Effectiveness of face masks for COVID-19

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Overview

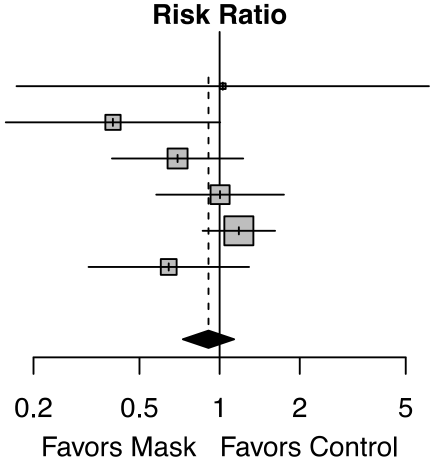
- Face masks are part of essential personal protective equipment for healthcare workers
- Community use of face masks has been more controversial, many health authorities initially recommending <u>against</u> face mask use by the general public, perhaps mainly because of supply shortages
- Mask use should do something, but limited evidence base on how much masks could reduce transmission in the community
- Some speculation (without any supporting evidence) that face mask use might increase risk of infection, or lead to false sense of security

Pre-COVID: evidence base on effectiveness of face masks against influenza in the community

Facemask and hand hygiene

Author	Mask Events	Mask Total	Control Events	Control Total	Weight	Risk Ratio	95% C.I.
Aiello et al. 2010	2	316	3	487	1.6%	1.03	[0.17; 6.11]
Aiello et al. 2012	6	349	16	370	10.8%	0.40	[0.16; 1.00]
Cowling et al. 2009	18	258	28	279	18.8%	0.70	[0.39; 1.23]
Larson et al. 2010	25	938	24	904	17.1%	1.00	[0.58; 1.74]
Simmerman et al. 2011	66	291	58	302	39.7%	1.18	[0.86; 1.62]
Suess et al. 2012	10	67	19	82	11.9%	0.64	[0.32; 1.29]
Fixed effect model		**2219**		**2424**	**100.0%**	**0.91**	**[0.73; 1.13]**

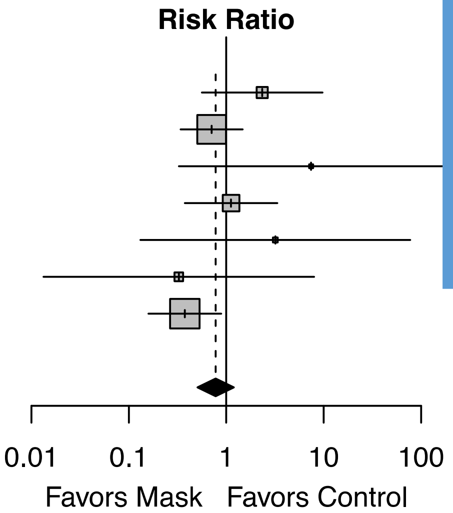
Heterogeneity: $I^2 = 35\%$, $\tau^2 = 0.0511$, $p = 0.17$
Test for overall effect: $z = -0.85$ ($p = 0.39$)



Mask only

Author	Mask Events	Mask Total	Control Events	Control Total	Weight	Risk Ratio	95% C.I.
Aiello et al. 2010	5	347	3	487	5.7%	2.34	[0.56; 9.72]
Aiello et al. 2012	12	392	16	370	37.3%	0.71	[0.34; 1.48]
Barasheed et al. 2014	1	11	0	28	0.7%	7.43	[0.33; 169.47]
Cowling et al. 2008	4	61	12	205	12.5%	1.12	[0.37; 3.35]
MacIntyre et al. 2009	1	94	0	100	1.1%	3.19	[0.13; 77.36]
MacIntyre et al. 2016	0	302	1	295	3.4%	0.33	[0.01; 7.96]
Suess et al. 2012	6	69	19	82	39.4%	0.38	[0.16; 0.89]
Fixed effect model		**1276**		**1567**	**100.0%**	**0.78**	**[0.51; 1.20]**

Heterogeneity: $I^2 = 30\%$, $\tau^2 = 0.1899$, $p = 0.20$
Test for overall effect: $z = -1.15$ ($p = 0.25$)



Ten RCTs were included in the meta-analysis, and there was no evidence that face masks are effective in reducing transmission of laboratory-confirmed influenza (pooled estimate was not statistically significant).

Some evidence of a limited benefit of hand hygiene and face masks for confirmed influenza

Point estimate – 10% to 20% reduction in influenza transmission associated with universal face mask use and enhanced hand hygiene

Xiao et al. 2020 Emerg Infect Dis

Rapid review in Lancet on face masks against SARS, MERS and COVID-19 mostly <u>in health-care settings</u>

	Country	Respirator (0=no)	Infection	Events, face mask (n/N)	Events, no face mask (n/N)	RR (95% CI)	% weight (random)
Health-care setting							
Scales et al (2003)[66]	Canada	0	SARS	3/16	4/15	0·70 (0·19–2·63)	3·2
Liu et al (2009)[51]	China	0	SARS	8/123	43/354	0·54 (0·26–1·11)	6·7
Pei et al (2006)[61]	China	0	SARS	11/98	61/115	0·21 (0·12–0·38)	7·9
Yin et al (2004)[75]	China	0	SARS	46/202	31/55	0·40 (0·29–0·57)	10·3
Park et al (2016)[59]	South Korea	0	MERS	3/24	2/4	0·25 (0·06–1·06)	2·8
Kim et al (2016)[48]	South Korea	0	MERS	0/7	1/2	0·13 (0·01–2·30)	0·8
Heinzerling et al (2020)[44]	USA	0	COVID-19	0/31	3/6	0·03 (0·002–0·54)	0·9
Nishiura et al (2005)[55]	Vietnam	0	SARS	8/43	17/72	0·79 (0·37–1·67)	6·5
Nishiyama et al (2008)[56]	Vietnam	0	SARS	17/61	14/18	0·36 (0·22–0·58)	9·0
Reynolds et al (2006)[64]	Vietnam	0	SARS	8/42	14/25	0·34 (0·17–0·69)	6·7
Loeb et al (2004)[53]	Canada	1	SARS	3/23	5/9	0·23 (0·07–0·78)	3·6
Wang et al (2020)[41]	China	1	COVID-19	0/278	10/215	0·04 (0·002–0·63)	0·9
Seto et al (2003)[67]	China	1	SARS	0/51	13/203	0·15 (0·01–2·40)	0·9
Wang et al (2020)[70]	China	1	COVID-19	1/1286	119/4036	0·03 (0·004–0·19)	1·7
Alraddadi et al (2016)[34]	Saudi Arabia	1	MERS	6/116	12/101	0·44 (0·17–1·12)	5·0
Ho et al (2004)[45]	Singapore	1	SARS	2/62	2/10	0·16 (0·03–1·02)	1·9
Teleman et al (2004)[68]	Singapore	1	SARS	3/26	33/60	0·21 (0·07–0·62)	4·2
Wilder-Smith et al (2005)[72]	Singapore	1	SARS	6/27	39/71	0·40 (0·19–0·84)	6·5
Ki et al (2019)[47]	South Korea	1	MERS	0/218	6/230	0·08 (0·005–1·43)	0·8
Kim et al (2016)[49]	South Korea	1	MERS	1/444	16/308	0·04 (0·01–0·33)	1·6
Hall et al (2014)[43]	Saudi Arabia	1	MERS	0/42	0/6	(Not calculable)	0
Ryu et al (2019)[65]	South Korea	1	MERS	0/24	0/10	(Not calculable)	0
Park et al (2004)[58]	USA	1	SARS	0/60	0/45	(Not calculable)	0
Peck et al (2004)[60]	USA	1	SARS	0/13	0/19	(Not calculable)	0
Burke et al (2020)[37]	USA	1	COVID-19	0/64	0/13	(Not calculable)	0
Ha et al (2004)[42]	Vietnam	1	SARS	0/61	0/1	(Not calculable)	0
Random subtotal (I^2=50%)				**126/3442**	**445/6003**	**0·30 (0·22–0·41)**	**81·9**
Non-health-care setting							
Lau et al (2004)[50]	China	0	SARS	12/89	25/98	0·53 (0·28–0·99)	7·5
Wu et al (2004)[74]	China	0	SARS	25/146	69/229	0·57 (0·38–0·85)	9·7
Tuan et al (2007)[69]	Vietnam	0	SARS	0/9	7/154	1·03 (0·06–16·83)	0·9
Random subtotal (I^2=0%)				**37/244**	**101/481**	**0·56 (0·40–0·79)**	**18·1**
Unadjusted estimates, overall (I^2=48%)				**163/3686**	**546/6484**	**0·34 (0·26–0·45)**	**100·0**
Adjusted estimates, overall (1 COVID-19, 1 MERS, 8 SARS)						**aOR 0·15 (0·07–0·34)**	
						aRR 0·18 (0·08–0·38)	

Interaction by setting, p=0·049; adjusted for N95 and distance, p=0·11

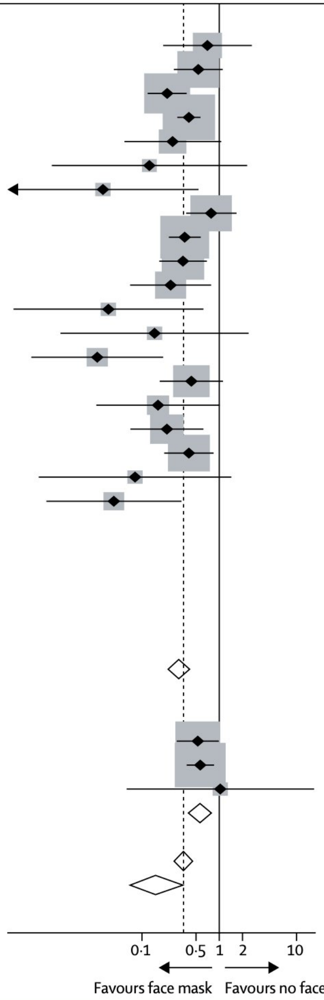


Figure 4: **Forest plot showing unadjusted estimates for the association of face mask use with viral infection causing COVID-19, SARS, or MERS**
SARS=severe acute respiratory syndrome. MERS=Middle East respiratory syndrome. RR=relative risk. aOR=adjusted odds ratio. aRR=adjusted relative risk.

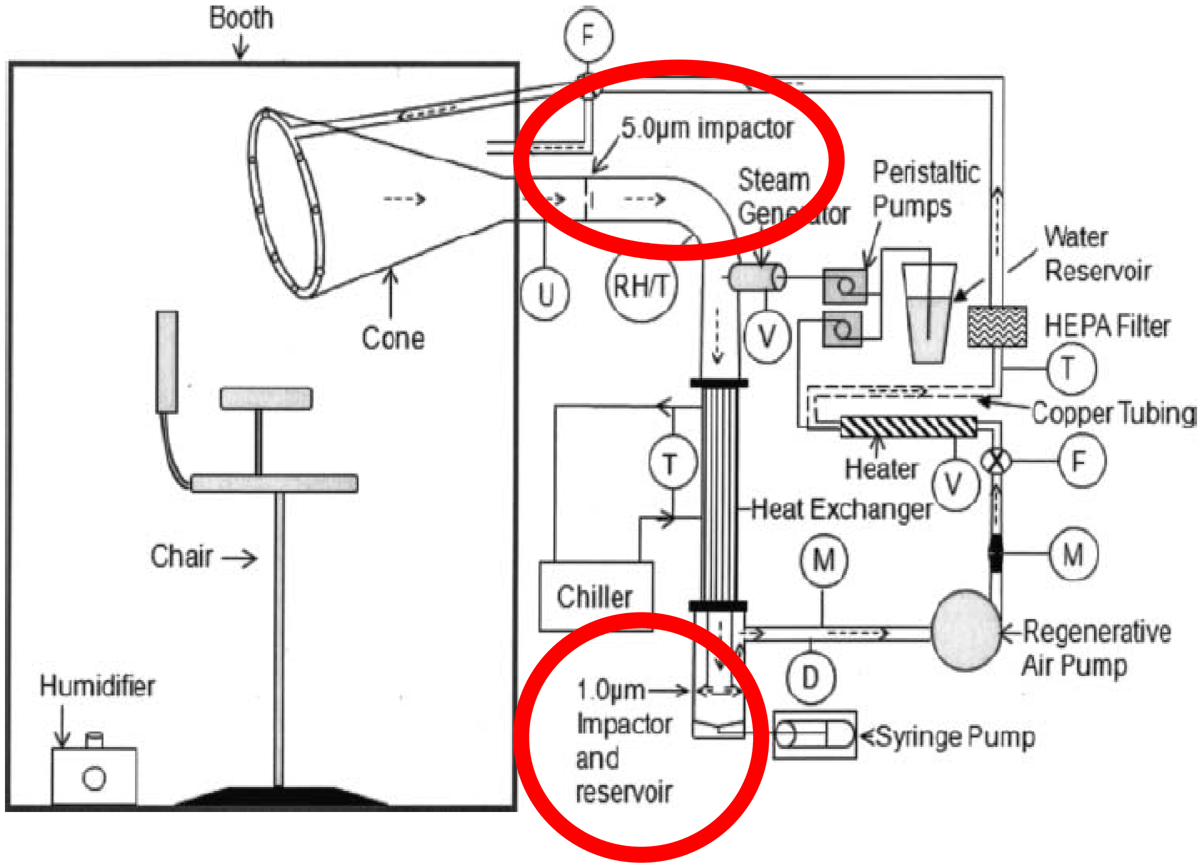
Very strong effects of face masks in health care settings (but likely confounded by use of other PPE). Many unadjusted estimates are included.

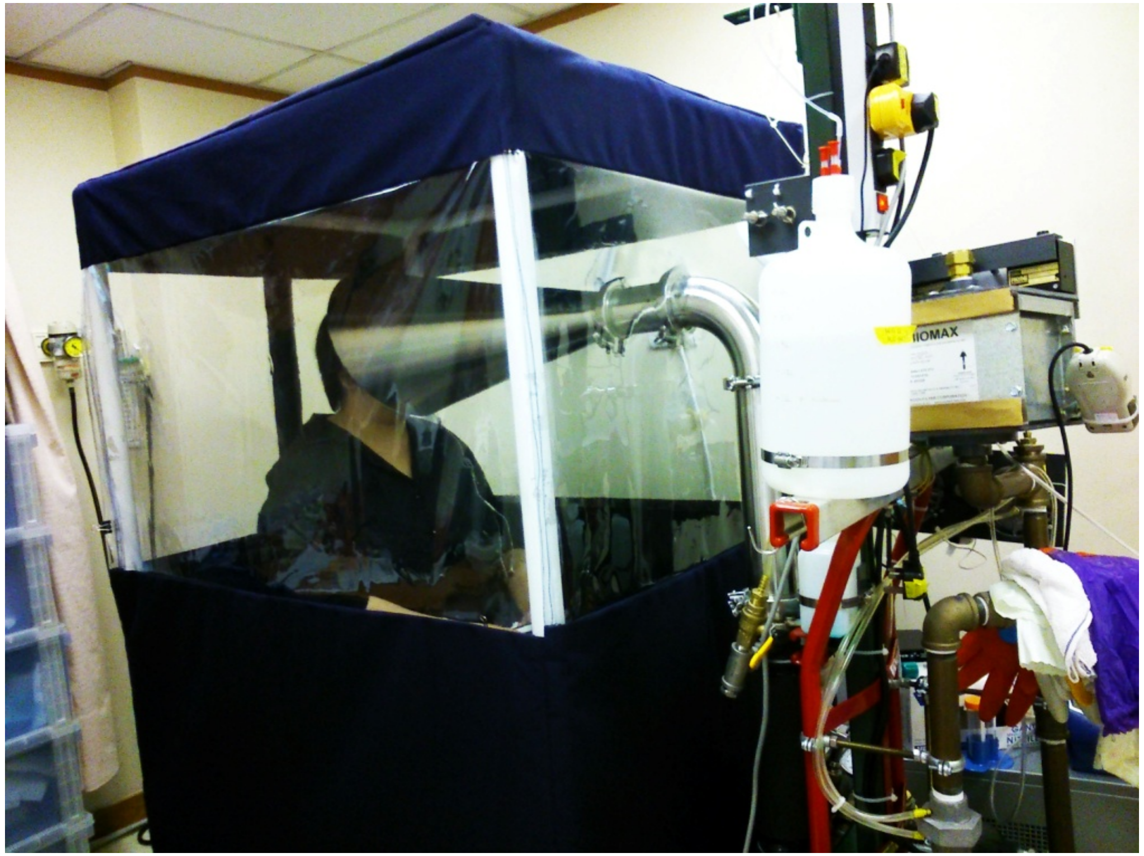
Three community studies shown at bottom of forest plot, but actually Lau et al. (2004) refers to mask use when visiting a family member with SARS in hospital, which is a healthcare exposure. SARS and MERS have limited community spread, data on community effectiveness of masks on these diseases are less informative.

By the way, the same review estimated that eye protection reduced the risk of SARS/MERS/COVID by 75% …

Chu et al. 2020 Lancet

HKU study on virus in exhaled breath

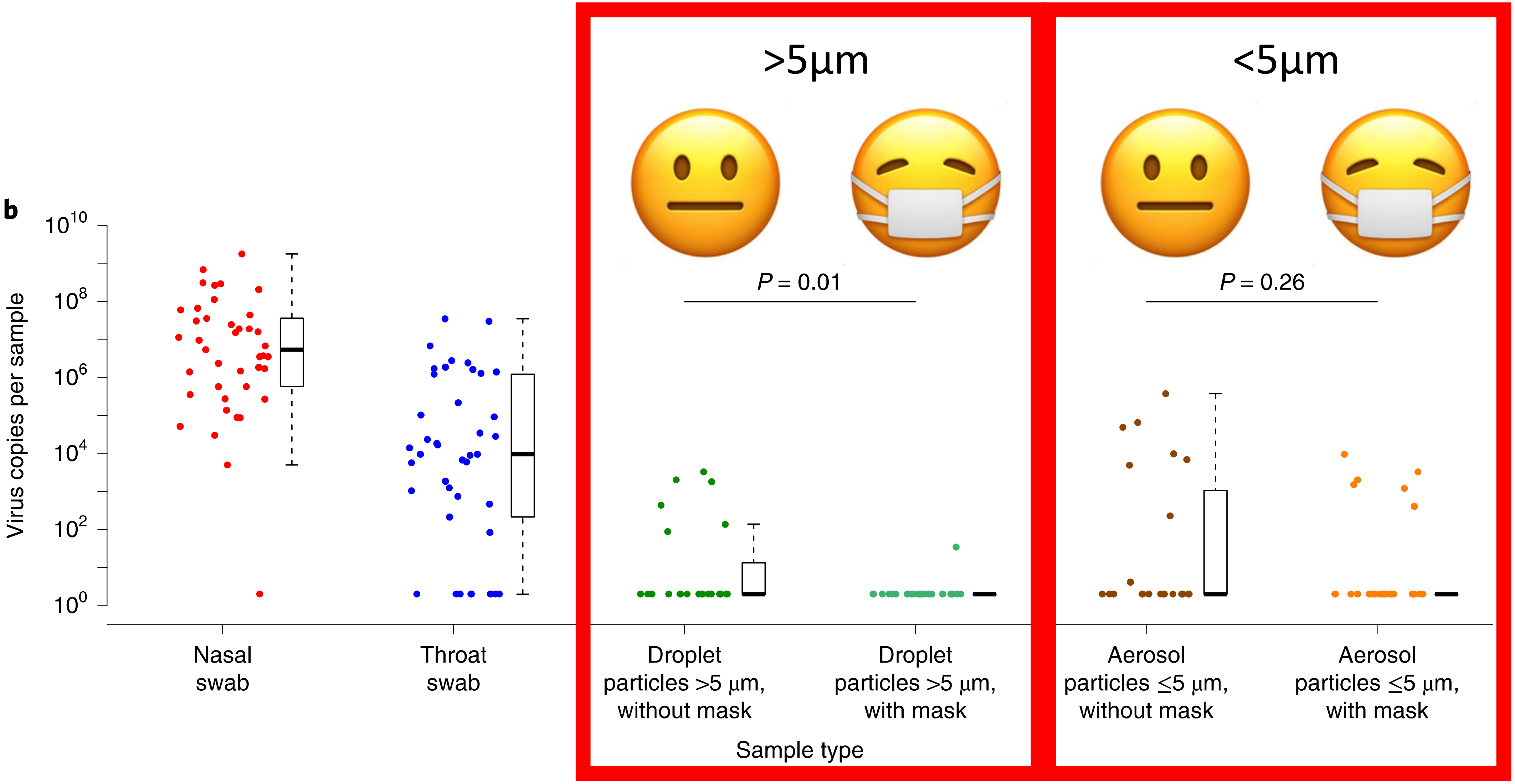




We collected exhaled breath (30-minute samples) from 246 outpatients with acute respiratory illness, randomly allocated to wear a surgical mask or not. Exhaled breath was split into coarse fraction >5µm and fine fraction <5µm

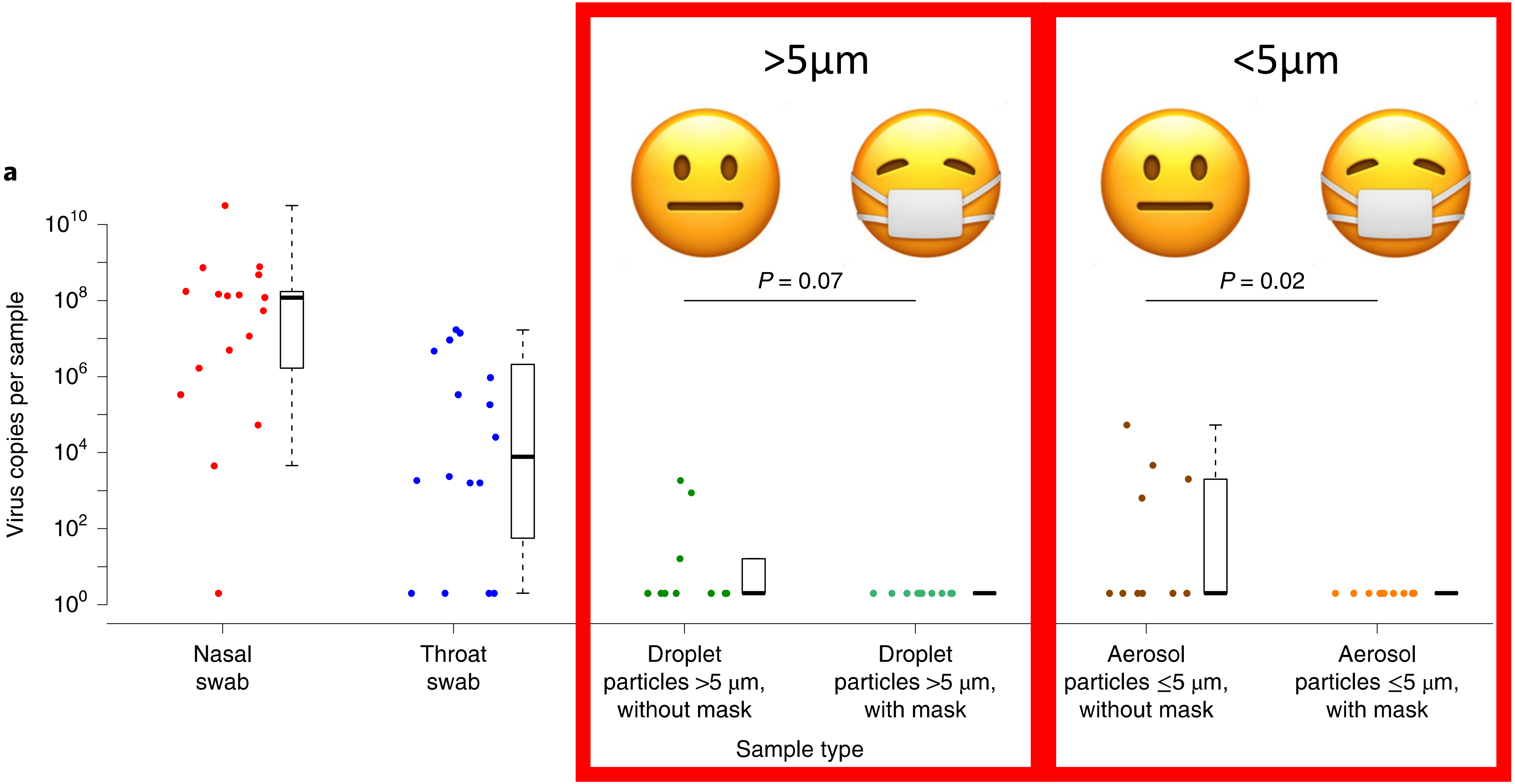
Milton DK, et al. Influenza Virus Aerosols in Human Exhaled Breath: Particle Size, Culturability, and Effect of Surgical Masks. PLoS Pathog 2013;9(3):e1003205.
McDevitt JJ, et al. Development and Performance Evaluation of an Exhaled-Breath Bioaerosol Collector for Influenza Virus. Aerosol Sci Technol 2013;47(4):444-51.

Influenza virus



Leung NHL et al. 2020 Nat Med

Human coronaviruses



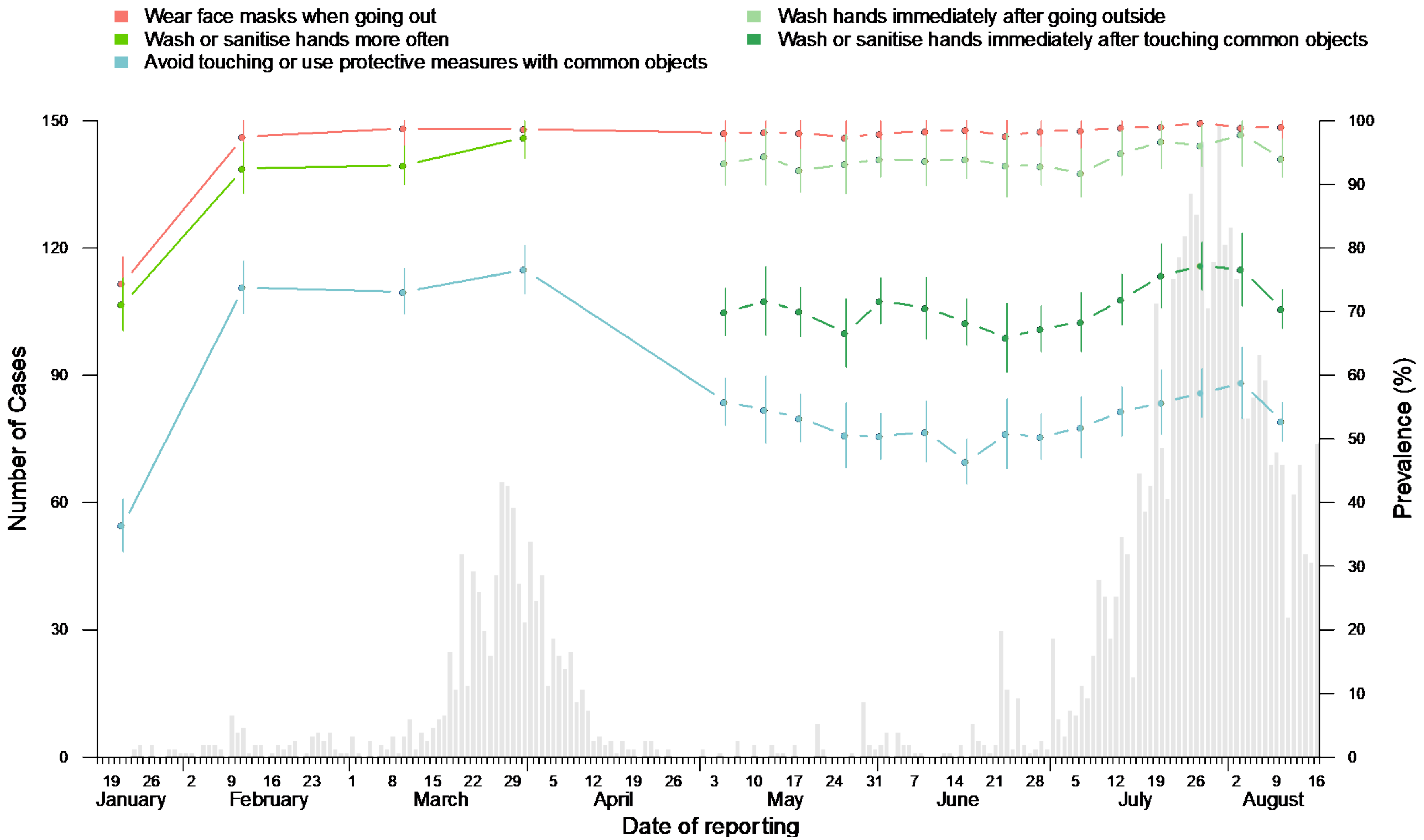
Leung NHL et al. 2020 Nat Med

Mechanistic evidence for masks protecting the wearer

- Davies et al 2013 conducted experiments and estimated that homemade cloth masks could provide 50% protection for the wearer[1]
- Van der Sande et al 2008 showed that masks made of tea cloths offered about 60% protection to the wearer. A surgical mask provided 76% protection and a FFP2 provided 99% protection. This is for total ambient particles 0.5µm and larger.[2]
- Belkin reviewed the history of mask development and noted the challenges:
  - Filtering efficiency is important, minimizing leakage is also important
  - Leakage increases with prolonged use (as the mask absorbs moisture)
- Another obvious limitation – we can't wear masks 24/7

1. Davies et al. 2013 Disaster Medicine and Public Health Preparedness
2. Van der Sande et al. 2008 PLoS ONE
3. Belkin 1997 Infection Control and Hospital Epidemiology

Two community epidemics of COVID-19 in Hong Kong despite >99% use of face masks in community



In repeated large telephone surveys of population behaviors we found >99% of adults in Hong Kong reported wearing masks in public.

However, most large outbreaks in Hong Kong have occurred in places where masks are not worn: Bars, restaurants, gyms, elderly homes, workers dormitories.

Methodology and first 4 datapoints reported in: Cowling et al. 2020 Lancet Public Health

Danish trial

clinicaltrials.gov/ct2/show/NCT04337541

Get the latest research information from NIH: https://www.nih.gov/coronavirus.

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Reduction in COVID-19 Infection Using Surgical Facial Masks Outside the Healthcare System

ClinicalTrials.gov Identifier: NCT04337541

Recruitment Status : Completed
First Posted : April 7, 2020
Last Update Posted : August 3, 2020

The safety and scientific validity of this study is the responsibility of the study sponsor and investigators. Listing a study does not mean it has been evaluated by the U.S. Federal Government. Read our disclaimer for details.

Sponsor:
Rigshospitalet, Denmark

Collaborators:
Nordsjaellands Hospital
Hvidovre University Hospital
Herlev Hospital
Technical University of Denmark

Information provided by (Responsible Party):
Henning Bundgaard, Rigshospitalet, Denmark

Trial of 6000 adults randomized to wear mask in community vs not

Powered to identify a 50% reduction in risk of COVID-19 (from 2% to 1%), but such a strong effect of face masks is quite unlikely based on previous literature …

Results have not yet been reported. A negative result in this trial would <u>not</u> mean that masks don't work.

Conclusions

- Limited evidence base for the effectiveness of face masks in the community for influenza epidemics and pandemics, but data are consistent with a 10% to 20% reduction in transmission.
- Mechanistic evidence that face masks can provide source control of virus-laden droplets and aerosols
- Mechanistic evidence that face masks can provide protection for the wearer
- Fallacious to argue "masks don't have 100% effect in stopping transmission therefore masks are useless". A 10% reduction in transmission would be valuable!
- However, widespread use of face masks in Hong Kong has been insufficient to stop two community epidemics. Both epidemics were controlled after the implementation of moderate social distancing measures.