



IMAGES IN THORAX

Face coverings and mask to minimise droplet dispersion and aerosolisation: a video case study

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To evaluate the effectiveness of the Centers for Disease Control and Prevention (CDC) recommended one- and two-layer cloth face covering against a three-ply surgical mask, we challenged the cloth covering against speaking, coughing and sneezing. The one-layer covering was made using 'quick cut T-shirt face covering (no-sew method)' and the two-layer covering was prepared using the sew method prescribed by CDC.¹ To provide visual evidence of the efficacy of face coverings we used a tailored LED lighting system (GS Vitec MultiLED PT) along with a high-speed camera (nac MEMRECAM HX-7s) to capture the light scattered by droplets and aerosols expelled during speaking, coughing and sneezing while wearing different types of masks ([figure 1](#) and online supplementary video). The video for speaking was captured at 850 frames/s (fps) and for coughing and sneezing a frame rate of 1000 fps was used due to the higher expulsion speeds. Frames of the captured videos were pre-processed by applying a calibration and a two-axis stabilisation.² We used a healthy volunteer without any respiratory infection and informed consent was obtained before conducting the experiments. The cough

performed was voluntary and to induce a sneeze the subject used a tissue paper to stimulate the mucus membrane of the nasal cavity. The cloth coverings were made from 175 GSM cotton fabric with a thread count of 170 TPI and the surgical mask used was a three-ply Bao Thach face mask.

DISCUSSION

From the captured video it can be observed that, for speaking, a single-layer cloth face covering reduced the droplet spread but a double-layer covering performed better. Even a single-layer face covering is better than no face covering. However, a double-layer cloth face covering was significantly better at reducing the droplet spread caused by coughing and sneezing. A surgical mask was the best among all the tested scenarios in preventing droplet spread from any respiratory emission. These visualisations show the value of using face masks and the difference between types of masks. Several other factors determine the efficacy of cloth masks such as type of material, the number of layers, the arrangement of different layers and frequency of washing. However,

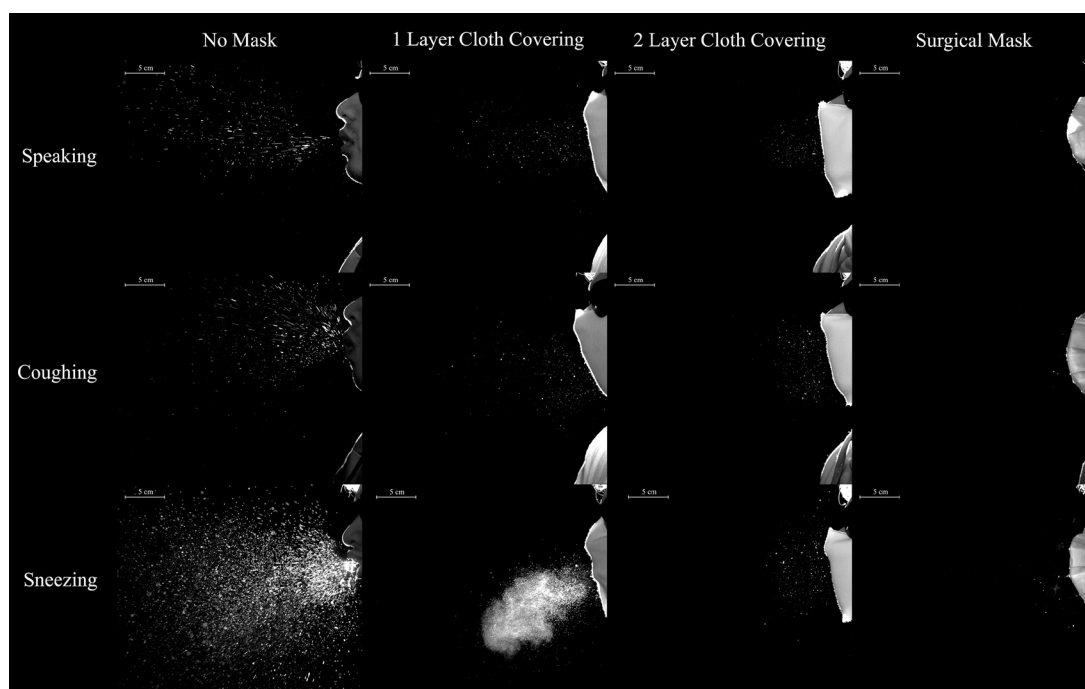


Figure 1 Face coverings and face mask to minimise droplet dispersion and aerosolisation in three different scenarios. Detailed high-speed visualisations of all the scenarios are provided in the online supplementary video.



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based on the visualisations presented, in case of shortages of surgical masks, a cloth face covering with at least two layers is preferable to a single-layer one. Guidelines on home-made cloth masks should stipulate multiple layers (at least 3). One study showed that a 12-layered cotton mask was as effective as a surgical mask, but a single-layered cloth mask was not protective against beta-coronaviruses.³ There is a need for more evidence to inform safer cloth mask design, and countries should ensure adequate manufacturing or procurement of surgical masks.

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