

N95 Respirators Provide Superior Source Control for SARS-CoV-2

Jianyu Lai^{1,2}, Kristen K. Coleman¹, S.-H. Sheldon Tai¹, Jennifer German¹, Filbert Hong¹, Barbara Albert¹, Yi Esparza¹, Aditya K Srikakulapu¹, Petri Kalliomaki¹, Maria Schanz¹, Isabel Sierra Maldonado¹, Molly Oertel¹, Naja Fadul¹, T. Louie Gold¹, Kathleen McPhaul¹, Tianzhou Ma², Benjamin J. Cowling³, and Donald K. Milton¹

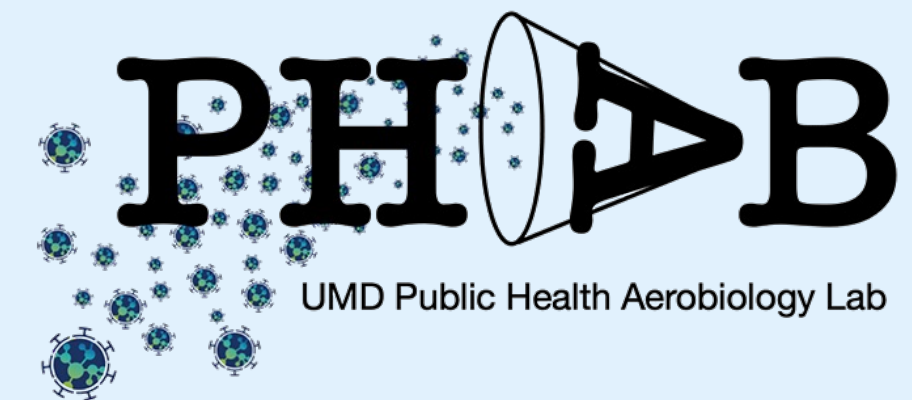


SCHOOL OF PUBLIC HEALTH

1 Maryland Institute for Applied Environmental Health, University of Maryland School of Public Health, College Park, MD, USA

2 Department of Epidemiology and Biostatistics, University of Maryland School of Public Health, College Park, MD, USA

3 World Health Organization Collaborating Center for Infectious Disease Epidemiology and Control, School of Public Health, The University of Hong Kong, Hong Kong Special Administrative Region, China



Background

- SARS-CoV-2 is transmitted by infectious aerosols.
- Face masks reduce viral exhaled breath aerosols (EBA) released by infected persons (source control), reducing risk of transmission.
- Study objectives:
 - Compare the efficacy of face masks (cloth and surgical) and respirators (KN95 and N95) as source control for SARS-CoV-2.

Methods

- Study Population:
 - Volunteers with SARS-CoV-2 infections from the University of Maryland College Park campus and community
 - Providing paired masked-unmasked same-day samples with at least one sample having detectable SARS-CoV-2 RNA
 - June 2020 through May 2022
- Sample Collection & Laboratory Analyses
 - 30-minute G-II EBA samples
 - With a mask on first and then without
 - Viral RNA: real-time RT-PCRs TaqPath COVID-19 Multiplex Assay
 - Limit of detection: 75 copies/sample
 - Two aerosol size fractions:
 - fine ($\leq 5 \mu\text{m}$) and coarse ($> 5 \mu\text{m}$)
 - Total EBA = fine EBA + coarse EBA
- Statistical Analyses (R and RStudio):
 - Crude comparison: Wilcoxon signed rank tests
 - Source-control factor: Percentage reduction in viral RNA load when wearing a mask
 - Geometric means and mask comparison: Linear mixed-effect models with censored responses (R package 'lme4')



Figure 1. Gesundheit-II (G-II) exhaled bioaerosol collector

Exhaled Breath Aerosol Viral RNA Load

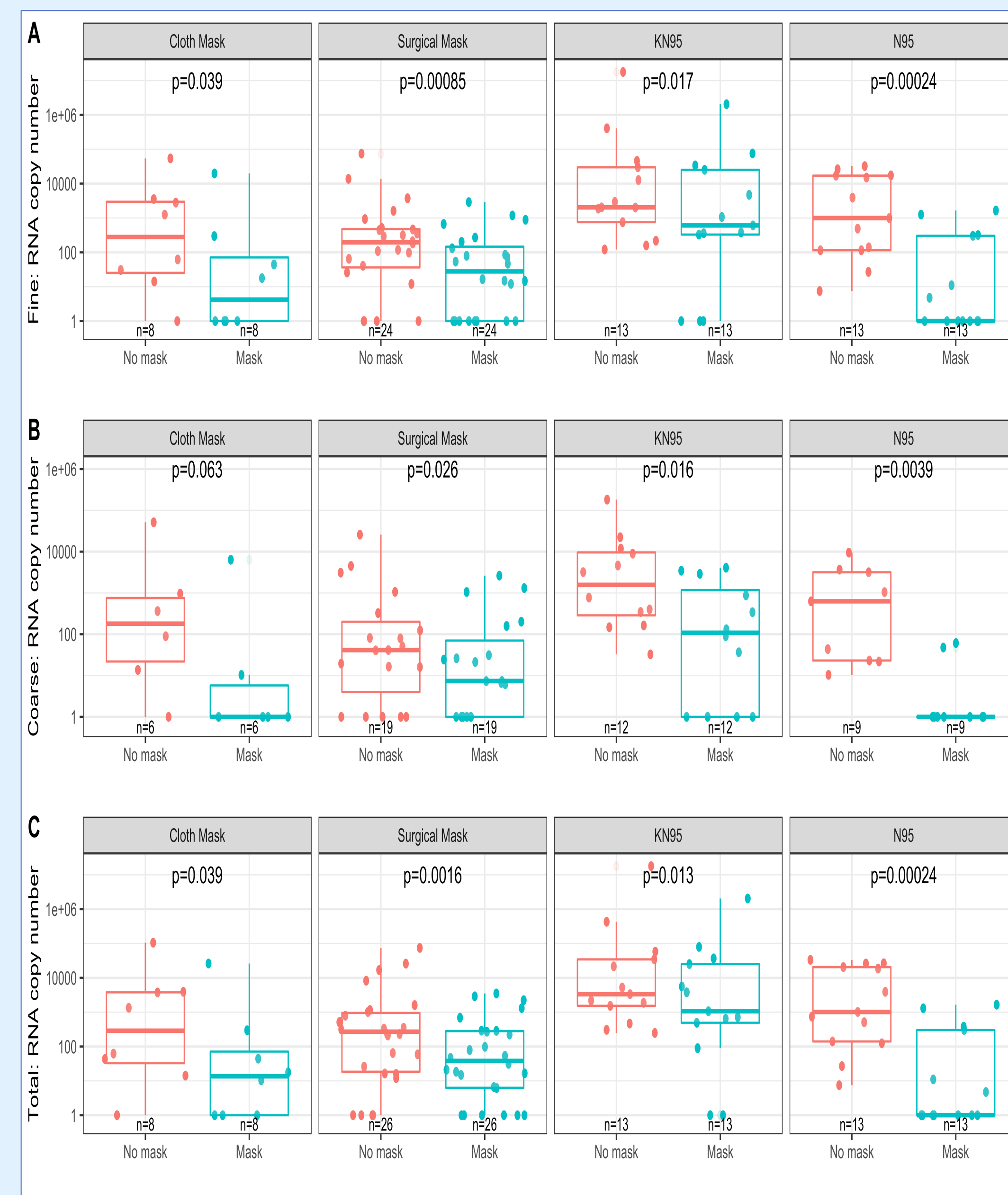


Figure 2. EBA viral RNA load in the masked and unmasked samples

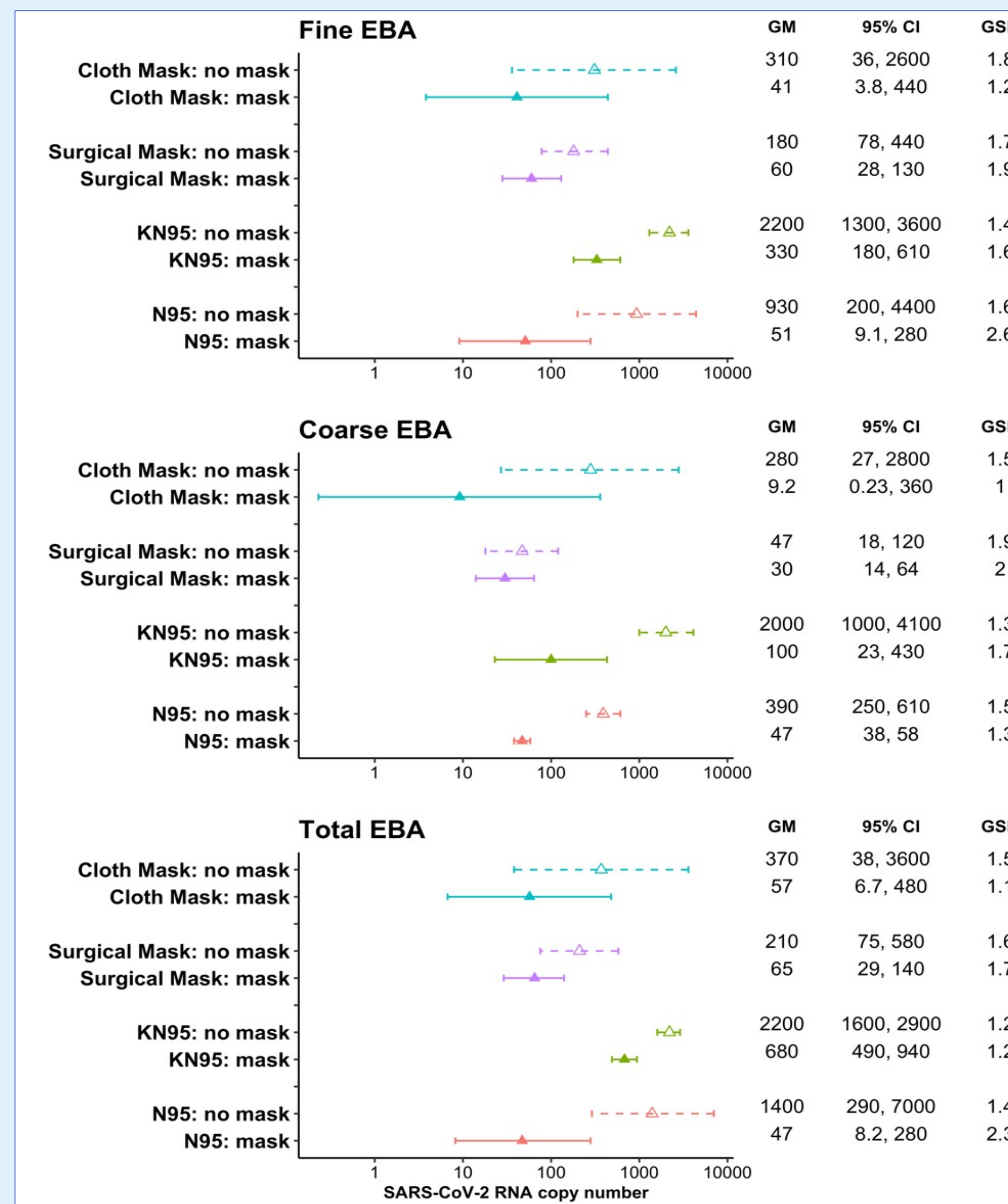


Figure 3. Geometric means of EBA viral RNA load by sample types

Mask Comparison

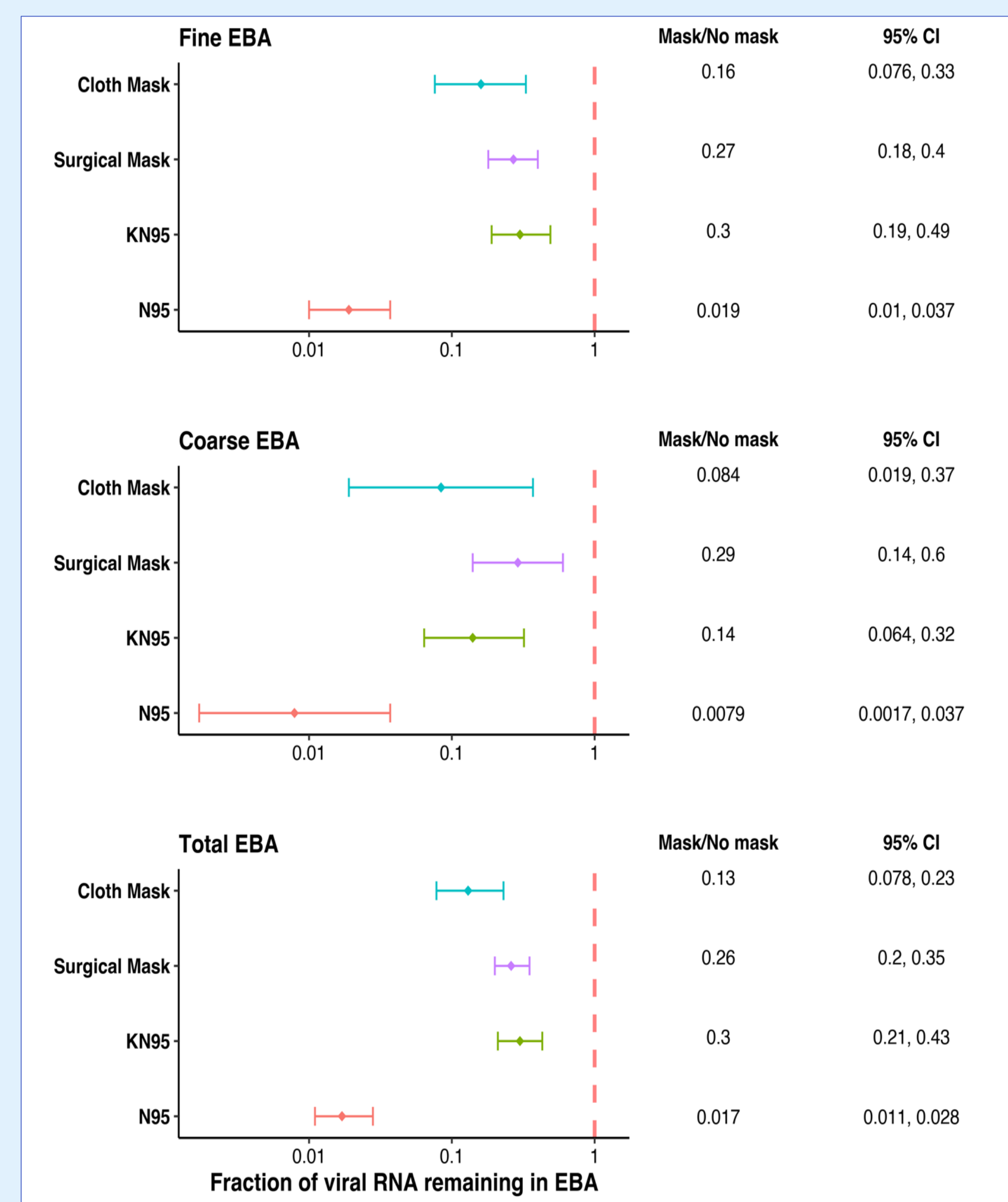


Figure 4. Ratio of viral RNA in EBA with to without mask controlling for cough

Table 1. Mask comparisons on source-control factors controlling for cough

	Improvement (%) ^a	P
Fine EBA	N95 vs. Cloth	88 (2.0x10 ⁻⁵)
	N95 vs. Surgical	93 (3.6x10 ⁻¹²)
	N95 vs. KN95	94 (9.8x10 ⁻¹²)
	KN95 vs. Cloth	-92 (0.14)
	KN95 vs. Surgical	-13 (0.69)
Coarse EBA	Cloth vs. Surgical	41 (0.21)
	N95 vs. Cloth	91 (2.9x10 ⁻²)
	N95 vs. Surgical	97 (2.5x10 ⁻⁵)
	N95 vs. KN95	94 (1.0x10 ⁻³)
	KN95 vs. Cloth	-70 (0.53)
Total EBA	KN95 vs. Surgical	51 (0.19)
	Cloth vs. Surgical	71 (0.13)
	N95 vs. Cloth	87 (2.1x10 ⁻⁸)
	N95 vs. Surgical	93 (<0.001)
	N95 vs. KN95	94 (<0.001)
Source-control factor	KN95 vs. Cloth	-130 (0.012)
	KN95 vs. Surgical	-15 (0.53)
	Cloth vs. Surgical	49 (0.028)

a. Improvement in source-control factor

Results

- Forty-four volunteers
 - 3 Alpha, 2 Delta, 21 Omicron, 18 Others
 - Mean age of 30 years (range: 17 to 66)
 - Mild symptomatic
- Sixty same-day paired EBA samples with detectable SARS-CoV-2 RNA
 - 8 cloth masks, 26 surgical masks, 13 KN95, and 13 N95 respirators
- Mask comparison:
 - All mask types significantly reduced viral RNA copies in the aerosol samples
 - N95 respirators reduced more viral RNAs than the other three types of masks (Contrast analysis: $p < 0.05$)
 - N95 respirators reduced total aerosol viral RNA by 98% (source-control factor, 95% CI: 97% to 99%)
 - The source-control factors (total EBA) for cloth masks were superior to those for both surgical masks and KN95 respirators

Discussion

- Face masks and respirators work as source control for SARS-CoV-2.
- Face masks and respirators are appropriate for general community use to reduce transmission.
- N95 respirators are more efficacious than all other types of masks even when used by untrained study participants.
- N95 respirators should become the standard in nursing homes and healthcare settings, if applicable, when community rates of respiratory infections are high.

Acknowledgement

- This project was funded by:
 - The Defense Advanced Research Projects Agency
 - National Institute of Allergy and Infectious Diseases
 - The Centers for Disease Control and Prevention
 - Bill & Melinda Gates Foundation
 - The Flu Lab

Scan this to view the poster!

