# Papers about effectiveness of basic masks

Curated by [Jeremy Howard](https://twitter.com/jeremyphoward) and the fast.ai community. Summaries by [Reshama Shaikh](https://twitter.com/reshamas). The papers below have been used to create a video summarizing the utility of basic masks. In summary: everyone should wear masks, which they should make themselves using t-shirts or paper towels, whenever they go out in public. Here’s [the video](https://youtu.be/BoDwXwZXsDI). I’ve also made a little [summary on Twitter](https://twitter.com/jeremyphoward/status/1242894378441506816?s=20).

## Key Introductory Videos

## [Introducing #Masks4All](https://www.youtube.com/watch?time_continue=12&v=HhNo_IOPOtU&feature=emb_logo)

## [We need #masks4all, Jeremy Howard](https://www.youtube.com/watch?v=BoDwXwZXsDI&feature=youtu.be)

## Summaries

* [A review of masks](https://docs.google.com/document/d/1ZgzJt6vk1-VLdOVCY17w8ruMroS-1lUD_sSQjquV9TA/edit#heading=h.xx5xghq76xhj)
* [Face Masks: Much More Than You Wanted To Know](https://slatestarcodex.com/2020/03/23/face-masks-much-more-than-you-wanted-to-know/)
* [Collection of Mask Research](https://docs.google.com/document/d/1xh0AMQXrdGVpRjBybldSJQW5Sdt78gh2mvABs0Rja-U/edit)
* [List of citations](https://scite.ai/reports/10.1046/j.1365-2044.2000.01327.x)

## Papers

See next section for “summary of publications”

1. [Professional and Home-Made Face Masks Reduce Exposure to Respiratory Infections among the General Population](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2440799/)
2. [Coronavirus can travel twice as far as official ‘safe distance’, study says](https://www.scmp.com/news/china/science/article/3074351/coronavirus-can-travel-twice-far-official-safe-distance-and-stay)
3. [Testing the Efficacy of Homemade Masks: Would They Protect in an Influenza Pandemic? | Disaster Medicine and Public Health Preparedness](https://www.cambridge.org/core/journals/disaster-medicine-and-public-health-preparedness/article/testing-the-efficacy-of-homemade-masks-would-they-protect-in-an-influenza-pandemic/0921A05A69A9419C862FA2F35F819D55)
4. [What is the efficacy of standard face masks compared to respirator masks in preventing COVID-type respiratory illnesses in primary care staff?](https://www.cebm.net/what-is-the-efficacy-of-standard-face-masks-compared-to-respirator-masks-in-preventing-covid-type-respiratory-illnesses-in-primary-care-staff/)
5. [Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1](https://www.nejm.org/doi/full/10.1056/NEJMc2004973)
6. [Addressing COVID-19 Face Mask Shortages: evaluating decontamination methods for N95 mask reuse.](https://stanfordmedicine.app.box.com/v/covid19-PPE-1-1)
7. [Rational use of face masks in the COVID-19 pandemic](https://www.thelancet.com/journals/lanres/article/PIIS2213-2600(20)30134-X/fulltext)
8. [Influenza Virus Aerosols in Human Exhaled Breath: Particle Size, Culturability, and Effect of Surgical Masks](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3591312/)
9. [Effectiveness of Masks and Respirators Against Respiratory Infections in Healthcare Workers: A Systematic Review and Meta-Analysis](https://pubmed.ncbi.nlm.nih.gov/29140516/)
10. [Physical interventions to interrupt or reduce the spread of respiratory viruses](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6993921/)
11. [Effectiveness of N95 respirators versus surgical masks against influenza: A systematic review and metaâ•'analysis](https://onlinelibrary.wiley.com/doi/pdf/10.1111/jebm.12381)
12. [Modeling the Effectiveness of Respiratory Protective Devices in Reducing Influenza Outbreak](https://onlinelibrary.wiley.com/doi/full/10.1111/risa.13181)
13. [Simple Respiratory Mask](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3373043/)
14. [What Hospitals Should Do to Prepare for an Influenza Pandemic](https://www.liebertpub.com/doi/pdfplus/10.1089/bsp.2006.4.397)
15. [Flight of the aerosol](https://virologydownunder.com/flight-of-the-aerosol/?share=twitter&nb=1)
16. [The bacterial and viral filtration performance of breathing system filters](https://onlinelibrary.wiley.com/doi/full/10.1046/j.1365-2044.2000.01327.x?sid=nlm%3Apubmed)
17. [Do N95 Respirators Provide 95% Protection Level Against Airborne Viruses, and How Adequate Are Surgical Masks?](https://pubmed.ncbi.nlm.nih.gov/16490606/)
18. [N95 Respirators and Surgical Masks](https://blogs.cdc.gov/niosh-science-blog/2009/10/14/n95/)
19. [Performance of N95 Respirators: Filtration Efficiency for Airborne Microbial and Inert Particles](https://pubmed.ncbi.nlm.nih.gov/9487666/)
20. [Performance of an N95 Filtering Facepiece Particulate Respirator and a Surgical Mask During Human Breathing: Two Pathways for Particle Penetration](https://pubmed.ncbi.nlm.nih.gov/19598054/)
21. [Reuse Mask? DIY Mask? | Consumer Council](https://www.consumer.org.hk/ws_en/news/2020/covid-19-diymasks)
22. [Editor's Choice: Transocular Entry of Seasonal Influenza–Attenuated Virus Aerosols and the Efficacy of N95 Respirators, Surgical Masks, and Eye Protection in Humans](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3164472/)
23. [A quantitative assessment of the efficacy of surgical and N95 masks to filter influenza virus in patients with acute influenza infection.](https://www.ncbi.nlm.nih.gov/pubmed/19522650)
24. [Sterilization of disposable face masks by means of dry and steam sterilization processes](https://repository.tudelft.nl/islandora/object/uuid%3Af048c853-7e1d-4715-b73d-3b506b274a30)
25. [A cluster randomised trial of cloth masks compared with medical masks in healthcare workers](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4420971/)
26. [How effective are face masks in operation theatre? A time frame analysis and recommendations](https://www.ijic.info/article/view/10788/7862)
27. [N95 Respirators vs Medical Masks for Preventing Influenza Among Health Care Personnel](https://jamanetwork.com/journals/jama/article-abstract/2749214)
28. [The role of facemasks and hand hygiene in the prevention of influenza transmission in households: results from a cluster randomised trial; Berlin, Germany, 2009-2011](https://www.ncbi.nlm.nih.gov/pubmed/22280120)
29. [Facemasks and hand hygiene to prevent influenza transmission in households: a cluster randomized trial.](https://www.ncbi.nlm.nih.gov/pubmed/19652172)
30. [Mask use, hand hygiene, and seasonal influenza-like illness among young adults: a randomized intervention trial.](https://www.ncbi.nlm.nih.gov/pubmed/20088690)
31. [Letter to editor: Role of masks/respirator protection against 2019-novel coronavirus (COVID-19)](https://www.cambridge.org/core/journals/infection-control-and-hospital-epidemiology/article/letter-to-editor-role-of-masksrespirator-protection-against-2019novel-coronavirus-covid19/BB222D45A82FB48E01F7CDF2E4084937)
32. [Association between 2019-nCoV transmission and N95 respirator use](https://www.journalofhospitalinfection.com/article/S0195-6701(20)30097-9/fulltext)
33. [Mass masking in the COVID-19 epidemic: people need guidance](https://www.journalofhospitalinfection.com/article/S0195-6701(20)30097-9/fulltext)
34. [Knowledge, attitudes, and practices towards COVID-19 among Chinese residents during the rapid rise period of the COVID-19 outbreak: a quick online cross-sectional survey](https://www.ijbs.com/v16p1745.pdf)
35. Understanding of COVID‐19 based on current evidence

# Summary of Publications

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| **#** | **Link** | **Title** |  |  | **Notes** |
| 1a | <https://pubmed.ncbi.nlm.nih.gov/30229968/>  //  <https://onlinelibrary.wiley.com/doi/full/10.1111/risa.13181> | Modeling the Effectiveness of Respiratory Protective Devices in Reducing Influenza Outbreak | 2018 | n=1000 | -- a 50% compliance in donning the device resulted in a significant (at least 50% prevalence and 20% cumulative incidence) reduction in risk for fitted and unfitted N95 respirators, high‐filtration surgical masks, and both low‐filtration and high‐filtration pediatric masks.  --An 80% compliance rate essentially eliminated the influenza outbreak.  --Outward protection (mask wearing by a mechanical head) was less effective than inward protection (mask wearing by healthy volunteers) |
| 1b | <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2440799/> | Professional and Home-Made Face Masks Reduce Exposure to Respiratory Infections among the General Population | 2018  Mask: FF2, N95, homemade (tea cloth) | Experiment 1, n=28 adults + 11 children  Experiment 2, n=22 adults  Experiment 3, n= artificial test head | “overall these experiments show that significant protection against influenza transmission upon exposure can be conveyed also for lay people, including children, in spite of imperfect fit and imperfect adherence.” “In our experiments, the main determinant of the magnitude of protection factors measured by masks was the type of mask” “any type of general face mask usage can still decrease viral transmission” “All types of masks provided a much higher degree of exposure protection against inward transmission of particles, then in preventing outward transmission by a mechanical head as a proxy for an infected patient exposing the environment.” |
| 2 | <https://www.scmp.com/news/china/science/article/3074351/coronavirus-can-travel-twice-far-official-safe-distance-and-stay> | Coronavirus can travel twice as far as official ‘safe distance’ and stay in air for 30 minutes, Chinese study finds | Mar 2020 |  | none of those passengers in the two buses who wore face masks were infected. |
| 3 | <https://www.researchgate.net/publication/258525804_Testing_the_Efficacy_of_Homemade_Masks_Would_They_Protect_in_an_Influenza_Pandemic> | Testing the Efficacy of Homemade Masks: Would They Protect in an Influenza Pandemic? | 2013  Masks:  -- surgical  -- homemade (cotton tshirts)  -- no mask | n=21  -- (p=.002)  -- (p=.007) | --surgical mask was 3 times more effective in blocking transmission than the homemade mask  --homemade mask should only be considered as a last resort to prevent droplet transmission from infected individuals, but it would be better than no protection. |
| 8 | <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3591312/> | Influenza Virus Aerosols in Human Exhaled Breath: Particle Size, Culturability, and Effect of Surgical Masks | 2013  Masks:  -- surgical  -- no mask | n=89 adults  p = 0.003 | --11% vs 43% efficacy of masks (no mask vs mask) |
|  | <https://www.nejm.org/doi/full/10.1056/NEJMc2004973> | Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1 | Mar 2020 |  | “aerosol and fomite transmission of SARS-CoV-2 is plausible, since the virus can remain viable and infectious in aerosols for hours and on surfaces up to days” |
|  | <https://stanfordmedicine.app.box.com/v/covid19-PPE-1-1> | Addressing COVID-19 Face Mask Shortages | Mar 2020 |  | --DO NOT use alcohol and chlorine-based disinfection methods.These will remove  the static charge in the microfibers in N95 facial masks, reducing filtration efficiency. In addition, chlorine also retains gas after de-contamination and these fumes may be harmful. |
|  | <https://www.thelancet.com/journals/lanres/article/PIIS2213-2600(20)30134-X/fulltext> | Rational use of face masks in the COVID-19 pandemic | Mar 2020 |  | --It is time for governments and public health agencies to make rational recommendations on appropriate face mask use to complement their recommendations on other preventive measures, such as hand hygiene. WHO currently recommends that people should wear face masks if they have respiratory symptoms or if they are caring for somebody with symptoms. |
|  | <https://pubmed.ncbi.nlm.nih.gov/29140516/> | Effectiveness of Masks and Respirators Against Respiratory Infections in Healthcare Workers: A Systematic Review and Meta-Analysis | 2017 | meta-analysis | --This systematic review and meta-analysis supports the use of respiratory protection.  --However, the existing evidence is sparse and findings are inconsistent within and across studies |
|  | <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6993921/> | Physical interventions to interrupt or reduce the spread of respiratory viruses | 2011 | meta-analysis | --67 studies including randomised controlled trials and observational studies with a mixed risk of bias.  --Simple and low‐cost interventions would be useful for reducing transmission of epidemic respiratory viruses. Routine long‐term implementation of some measures assessed might be difficult without the threat of an epidemic. |
|  | <https://onlinelibrary.wiley.com/doi/pdf/10.1111/jebm.12381> | Effectiveness of N95 respirators versus surgical masks against influenza: A systematic review and meta-analysis | Feb 2020 | meta-analysis | --The use of N95 respirators compared with surgical masks is not associated with a lower risk of laboratory-confirmed influenza. --It suggests that N95 respirators should not be recommended for general public and non-high-risk medical staff those are not in close contact with influenza patients or suspected patients  --, the sensitivity analysis after excluding the trial by Loeb et al18 showed a significant effect of N95 respirators on preventing respiratory viral infections (RR=0.61, 95% CI 0.39-0.98, P < .05). |
|  | <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3373043/> | Simple Respiratory Mask | 2006 |  | --WHO recommends protective equipment including masks (if they not available, a cloth to cover the mouth is recommended) for persons who must handle dead or ill chickens in regions affected by H5N1 ([*5*](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3373043/#R5)).  -- Quality commercial masks are not always accessible, but anecdotal evidence has showed that handmade masks of cotton gauze were protective in military barracks and in healthcare workers during the Manchurian epidemic ([*6*](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3373043/#R6)*,*[*7*](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3373043/#R7)).  --simple, locally made, washable mask may be a solution if commercial masks are not available. |
|  | <https://www.liebertpub.com/doi/pdfplus/10.1089/bsp.2006.4.397> | What Hospitals Should Do to Prepare for an Influenza Pandemic | 2006 |  | --Limit accidental droplet contamination of the hospital environment by implementing respiratory etiquette and by having everyone entering the facility (staff, patients, and visitors) use simple surgical masks. Assuming that resupply may be difficult during a pandemic, hospitals should stockpile enough masks for 3 weeks.  --Shortages of N95 masks should be anticipated,  --If no other masks are available, surgical masks, which will provide droplet protection, should be used.3 Powered air purifying respirators (PAPRs) should be available for use in high risk aerosol-generating procedures. |
|  | <https://virologydownunder.com/flight-of-the-aerosol/?share=twitter&nb=1> | Understanding what we mean when we discuss airborne virus infection risk. | Feb 2020  ebola |  | For a virus described as spreading only through direct contact, recommendations for the use of masks, implying airborne spread to many, fuel such questions. In fact, face protection is recommended to prevent infectious droplets landing on vulnerable membranes (mouth and eyes). |
|  | <https://onlinelibrary.wiley.com/doi/full/10.1046/j.1365-2044.2000.01327.x?sid=nlm%3Apubmed> | The bacterial and viral filtration performance of breathing system filters\* | 2001  --Streptococci  --faucial diphtheria  --tuberculosis |  | --filtration performance of pleated hydrophobic membrane filters was demonstrated to be markedly greater than that of electrostatic filters |
|  | <https://repository.tudelft.nl/islandora/object/uuid%3Af048c853-7e1d-4715-b73d-3b506b274a30> | Sterilization of disposable face masks by means of dry and steam sterilization processes: an alternative in case of acute mask shortages due to COVID-19 | Mar 2020  single use  FFP2  masks  (type 1  862+  3M) | n=11 | The effectiveness of these processes are  sufficient to inactivate the coronavirus based on knowledge of inactivation of such viruses |
|  | <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4420971/> | A cluster randomised trial of cloth masks compared with medical masks in healthcare workers | 2015  masks:  --cloth  --medical | n=1607  --Clinical respiratory illness (CRI), --influenza-like illness (ILI) --respiratory virus infection | --Penetration of cloth masks by particles was almost 97% and medical masks 44%.  --Moisture retention, reuse of cloth masks and poor filtration may result in increased risk of infection. Further research is needed to inform the widespread use of cloth masks globally. However, as a precautionary measure, cloth masks should not be recommended for HCWs, particularly in high-risk situations, and guidelines need to be updated. |
|  | <https://www.ijic.info/article/view/10788/7862> | How effective are face masks in operation theatre?  A time frame analysis and recommendation | 2013 |  | Wherever the surgeon operates more  than 2-3 hours at a stretch, he/she should change their face mask every 1.5 to 2 hours  --study helps to establish that in developing countries, where resources could be a constraint for providing disposable face masks, the  fabric face masks can also be used equally effectively  if changed frequently ideally at around 90 minutes. |
|  | <https://jamanetwork.com/journals/jama/article-abstract/2749214> | N95 Respirators vs Medical Masks for Preventing Influenza Among Health Care Personnel | 2019  masks:  --N95  --medical | n=2862  (p=0.18) | N95 respirators vs medical masks as worn by participants in this trial resulted in no significant difference in the incidence of laboratory-confirmed influenza. |
|  | <https://www.ncbi.nlm.nih.gov/pubmed/22280120> | The role of facemasks and hand hygiene in the prevention of influenza transmission in households: results from a cluster randomised trial; | 2012 | n=84 households | Results suggest that household transmission of influenza can be reduced by the use of NPI, such as facemasks and intensified hand hygiene, when implemented early and used diligently. Concerns about acceptability and tolerability of the interventions should not be a reason against their recommendation. |
|  | <https://www.ncbi.nlm.nih.gov/pubmed/19652172> | Facemasks and hand hygiene to prevent influenza transmission in households: a cluster randomized trial. | 2009 | n=407 vs n=794 | Hand hygiene and facemasks seemed to prevent household transmission of influenza virus when implemented within 36 hours of index patient symptom onset. These findings suggest that nonpharmaceutical interventions are important for mitigation of pandemic and interpandemic influenza. |
|  | <https://www.ncbi.nlm.nih.gov/pubmed/20088690> | Mask use, hand hygiene, and seasonal influenza-like illness among young adults: a randomized intervention trial. | 2010 | n=1437 | These findings suggest that face masks and hand hygiene may reduce respiratory illnesses in shared living settings and mitigate the impact of the influenza A(H1N1) pandemic. |
|  | <https://www.cebm.net/covid-19/what-is-the-efficacy-of-standard-face-masks-compared-to-respirator-masks-in-preventing-covid-type-respiratory-illnesses-in-primary-care-staff/> | What is the efficacy of standard face masks compared to respirator masks in preventing COVID-type respiratory illnesses in primary care staff? | March 24, 2020 | Review considered 126 studies and withheld 12 randomised controlled trials or reviews | “Systematic review evidence provides cautious support for the use of standard surgical masks in non AGPs [aerosol-generating procedures], though the empirical studies underpinning this conclusion were not in a COVID-19 population, and only one was in a community setting.” |
|  | <https://academic.oup.com/cid/article/49/2/275/405108> | A Quantitative Assessment of the Efficacy of Surgical and N95 Masks to Filter Influenza Virus in Patients with Acute Influenza Infection | 2009 | n=26 | “recommending surgical or procedural masks be worn by patients with suspected influenza to limit viral dissemination to others. “ |
|  | <https://www.cambridge.org/core/journals/infection-control-and-hospital-epidemiology/article/letter-to-editor-role-of-masksrespirator-protection-against-2019novel-coronavirus-covid19/BB222D45A82FB48E01F7CDF2E4084937> | Letter to editor: Role of masks/respirator protection against  2019-novel coronavirus (COVID-19) | 2020 |  | “the protective role of both N95 and medical masks in other diseases could be  translated into the fight against COVID-19, with specific contribution yet to be quantified” |
|  | https://www.journalofhospitalinfection.com/article/S0195-6701(20)30097-9/fulltext | Association between 2019-nCoV transmission and N95 respirator use | 2020 | n=493 medical staff | “infection rate for medical staff was significantly increased in the no-mask group compared with the N95 respirator group”  -- none of the 278 staff in the N95 group became infected, but 10 of 213 staff from the no-mask group were confirmed as infected |
|  | <https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30520-1/fulltext> | Mass masking in the COVID-19 epidemic: people need guidance | 2020 |  | “WHO recommends against wearing masks in community settings because of lack of evidence. However, absence of evidence of effectiveness should not be equated to evidence of ineffectiveness, especially when facing a novel situation with limited alternative options. It has long been recommended that for respiratory infections like influenza, affected patients should wear masks to limit droplet spread. If everyone puts on a mask in public places, it would help to remove stigmatisation that has hitherto discouraged masking of symptomatic patients in many places. Furthermore, transmission from asymptomatic infected individuals has been documented for COVID-19, and viral load is particularly high at early disease stage. Masking, as a public health intervention, would probably intercept the transmission link and prevent these apparently healthy infectious sources.” |
|  | <https://www.ijbs.com/v16p1745.pdf> | Knowledge, attitudes, and practices towards COVID-19  among Chinese residents during the rapid rise period of  the COVID-19 outbreak: a quick online cross-sectional  survey | 2020 | n=6910 | “the practices of Chinese residents were  very cautious: nearly all avoided crowded places  (96.4%) and wore masks when leaving the home  (98.0%) during the rapid rise period of the COVID-19  outbreak.” |
|  | https://onlinelibrary.wiley.com/doi/full/10.1002/jmv.25722 | Understanding of COVID‐19 based on current evidence | 2020 |  | “For individuals, protective measures, including improving personal hygiene, wearing medical masks, adequate rest, and keeping rooms well ventilated, can effectively prevent SARS‐CoV‐2 infection.” |

Note: N95 = respirator that blocks at least 95% of 0.3 micrometer sized particles