

Tools & Resources Webinar: Effectiveness of Medical and Cloth Masks for COVID-19 Protection
January 27, 2021 | Q&A Log

1. How can we assume any consistent perfect fitting by wearers of the masks?

The majority of the testing was done on the same individuals to ensure consistency of facial characteristics. Each individual was assisted in fitting by an additional staff member. The team has done many hundreds of tests since March of 2020.

2. Are N95 masks effective and safe for wastewater workers regarding COVID-19 in wastewater? What about KN95 masks?

Masks are given “N”, “R”, or “P” ratings based on their ability to repel oil https://www.cdc.gov/niosh/npptl/topics/respirators/disp_part/default.html Depending on what type of exposure is common for such workers, an elastomeric mask, typically worn in the construction and manufacturing may be more appropriate. These masks have a surface that can be cleaned and disinfected, with filter disks that are replaceable. Here is a link to a study of healthcare personnel and adapting these masks to their context with lower supply of traditional N95 masks available <https://jamanetwork.com/journals/jama/fullarticle/2763841> KN95 or even procedure type (often called surgical) masks can offer protection, provided they fit well. Surgical masks that are FDA approved are frequently used in the healthcare field for their robustness to fluid exposure. However, although their inward filtration ability is adequate from a material standpoint, they are often lower values in real world testing due to loose/poor fit and gaps. These can be improved with a fit adjustment technique (“hack”, “fixthefit” brace, etc.).

3. What about pathogen build-up in the mask and CO build-up?

Masks do get contaminated by bacteria, oil, skin cells from the wearer’s skin and eventually need to be thrown out (disposable masks) or laundered. CO2 does not build up inside filtering face piece masks to an extent that it would cause health problem.

4. Were the surgical masks with ties and ear loop similar in size (area)? And, did you test masks with the plastic ear loop adjusters?

The masks had a similar coverage area. One of the “fit hacks” tested was a plastic “ear saver” adjuster with multiple levels. A hair clip securing the ear loops at the back of the head was also tested and both of these hacks resulted in improved fit and thus filtration efficiency. Secure fit around the head is an important factor. Anecdotally, hospital staff who use masks with ties report that they loosen over time worn and need periodic tightening.

- 5. What type of mask would be recommended to wear with a face shield on a plane (a KN95 sticks out too much to wear with the shield)?**

Perhaps a KF94, which has a shorter profile would work better.

- 6. Prior to testing, did personnel who participated in the mask fit test complete the required OSHA medical questionnaire and evaluation and receive medical approval to wear a respirator?**

All study team members involved in this testing are subject to health and safety requirements from the University of North Carolina and the EPA's Office of Research and Development.

- 7. Do you have an idea why bandanas were more effective than the 3-layer cotton mask?**

Woven cotton has been reported to be more effective than knit fabrics as a filtering medium. Perhaps this contributed to the differences.

- 8. Was the use of filters studied?**

One of the masks tested had a pocket for a nonwoven filter insert. Filtration efficiency for this mask improved when the filter was used. Other tests were done with various filter materials, many of which proved effective when used as part of a mask that fit well. An important consideration to keep in mind is breathability. Materials such as a shop towel may provide good filtration, but care should be taken with the number of layers used.

- 9. The first study was on particulates, whereas liquid droplets contain the SARS CoV 2 virus. Since liquid absorption is expected for masks that are not coated for fluid resistance, would the efficiency be slightly higher for droplets containing the virus?**

Respirators are made of non-woven polypropylene, which is not very absorptive since polypropylene is hydrophobic. Supra micron droplets should be sieved by the fibers with efficiency comparable to that of "dry" particulates of the same size.

- 10. How did the KN95 masks compare to the N95 masks?**

KN95 masks were more variable than N95 masks. While some performed well (80-90% fitted filtration efficiency or FFE), others tested as low as 53% FFE. Testing with varying lengths of beard hair negatively impacted the FFE of a KN95 mask to a greater extent than the N95 mask. A Korean standard (KF94) mask with ear loops, although lower performing than the N95, was more robust to beard hair overall than the KN95.

11. Can you share information on the difference in the effectiveness of cotton vs. nylon masks? Is material or how well the mask fits a bigger factor in effectiveness?

Fit seems to be a limiting factor with surgical/procedure style masks. For cloth masks, it is often the material that is the limitation.

12. Would a high thread-count cotton fabric (e.g. at least 300) be effective for use in making a home-made facemask? Unfortunately, thread-counts only seem to be noted on some bed sheets, not on fabric sold at fabric stores.

Researchers at Argonne National Lab tested 600 thread per inch (tpi) vs. 80 tpi quilters cotton. They also tested materials like chiffon, silk, and flannel. In general, higher thread count materials performed better than lower count. Doubling up on layers also helped, for example with a cotton quilt that had 120 tpi sheets enclosing cotton batting. Combining material types may provide improved efficiency or other benefits for balancing comfort against the skin with elasticity and tighter fit. These materials were tested in a chamber, rather than on a human or head form. Cotton alone may not provide optimal filtration, which may be a function of a looser fit when actually worn against the face. It is worth considering a pocket between layers for additional filter material (purchased or home-made) and efforts to get a good seal such as using foam and strong but bendable metal for a nosepiece. Finally, the mode of securing to the head, e.g. tight elastic straps for the neck and crown of the head vs. ear loops are likely to provide a better seal with the face. Look at the designs of N95 mask straps or the "Fix the Mask" brace for ideas of how to secure a mask to achieve a good seal.

<https://www.energy.gov/science/bes/articles/facemask-fabric-filtration-efficiency>

<https://pubs.acs.org/doi/10.1021/acsnano.0c03252>

<https://www.fixthemask.com/>

13. Are there any agencies working on certifying filter efficiencies for non-N95 masks that are purchased by the general public? It is very confusing trying to find a good mask, lots of bad information out there.

We agree that standardization is urgently needed for face coverings available to the consumer. We undertook these studies to try to provide actionable information to the public. The CDC has a website with data about manufacturers and material performance results from non-N95 masks.

<https://www.cdc.gov/niosh/npptl/respirators/testing/NonNIOSHresults.html>

14. What do the percentages of effectiveness mean? Do they mean particles that get into the wearer's nose and mouth, or particles that leave the wearer's nose and mouth, or both?

The studies tested the fitted filtration efficiency (FFE) of a mask or face covering. This is calculated as $[1 - (\text{particle concentration behind the mask} / \text{ambient particle concentration})] \times 100$. Other similar terms for this include "total inward leakage." In other words, by sampling and counting the particles both for the air inside a small chamber and also behind the mask/face covering of a participant in the same room, we measured how effective a mask was at keeping

particles (generated using a saltwater particle generator) outside of a mask or face covering as worn and tested during a few minutes of exercise tests (bending, speaking, looking). Efforts are underway to evaluate the effectiveness of a mask for outward leakage, or how good they are at keeping those particles from escaping from behind the mask. The materials for many masks have been evaluated on static machines that move particles over material or head forms that simulate human breathing. But it is also important to test with actual “moving” humans to better approximate real-world conditions.

15. Several people have allergic reactions to the N95 mask. Doesn't this leave them with the cloth mask as their only option?

If there is an allergy to the materials, choosing a face covering with an alternative material would be the only choice, yes. Some manufacturers use a different layer of material for the portion that makes contact with the skin, so the type of allergy may make a difference (contact dermatitis, etc.).

16. Will the mask brands used in the testing and where to purchase be available?

The face covering brands and manufacturer locations are described in the manuscripts. Often the manufacturer provides information for purchase. The CDC has a webpage that includes some KN95 mask ratings which may be useful for checking brand or manufacturers available from major retailers, e.g. Dasheng DTC3X, Powecom.

<https://www.cdc.gov/niosh/npptl/respirators/testing/NonNIOSHresults.html>

Sickbert-Bennett, E. E. et al. Filtration Efficiency of Hospital Face Mask Alternatives Available for Use During the COVID-19 Pandemic. JAMA Intern Med, doi:10.1001/jamainternmed.2020.4221 (2020).

Clapp, P. W. et al. Evaluation of Cloth Masks and Modified Procedure Masks as Personal Protective Equipment for the Public During the COVID-19 Pandemic. JAMA Intern Med, doi:10.1001/jamainternmed.2020.8168 (2020).

17. The procedure mask is that medical grade/surgical or not?

Some were medical grade, others were clearly marked as non-medical grade, others did not specify. In the first study, we examined masks available to hospital personnel. In the second, those available to the public.

18. Which cloth mask was used in the beard test?

The cloth mask tested was from Hanesbrands, Winston-Salem, NC and is sold in retail outlets such as the Home Depot, Lowe's, and Walmart. It is the same mask that tested at 26% fitted filtration efficiency (FFE) in the manuscript describing cloth masks and procedure mask

modifications for the general public. With varying lengths of beard hair, it tested between about 23-40% FFE.

Clapp, P. W. et al. Evaluation of Cloth Masks and Modified Procedure Masks as Personal Protective Equipment for the Public During the COVID-19 Pandemic. JAMA Intern Med, doi:10.1001/jamainternmed.2020.8168 (2020).

- 19. As the name implies, doesn't the OSHA fit test basically check the seal you are getting to prevent the intrusion of vapors and gases? Since the transmission mechanism for COVID is aerosols and not gases, isn't this a false premise for COVID?**

Filtering face pieces like N95 masks and surgical masks do not protect against gases or vapors. They work by filtering aerosols (i.e., suspended particles and droplets). The OSHA fit test measures performance of the seal for aerosols, not gases.

- 20. So the beard length didn't impact the cloth/procedure mask efficiency because they already had gaps in the sealing surface?**

We speculate that the looser fit of these masks contributed the most to the lower fitted filtering efficiency (FFE) and that beard hair did not markedly or consistently change the fit. The exercise band intervention improved FFE of these masks but not as dramatically as it did for the tighter fitting masks, suggesting that fit improvements may further benefit these masks. Indeed, the hacks tested using the procedure mask to make it fit better yielded much higher FFE (in a different clean-shaven participant). From a materials standpoint, a procedure mask may have better achievable FFE, if the fit is altered. Fit hacks may also need to be tested with bearded individuals to explore the contributions of fit vs. material.

Clapp, P. W. et al. Evaluation of Cloth Masks and Modified Procedure Masks as Personal Protective Equipment for the Public During the COVID-19 Pandemic. JAMA Intern Med, doi:10.1001/jamainternmed.2020.8168 (2020).

- 21. How was the testing correlated to aerosol particles? The COVID-19 virus is small and well suspended in air.**

We tested fitted filtration efficiency against aerosolized salt particles averaging 40 nm in diameter, approximately the same size as a SARS-CoV-2 virion.

- 22. If we cannot get an N95 mask , a cotton mask, double layer with ties, not elastic loops is probably the best?**

KF94 and KN95 masks also tested well for inward filtration. Checking for KN95 results at the CDC website might help find more information about a specific manufacturer.

<https://www.cdc.gov/niosh/nppt/respirators/testing/NonNIOSHresults.html>

Cloth or fabric masks with good materials and good fit can achieve high filtration efficiency. A layered mask with a pocket for a filter might be a good option. Double masking where a fabric covers and secures a procedure mask might be a consideration and a brace or hack to fix a procedure mask might also help. In general, securing a mask via straps as opposed to ear loops provides a better fit. Straps that tie may loosen over time as a mask is worn and ear loops can be made tighter with clips or other commonly available solutions.

23. Although not mask related, can you comment on wearing safety glasses to reduce exposure through the eyes?

Our testing did not address ocular exposure. It would be advisable to wear some type of eye protection against exposure to infectious droplets emitted by COVID-19 patients. However, to protect against submicron aerosols, safety goggles or a full face covering may be needed.

24. Do you have an example or full head/face picture of the exercise band usage with masks? I may have missed it. The picture I saw was a closeup and couldn't tell how they had fully worn it.

Below you can see the band secured around the head and tied with a knot (or two) to secure it. Adjust it so it is comfortable under the neck and leaves the mouth and nose uncovered with the back of the ears accessible (if the mask uses ear loops- even if it does, a clip or other securing mechanism may be preferable). The mask is worn over the mouth and nose "as usual" with the band in place to provide a smooth surface and form a better seal. Exercise bands have many resistance levels and a "lighter weight" may be more comfortable.



25. Do you have any information about filtering efficiency of silk vs cotton?

We have not tested silk face coverings. Below are references to tests of various materials by researchers at the Argonne National Lab.

<https://www.energy.gov/science/bes/articles/facemask-fabric-filtration-efficiency>

<https://pubs.acs.org/doi/10.1021/acsnano.0c03252>

26. Should people continue to keep their masks on inside a meeting room where they are 6+ feet apart, or is it okay for them to take their masks off in that situation? Does the virus remain in the air within a closed space such as a meeting room?

An indoor gathering conveys much higher risk than outdoor spaces. The virus is emitted simply by breathing but even more with activities such as talking, shouting, or singing. Coughing and sneezing are other considerations since these can transmit particles over large distances. Masks

are important not only within the 6-foot range (which is simply a reminder that physical distance can help to reduce risk) as aerosols can and do spread across a room. Several studies have provided evidence for long range transmission, for example an infected and unmasked passenger on a bus likely infected several other passengers further than 6 feet away (see link). Ventilation and filtration of the air can help to reduce the risk, higher ceilings and larger rooms are better than cramped spaces, but the combination of distance, everyone wearing masks, shorter time of interaction, etc. will combine to help reduce risk, with high quality masking providing an important layer of protection. An example to consider indoor risk is available here:

<https://safeairspace.com/>

<https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/2770172>

27. Can you explain why you saw less efficiency on women?

There are small differences but, generally, the same trends were observed between our male and female study subjects. This may be due as much to interindividual facial morphometry differences as it is to gender. In specific, the data we provided related to different sized masks (for styles that had size options) informs the overall idea of ensuring a mask fits the particular wearer's face well. Factors like age, gender and presence of facial hair (for men) will contribute to differences in fit.

28. Is the effectiveness of cloth masks considered comparable to that of surgical masks because surgical masks often don't fit well?

Fit provides a very important contribution to the overall performance of a mask. Another important contribution is materials. Poorly fitting masks with noticeable gaps on the sides or below the eyes will allow air to flow freely behind the mask. When these gaps are fixed with hacks, as shown in the paper listed below, the surgical mask can perform quite well. The material provides for a good filtering of the air, if it can be made to fit well. Cloth masks, in addition to often not fitting well, are made of varying materials. A cloth mask with good materials, multiple layers, a pocket for an insertable filter and a good fit can also perform well.

Clapp, P. W. et al. Evaluation of Cloth Masks and Modified Procedure Masks as Personal Protective Equipment for the Public During the COVID-19 Pandemic. JAMA Intern Med, doi:10.1001/jamainternmed.2020.8168 (2020).

29. Can you speak to the effects of repeated washing on masks available to the public, as in the second study?

We did not examine this in detail but observed that the laundering of one mask may have improved its efficiency. We speculate that this may be due to change in the fibers or an electrostatic effect.

30. Are all KN95 masks equal? Is there a list? Are the KN95 with head straps any better than those with ear loops?

Unfortunately, there seems to be a lot of variability in the performance of KN95 masks. Checking results at the CDC website might yield more information about a specific manufacturer.

<https://www.cdc.gov/niosh/npptl/respirators/testing/NonNIOSHresults.html>

We have not tested any KN95 with head straps, but there is reason to believe they would provide a better fit compared to ear loop versions. If testing shows this, it would be consistent with performance differences found between surgical masks with ties and those with ear loops. Features of N95 masks that seem important to the fit include 1) a tight fit around the nose extending out over the cheeks provided by strong metal and high quality foam and 2) a secure mechanism of attaching to the face with good elastic tension across the neck and crown of the head. Strong straps on a KN95 may provide a more secure attachment, potentially worth testing.

31. Did you check pantyhose or gators with beards?

Unfortunately, we could not test all of the products available to the public in bearded individuals. It is an interesting idea though.

32. Are there plans to research the effectiveness of wearing more than one (non-respirator type) masks for public use?

Yes, the double masking phenomenon warrants investigation, data, and rapid communication of results. Techniques that could improve effectiveness of existing “supply” are important – these include fit and filtration.

33. What category does the mask with N95 insert come under (it is made of cloth)?

Some reusable cloth masks have a pocket for the insertion of a filter. These filters appear to be made of non-woven polypropylene, the same material as the higher grade respirators and other masks.

34. Can are supply website links for masks that are fake or approved?

Checking for KN95 results at the CDC website might help find more information about a specific manufacturer. <https://www.cdc.gov/niosh/npptl/respirators/testing/NonNIOSHresults.html>

KN95 masks and N95 respirators seem to be more frequent targets of counterfeiting efforts. We are not aware of similar reports for KF94 (Korean standard) masks. Cloth masks/face coverings do not currently have a standard and so selecting materials (nylon, high thread per inch cotton) layers, and fit parameters (strong nose wire) may be the best current guidance.

35. What is the minimum particle size detected in these studies?

We tested in an atmosphere containing aerosolized salt particles 40 nm in average diameter. For comparison the SARS-CoV-2 virion range from 50 to 200 nm in diameter.

36. Is a well-fitting double-sheet cotton cloth (t-shirt type) mask effective?

Researchers at Argonne National Lab tested 600 thread per inch (tpi) vs. 80 tpi quilts cotton. They also tested materials like chiffon, silk, and flannel. In general, higher thread count materials performed better than lower count. Doubling up on layers also helped, for example with a cotton quilt that had 120 tpi sheets enclosing cotton batting. Combining material types may provide improved efficiency or other benefits for balancing comfort against the skin with elasticity and tighter fit. These materials were tested in a chamber, rather than on a human or head form. Cotton alone may not provide optimal filtration, which may be a function of a looser fit when actually worn against the face. It is worth considering a pocket between layers for additional filter material (purchased or home-made) and efforts to get a good seal such as using foam and strong but bendable metal for a nosepiece. Finally, the mode of securing to the head, e.g. tight elastic straps for the neck and crown of the head vs. ear loops are likely to provide a better seal with the face. Look at the designs of N95 mask straps or the “Fix the Mask” brace for ideas of how to secure a mask to achieve a good seal.

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37. People seem to have a greater sense of security about going mask-less outside – if we’re outside, we don’t have to wear a mask. Is that true?

The recommendation from public health officials is that, while the risk outdoors is reduced, face coverings should still be used. We find it helpful to think of potentially infectious aerosols as cigarette smoke. It is certainly worse indoors, but we’ve all had the experience of being exposed to cigarette smoke in outdoor settings too. The potential number of people nearby and the duration of an activity might be additional considerations.

38. From the research, the 2-layer nylon mask performed better than the 3-layer cotton (from Walmart). Is that surprising? Most literature on making non-medical face masks usually says to use tightly woven cotton. Do you have any comments on this? Should masks be nylon/spandex?

Researchers at Argonne National Lab tested 600 thread per inch (tpi) vs. 80 tpi quilts cotton. They also tested materials like chiffon, silk, and flannel. In general, higher thread count materials performed better than lower count. Doubling up on layers also helped, for example with a cotton quilt that had 120 tpi sheets enclosing cotton batting. Combining material types may provide improved efficiency or other benefits for balancing comfort against the skin with elasticity and

tighter fit. These materials were tested in a chamber, rather than on a human or head form. Cotton alone may not provide optimal filtration, which may be a function of a looser fit when actually worn against the face. It is worth considering a pocket between layers for additional filter material (purchased or home-made) and efforts to get a good seal such as using foam and strong but bendable metal for a nosepiece. Finally, the mode of securing to the head, e.g. tight elastic straps for the neck and crown of the head vs. ear loops are likely to provide a better seal with the face. Look at the designs of N95 mask straps or the "Fix the Mask" brace for ideas of how to secure a mask to achieve a good seal. Mixing materials might enhance performance relative to only one type of material. Nylon could provide extra filtering capacity, and spandex is certainly associated with a stretchiness that could improve the fit and seal.

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39. We should all be wearing N95 masks, but where can we get them? For example, it doesn't seem possible to purchase them from Amazon.

N95 respirators do offer the best protection, but they are not available in sufficient quantities to supply the entire population. They also require training and testing to don properly and can also be cumbersome to wear for long periods. KF94, some KN95 and some types of reusable cloth masks can also offer good protection and are widely available. The key is wide adoption. If you and I are wearing face coverings that each offer 70% efficiency, the combined effect is over 90%.

40. For N95 masks, how many times can they be re-used?

Unfortunately, there is no magic number. Manufacturers typically suggest that a respirator can be worn until dirty, soiled, or a change in breathing efficiency. It may be an optimal number of hours (~40)- in a hospital or workplace context this might be something like five 8-hour shifts. Healthcare workers frequently cover their respirator with a surgical mask to prevent soiling or contact with any fluids. For a non-healthcare or nonworkplace context, the same 40-hour time frame might reflect twenty 2-hour excursions. Researchers are investigating whether electrostatic "re-charging" might be a solution for filtration efficiency losses that occur over time. An analogy to consider is the air filter in home HVAC units (often made from the same materials)- they may have a 90-day recommended usage time. That recommendation will be for "average" use patterns and the filter likely "lasts" longer with less frequent use. But, in the N95 case, you are wearing the filter on your face so it's an imperfect analogy at best.

41. Have you considered comparing the OSHA standards translate to FDA considerations across different masks?

We chose the OSHA test because it is performed on an actual person and it involves maneuvers that mimic activities that a person might perform while wearing a face covering.

42. What does fogged spectacles mean? Poor seal on the upper edge of the mask, or mis-positioning the mask in relation to the spectacles?

Fogging is very likely the result of hot and humid air “venting” from the upper edge of the mask. A mask with a tight seal such as the N95 typically does not fog up the lenses. Positioning the lenses below the top of a mask (even a poorer seal on the upper edge) may reduce fogging, but likely because the air is able to escape before “sticking.” Recommended hacks include cosmetic tape to adhere the mask to the skin at the upper edge, affixing a mask fixer to press the mask and secure it to the face with a strap configuration, or tightening ear loops to achieve a better fit. Spraying eyeglasses with solutions or using soap to prevent fogging may prevent the symptom but not address the cause.

43. Have you done any studies on the impact to FFE on the frame inserts that can be worn with a cloth mask?

Yes, we have. Some work very well to improve the FFE of surgical masks, which are limited not by their material but by their fit. They can be somewhat cumbersome to use and uncomfortable to wear for long periods.

44. Would you be willing to develop a quick review guideline brochure based on the results with a University or communication organization?

Guidelines may rapidly change, but certain features are constants in the performance of masks for personal protection, including trying to ensure that a mask fits well, is sized properly, and has a good seal. Materials that filter the air well and are comfortable to wear for extended periods of time are recommended for personal protection and to increase the likelihood of use. We will defer to our communications staff as to the level of input we might be able to provide to such an effort. As the disclaimer in our slides states, mention of trade names or products does not constitute EPA endorsement or recommendation for use, nor do our views expressed in the presentation necessarily reflect the views or policies of the US EPA.

45. Any guess on how low the protection would fall if the mask is worn below the nose?

During the OSHA fit test, the subject breathes normally, which would mean through the nose. If the nose is not behind the mask, the person would be inhaling air directly from the chamber atmosphere and we should see no protection at all (0% FFE).

46. Have you tested copper thread masks such as Tommie Copper's CopperFit masks from Home Depot? If so, what was the effectiveness?

To my knowledge, we have not tested “CopperFit” masks. Layers with materials such as high thread count cotton and nylon should help to improve filtering capability. Ear loops tend to provide a weaker seal which might be improved with a fit hack such as a clip or ear guard. The

strength of metal used for the nose bridge and distance it extends typically influence both the fit and the filtering performance of a given mask.

47. Is there a plan to post highlights on EPA or CDC webpages, or otherwise communicate this information to the public at large?

Our communications team is considering strategies to convey this information to the public through available channels. It should be noted that JAMA IM and many other journals are making COVID-19 research articles available without a subscription free of charge during the pandemic.

48. Why is there so little discussion about any potential health concerns around breathing through polypropylene (used in masks) which is a known endocrine disrupter?

There are reports expressing concern about microplastic pollution as a threat to the environment, including landfills, rivers, and oceans.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7297173/> *These relate to the degradation of fibers and materials used and more discussion should exist about the usage and disposal of so-called “disposable” masks. Although I am not aware of research investigating individual exposure from the inhalation route, it would benefit society to research whether “naturally occurring” fibers may provide similar filtration benefits without some of the risks associated with synthetic fibers. Filtering facepiece respirators came into existence largely to address and reduce hazardous workplace exposures such as mines or industrial processes with exposures that would put employees at risk for severe respiratory infection or worse and unreasonable toxic exposures. In the context of wildfire smoke and biological pathogens, it is important to consider both the benefits of reduced inhalation of highly harmful particles as well as risks that wearing respirator masks might be associated with. There is always room for improvement in tools that are used to protect the health and well-being of humans and the air we all breathe.*

49. If you inhale 1 particle or 50 particles, aren't you still going to get COVID?

The number of viral particles required to infect a person has not been conclusively determined. It is safe to assume that your risk of infection is directly proportional to the number of particles that you are exposed to. While no mask can guarantee 100% effectiveness, studies support reducing the concentration of viral particles in the air that you breathe as much as possible as a means to lower your individual risk of contracting COVID-19.

50. If we can only get KN95s, how can we make sure they are providing adequate filtration to prevent inhaling virus particles, should we add a surgical mask outside the KN95? Is it OK to re-use those or does the efficiency go down quickly after it is used?

Great question – there are hacks to improve the efficiency of surgical masks alone, most of which improve the fit by making a tighter seal. Doubling up with masks may improve the performance and it likely depends on whether the fit and filtration parameters benefit in real-world

application. We will be investigating impacts of some types of double-masking with fit testing and hope to contribute answers soon. Surgical masks are not designed for extensive use, not necessarily because of efficiency losses, but rather because of the likelihood of contact with fluids or contaminants. A KN95 that fits well can achieve high levels of filtration efficiency. Checking for KN95 results at the CDC website might help find more information about a specific manufacturer. <https://www.cdc.gov/niosh/npptl/respirators/testing/NonNIOSHresults.html> KF94 masks (the Korean standard) are another mask type to consider. Finally, cloth masks that have multiple layers or a pocket for a filter to be inserted might work well as a doubled mask in combination with a surgical mask underneath. We hope to share more data soon about effective options for the general public.

51. Do surgical masks not work as well once they've gotten wet, or is that just a rumor?

We have not tested wet masks. However, a wet mask may be harder to breathe through and may not form an effective seal on the facial skin.

52. Can a filter be porous to be more breathable?

Not sure whether there is a simple answer to this question. Different materials might have different filtration abilities and for different particle sizes. Breathability may be related to the change in pressure that occurs related to the weight and thickness of the material and the tightness of the seal of that material. The KF94 mask we tested is relatively breathable while also filtering relatively effectively. A thick wool scarf may be very difficult to breathe through while also filtering relatively poorly. Sorry if that's not what you are exactly asking, but here's an answer we gave to people who were asking about materials for home-made masks – Researchers at Argonne National Lab tested 600 thread per inch (tpi) vs. 80 tpi quilts cotton. They also tested materials like chiffon, silk, and flannel. In general, higher thread count materials performed better than lower count. Doubling up on layers also helped, for example with a cotton quilt that had 120 tpi sheets enclosing cotton batting. Combining material types may provide improved efficiency or other benefits for balancing comfort against the skin with elasticity and tighter fit. These materials were tested in a chamber, rather than on a human or head form. Cotton alone may not provide optimal filtration, which may be a function of a looser fit when actually worn against the face. It is worth considering a pocket between layers for additional filter material (purchased or home-made) and efforts to get a good seal such as using foam and strong but bendable metal for a nose piece. Finally, the mode of securing to the head, e.g. tight elastic straps for the neck and crown of the head vs. ear loops are likely to provide a better seal with the face. Look at the designs of N95 mask straps or the "Fix the Mask" brace for ideas of how to secure a mask to achieve a good seal. Mixing materials might enhance performance relative to only one type of material. Nylon could provide extra filtering capacity, and spandex is certainly associated with a stretchiness that could improve the fit and seal.

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53. Would you expect the CDC guideline to reflect the need to use a mask or combo that achieves over 30% FFE?

Any reduction in individual exposure would have an effect across the population. If we could reduce the viral concentration by 30% it may well have meaningful reductions in the number of COVID-19 cases. Fortunately, there are face coverings that offer significantly better protection than 30%.

54. How to deal with public perception if some masks are only 30% effective, why bother wearing one?

Wearing any mask is better than not wearing a mask at all. But, once you are wearing one, and we all should mask up, especially in higher risk indoor spaces, there are simple hacks or better masks that can improve the filtering performance which will protect you better. For example, fixing a procedure mask by tightening ear loops and gaps with a knot/tuck, or using a hair clip or ear guard at the back of the head is an easy and available “upgrade.” Doubling up may provide benefit and we’ll test this and share the results to let you know. Higher efficiency masks (KF94, KN95, and filter pocket cloth masks) are available, and it’s good to consider upgrades and improvements.

55. You want to encourage more mask wearing.

Thank you for your comment. To the extent that mask wearing is a proven protective strategy that we currently have to protect the population against COVID-19 morbidity and mortality, one would think that everyone would want to encourage more mask wearing.

56. Are you recommending KN95 over procedure masks?

Procedure masks can perform effectively – they usually need some fixes to get them to seal and fit the face better. We are recommending trying to achieve the best fit and filtering performance in order to protect the wearer. This would involve implementing those fixes for procedure masks to improve their performance by improving the fit. KF94 and KN95 masks tend to fit better “out of the package” and likely represent an upgrade compared to what people might be using. Finally, double masking may also represent an upgrade if fit and filtering are enhanced by the masks that are used. We hope to have some results to share soon related to this.