees>

Privacy <https://epa.gov/privacy>

Privacy and Security Notice <https://epa.gov/privacy/privacy-and-security-notice>

Connect.

Data.gov <https://www.data.gov/>

Inspector General <https://epa.gov/office-inspector-general/about-epas-office-inspector-general>

Jobs <https://epa.gov/careers>

Newsroom <https://epa.gov/newsroom>

Open Government <https://epa.gov/data>

Regulations.gov <https://www.regulations.gov/>

Subscribe <https://epa.gov/newsroom/email-subscriptions-epa-news-releases>

USA.gov <https://www.usa.gov/>

White House <https://www.whitehouse.gov/>

Ask.

Contact EPA <https://epa.gov/home/forms/contact-epa>

EPA Disclaimers <https://epa.gov/web-policies-and-procedures/epa-disclaimers>

Hotlines <https://epa.gov/home/epa-hotlines>

FOIA Requests <https://epa.gov/foia>

Frequent Questions <https://epa.gov/home/frequent-questions-specific-epa-programstopics>

Follow.

LAST UPDATED ON AUGUST 5, 2021