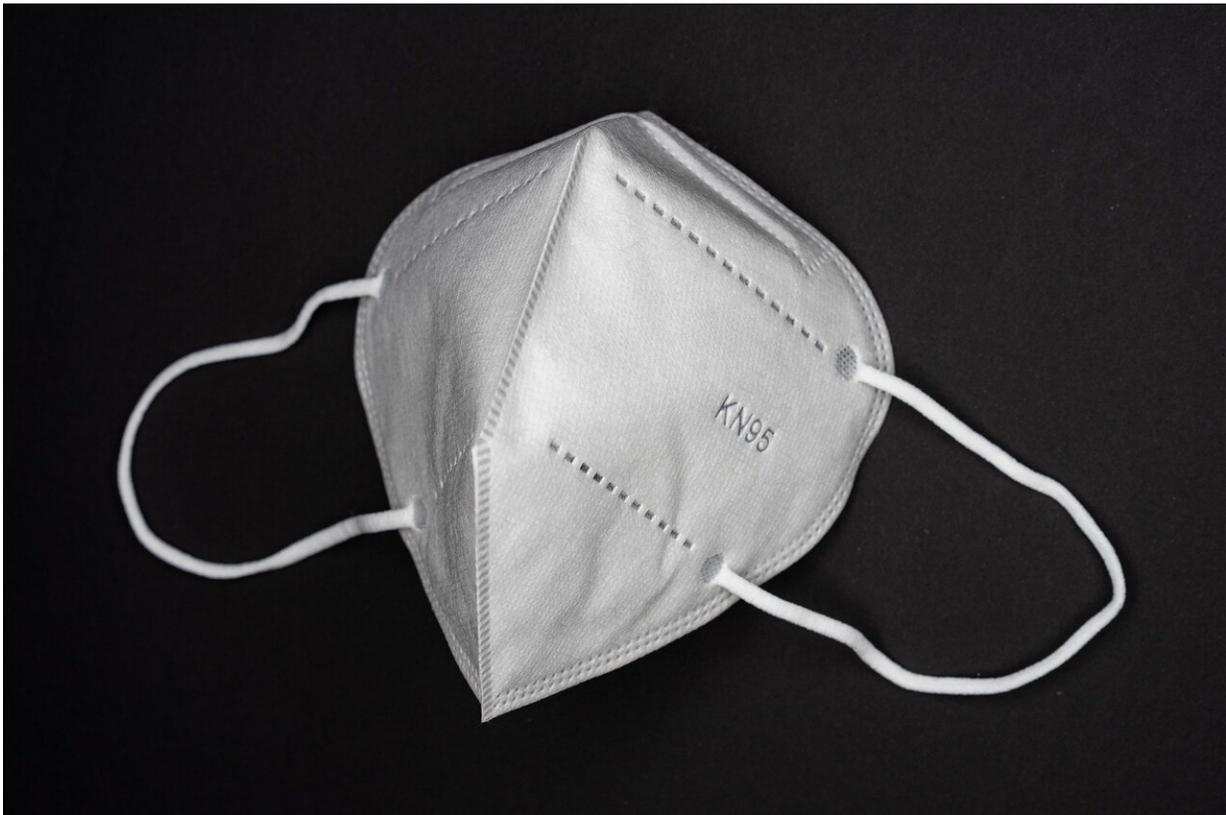


Testing the effectiveness of KN95 and surgical mask 'fit hacks'

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Researchers have tested a variety of popular hacks for improving the fit of KN95 and surgical masks, and found that while some hacks do improve fit, they can also come at the cost of the wearer's comfort.

Proper fit is essential to the effectiveness of a face mask, especially for those in healthcare settings who are caring for patients with COVID-19.

However, [face masks](#), like [faces](#), come in a variety of shapes and sizes, and some users have experimented with 'hacking' their masks to improve the fit. Some popular hacks include using rubber bands as a 'brace', knotting the elastic ear loops, or taping the edges of the mask directly to the face.

Researchers from the University of Cambridge tested seven different hacks for surgical and KN95 masks (similar to FFP2 masks in the UK) and found that two hacks in particular: first aid tape and nylon tights, significantly improved mask fit. However the tights, in particular, were highly uncomfortable for wearers.

The researchers hope their results, reported in the journal *PLoS ONE*, could be used by mask designers and manufacturers to improve fit for as wide a range of users as possible in future, particularly in healthcare settings.

Masks have been a defining feature of the COVID-19 pandemic. In early 2020, when high-quality masks and PPE were unavailable in many areas, [health care workers](#) and others made poorly-fitting face coverings out of whatever was available: scarves, t-shirts, or layered cloth.

Now, as we enter the third year of the pandemic, high-quality masks, such as N95, KN95, FFP2 and FFP3 masks have been shown to provide far greater protection than cloth masks, and are widely available.

However, fit of a mask is even more important than the material it is made of. "In order to provide the advertised protection, a mask needs to fit tightly to the face—there should be no visible gaps around the edge of the mask," said Eugenia O'Kelly from Cambridge's Department of

Engineering, the paper's first author.

Most hospitals and other healthcare settings provide KN95 and [surgical masks](#) in a range of sizes, and staff carry out 'fit-check' routines before starting work to ensure their mask is properly fitted. However, in some cases, only certain sizes are available, and so individuals have used different 'hacks' to improve fit.

"We've seen lots of anecdotal evidence of people hacking their masks to better fit the shape of their face, but we wanted to validate whether any of these hacks actually work, as very little research has been done in this area," said O'Kelly.

O'Kelly and her colleagues conducted qualitative and quantitative fit testing, with and without 'hacks', on four participants, in order to test their effectiveness. Qualitative testing is usually measured by spraying a flavored compound and testing whether the wearer can taste the compound while wearing the mask. Quantitative testing, which is far more accurate, measures the concentrations of particles both inside and outside the mask.

The researchers tested seven different hacks: sealing the edges with cloth tape, stuffing the gaps with first aid gauze, binding the mask to the face with gauze like a mummy, pressing the mask to the face with tights, knotting the ear loops, and using rubber bands to create a 'brace'.

For the KN95 masks, the tights and cloth tape were the most effective at improving fit, although there were significant variations between participants. The tights helped produce a tight fit, but participants found them highly uncomfortable. The tape, while it did not cause any discomfort while wearing the mask, did cause discomfort during removal. The other hacks mostly improved the fit, but not by a significant amount.

For surgical masks, again the tights and tape improved fit most significantly, with the other hacks only providing small to moderate improvements.

"For most of the hacks, comfort was a big issue," said O'Kelly. "The rubber bands for example, tended to put painful pressure on the ears and face, to the point where they hindered circulation to the ears. However, using an effective but uncomfortable hack may make good sense in some high-risk situations, where the discomfort is worth it for the added protection, but it would be harder to wear these hacks day in and day out."

The researchers also point out that fit is highly influenced by the shape of the wearer's face: whether they have relatively high or low deposits of fat under their cheeks, for example.

"We hope these results can be used in the design of future masks, in order to ensure that they are as tight to the face as possible, for as many wearers as possible, without making them uncomfortable," said O'Kelly.

While the results of the current study are meant to be of use mostly to healthcare workers, as increasing numbers of civilians are wearing high-filtration masks, the researchers say that fit-checks are a useful exercise for anyone to carry out.

In the absence of testing equipment, wearers should check their mask in the mirror, with their face still and in motion, and see whether there are any visible gaps. If possible, users should test a range of different high-filtration [masks](#) to find the one that fits best.

"If you take a breath in, you'll want to see the material move a little bit, which indicates a pretty good fit," said O'Kelly. "If you're worried about getting the best fit possible, you may want to try first aid tape around

your chin and cheeks."

More information: *PLoS ONE* (2022). [DOI: 10.1371/journal.pone.0262830](https://doi.org/10.1371/journal.pone.0262830)

More information about the research group and their upcoming projects is available at www.facemaskresearch.com

Provided by University of Cambridge

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