



A Review of:

An upper bound on one-to-one exposure to infectious human respiratory particles
Bagheri G, Thiede B, Hejazi B, Schlenczek O, Bodenschatz E
PNAS November 1, 2021

also known as

Rumblings from the Echo Chamber

Caoimhín P Connell
Forensic Industrial Hygienist
December 22, 2021

I'm very frequently presented with a citation to a publication by someone who thinks the referenced work supports their argument. This recently happened when someone didn't agree with my factual statement that, as of today, there is no scientific or medical justification for community masking or social distancing vis-à-vis the SAR-CoV-2 virus.

That person pointed to the Bagheri paper as a refutation -- here is my response.

The SARS-CoV-2 pandemic has resulted in a surge in two troubling trends:

- 1) The publication of [junk science](#)¹
- 2) Politically motivated people are preferentially referencing said junk science as gospel²

Very often, the problem with the "study" being referenced is that the authors make conclusions that reach far beyond what their work would support. A recent example of course would be Zhang *et al.*³ Such is the case, writ large, with Bagheri *et al*, 2021.

As described below, the authors of Bagheri *et al* 2021 drew conclusions on topics they never studied in their work, and indeed, their study was entirely incapable of supporting the conclusions they attributed to their work. Ultimately the authors merely re-defined words to

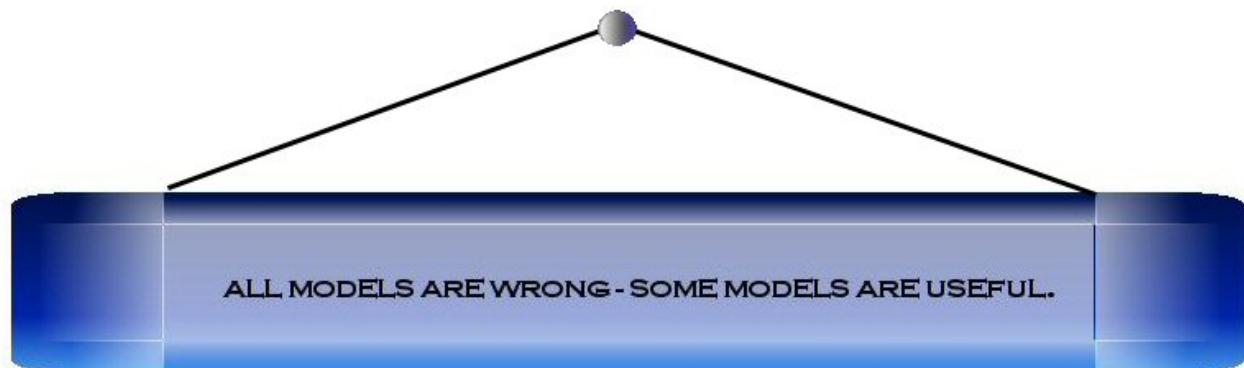
mean what they want the words to mean for the purposes of the acceptance of their paper regardless of actual meanings and uses. For example, the authors have redefined "universal masking" to mean "When imaginary mathematical models wear specific masks in specific ways in specific environments of specific contaminants." Similar redefinitions occur for "social distancing."

In the last 24 months, I have experienced an increase in people citing "scientific papers" claiming the papers support their position; whatever that may be. Upon inspection, I typically find two things:

- 1) The person citing the paper never actually read the paper
- 2) The paper doesn't support the claim by the person citing the paper

Although this isn't a new problem, and I have discussed the problem [elsewhere](#),^{4,5} the frequency of both problems is increasing. I should also add that there seems to be an increase in people claiming to have read a particular paper, but clearly they haven't, otherwise, (if they were technically competent), they would have caught the multitude of problems within the citation.

In mathematical modeling, we have a saying:



In the case of Bagheri *et al*, the paper certainly has attained the first element of the modeler's paradigm, but utterly fails to meet the second element. The Bagheri paper is rather an odd mixture of *post hoc ergo propter hoc*, confusing necessary conditions with sufficient conditions and simple *non sequitur*. That is, it is like writing an extremely detailed discussion on the dendrochronology of Northwest Pacific pine trees, and concluding that you can now predict the price of lemons in China 20 years from now, because, after all, trees come from lemons.⁶

This is because the Bagheri authors look at one extremely narrow set of parameters (some of which they made up from thin air) and then pretending that those parameters are actually translatable in a germane way to something completely different found in real life.

In summary, Bagheri has three components:

- 1) Establishment of unsupported preconceived, desired, conclusions.
- 2) A model of an imaginary game-space using narrowly constrained inputs.
- 3) An attempt to take the model outputs and make them applicable to the desired conclusions.

If this paper was a high-school science project, it is not likely that it would pass an astute teacher's scrutiny.

The very first statement in the paper, is an unsupported [tautology](#):

There is ample evidence that masking and social distancing are effective in reducing severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission.

The authors give not a single citation to back up the false claim. But remarkably, Bagheri's very first citation (I'm not joking) is the aforementioned 2020 discussion found in the Proceedings of the National Academy of Sciences (PNAS):

R. Zhang, Y. Li, A. L. Zhang, Y. Wang, M. J. Molina, Identifying airborne transmission as the dominant route for the spread of COVID-19. Proc. Natl. Acad. Sci. U.S.A. 117, 14857–14863 (2020).

For readers who may not be aware of this, now customary, paper, I have discussed it [here](#). However, suffice to reproduce a quote from the letter that was immediately submitted to the PNAS in reaction to the Zhang publication.

"We are writing with deep concerns about a paper recently published in your journal, entitled "Identifying airborne transmission as the dominant route for the spread of COVID-19." The paper made extraordinary claims about routes of transmission, the effectiveness of mask-wearing, and by implication, the ineffectiveness of other non-pharmaceutical interventions."

The second citation in the Bagheri paper doesn't help their credibility much in that it's the WHO July 9, 2020 document "*Transmission of SARS-CoV-2*." But surely, since Bagheri *et al* states they referenced the WHO document on November 24, 2021, they would have seen the opening lines of that document:

This scientific brief (text below) is outdated. For the latest information on COVID-19 transmission, please see: Mask use in the context of COVID-19 (1 December 2020)

And if we then go to the referenced document, "*Mask use in the context of COVID-19 (1 December 2020)*" we find a poorly written hodgepodge of conflicting positions that indicate the paper was written by committee members who never spoke to each other and, like something from The Island of Dr. Moreau, a stitched together monstrosity emerges which tells us:

However, the use of a mask alone, even when correctly used (see below), is insufficient to provide an adequate level of protection for an uninfected individual or prevent onward transmission from an infected individual (source control).

Ooops... Did that really show up in the WHO document? Is that why Bagheri *et al* used references identified by WHO as "outdated" instead? Was this part of the "ample evidence"

Bagheri was referencing in the first sentence? (For readers unfamiliar with the WHO's 2020 document, I have addressed that [here](#).)

It gets worse. Later on, in the body of the paper, Bagheri *et al* do cite papers in support of their empty claim, but those citations are other remarkably poor junk-science discussions such as Howard, *et al*⁷ (which I have discussed [here](#)). So, either Team Bagheri, cited Howard *et al* without reading Howard *et al*, or Team Bagheri lacked the technical (or ethical) competency to know that Howard is gibberish and Howard *et al*, themselves cite papers that falsely claim to contain the information that the authors of Howard *et al* claims they contain.

Tautology. Not [science](#). [Circular](#) reasoning works.

If one has to rely on discussions like Zhang *et al*, and Howard *et al* etc, to support their position, then they are truly grasping at straws. By the way, not all references given by Bagheri are junk, there are many excellent papers cited - but I wonder if Team Bagheri actually read those either.

By the way - remember, I'm still on just the first sentence found in the Bagheri paper.

So, let's look at how Bagheri undermines their own argument in the second sentence of their paper:

However, due to the complexity of airborne disease transmission, it is difficult to quantify their [masks] effectiveness, especially in the case of one-to-one exposure.

Ya think? Maybe that, and the fact that there's no actual evidence that community masking actually works, may be the reason one can't quantify the effectiveness of masks. Team Bagheri knows that's the case because they mention:

A notable example is the use of face masks, which were initially discouraged to the public or recommended only for symptomatic cases and health care workers in the United States.

Of course masks were discouraged, by EVERYONE, because we had some [107 years of science](#) to support the position before [masks became a political issue](#), not a scientific issue.

In spite of the claims made by Bagheri *et al* that their study conclusively proves that community masking and social distancing is effective, nowhere in the Bagheri study do we see where Team Bagheri even looked at social distancing or community masking. That is, the conclusions by Bagheri *et al* is that their study confirms that community masking and social distancing is effective; but NOWHERE in their study does Team Bagheri provide ANY information that they even looked at community masking or social distancing. Nowhere.

The Bagheri study is not about community masking or public mask efficacy. In spite of their conclusions, The Bagheri study is not about the efficacy of social distancing .

So how can Team Bagheri make their claims? I don't know, it's not described in the paper how they made the huge jump from one topic to another - they just jumped.

Instead, Bagheri *et al* describe a mathematical model they produced regarding particle migration and theoretical masked people who occupy an imaginary face-to-face game-space (that is neither in an indoor environment because indoor environments are too complicated to model, nor in an outdoor environment because outdoor environments are also too complex to model). The imaginary people, (who don't move, and who never don a mask, doff a mask, touch their masks, chew gum, briskly shake their mask before donning, etc) wear imaginary masks in spatially static environments. The imaginary people in the imaginary game-space share imaginary airborne particles that have very tightly controlled theoretical characteristics.

Nowhere in the Bagheri paper do the authors EVER address the efficacy of community masking or social distancing. Nowhere. Their result is an utterly facile scenario with regard to applications to either community masking or social distancing.

But why the strict limitations found within the models? Well, according to Bagheri *et al*:

It can be concluded that airborne disease transmission is a problem that involves complex physical processes across a wide range of spatial and temporal scales, making it very difficult to predict its subsequent course with an acceptable degree of certainty.

And...

Therefore, it is very difficult, if not impossible, to make a detailed prediction on the situational risk of infection during a one-to-one exposure. Even if one knew an example, the situational variability is so large that exemplary knowledge can hardly be generalized. Thus detailed examples may not help much in guiding infection control measures.

The Bagheri paper isn't a paper about masks or their efficacy. The Bagheri paper isn't a paper about social distancing or its efficacy. The paper is certainly about masking materials, and particle behavior vis-à-vis masks and materials. But really, the paper is a desperate attempt to take a theoretical mathematical model and make it germane to a hot political issue but is otherwise no value to Public Health Officials. Don't get me wrong, in the Bagheri model there is a lot of fun, cool stuff that is of interest to mathematical modelers. I have discussed other papers that conflate mask materials and efficacy of masks [here](#) and I have addressed models for modeler's sake [here](#) (Eikenberry, 2020).

An analogy of the Bagheri paper would be thus: Imagine an engineering firm is asked to study another control device - laboratory fume hoods. The engineering team sits down and carefully defines all the terms needed to model the capture and evacuation of respirable particles of a particular material used by laboratory employees.

The engineers do an excellent job in developing their mathematical models and, provided the building is designed *exactly* as X, and the laboratory room is designed *exactly* as Y, and the ventilation system is *exactly* V, and the fume hood has *exactly* D designed criteria and *exactly* M fans operating at *exactly* F parameters, and the hood's baffles and sash are at *exactly* S

positions, and the contaminant is released at *exactly* T, with *exactly* the characteristics of P, then the model is, you know, like, PERFECT!!

The engineering team announces, categorically, that they have proven that fume hoods are effective in controlling human exposures to dimethyl death wherever it's used. But it is a facile result.

Then the lab director gets hot under the collar when lab employees drop dead in the laboratory. Nobody noticed that the model only works so long as a human doesn't stand in front of the hood during use, thus creating [reverse vector flow](#) sucking the interior of the fume hood out into the operator's face. Nobody realized that the model was perfect until an employee actually put an item in the fume hood, thus disrupting laminar flow causing the hood's contaminated air to become turbulent and spill out into the laboratory. Nobody noticed that the game-space for the model in no way actually resembled the building or the laboratory rooms or the ventilation system in the room. Importantly, nobody noticed the lab fume hoods are exhausting at the roof that is surrounded by a parapet and the exhaust is taken directly back into the building by the intake manifolds on the roof and distributed throughout the building. The engineers never noticed that there are multiple operations in the lab that released dimethyl death into the ambient air, and the engineers never noticed that the laboratories in the building next door release dimethyl death into the pocket of ambient air that constitutes the building envelope.

The question the lab director wanted to know was "How do I protect my employees?" The models by the engineers answered a different question "How do fume hoods perform when handling airborne particulates under extremely narrow conditions?" But the engineers presented their answer to the lab director in terms not consistent with their work: "We have concluded the hoods are efficacious and will protect your employees." But the engineers never studied the efficacy of the hoods in question, so how could they possibly make their assertions? Simple - they did what Team Bagheri did: Study one thing and pretend their results speak to something completely different that they never even looked at.

The efficacy of community masking is an epidemiological question, not an engineering question. NOWHERE in the Bagheri paper did the authors even make an attempt to address this epidemiological issue.

The efficacy of social distancing is an epidemiological question, not an engineering question. NOWHERE in the Bagheri paper did the authors even make an attempt to address this epidemiological issue.

Their work was modeling engineering issues their conclusions were epidemiological conclusions, not engineering conclusions.

Here is a real-life scenario, I would like to put it to Team Bagheri: My favorite restaurant is located in a jurisdiction that is governed by imbecilic Health Officials who have implemented a "mandatory mask mandate." Patrons waiting for a table are required to wear a mask (either sitting or standing). Patrons are required to wear their mask as they walk to the bar or to their table. Once sitting at the bar or the table, they can remove their masks. All the wait staff are required to wear masks at all times. I watch the wait staff as they touch their mask, then touch my plate, then touch their mask then gather up someone else's plate, then touch their mask, then touch the customer's credit card, then touch their mask and touch my glass... can anyone identify the reservoir of viral particles here? Like, oh, I dunno... maybe the mask?

This is community masking at its finest and just one of dozens of real life examples I can give. People sitting on four foot high bar chairs are exactly the same height as someone standing on the floor. If a patron is sitting on the bar chair, no mask is required, someone standing next to them must be wearing a mask. How does wearing a mask while standing protect the people sitting down not wearing masks? How does not wearing a mask while sitting not impact the spread of viruses but not wearing a mask while standing increases transmission of said virus? Importantly, how does the Bagheri model accommodate this very ordinary real life scenario? Answer: It can't.

The upper bounds do not need to address the details of the specific situation, which include the long list of parameters we have already mentioned for the source–medium–receptor trilogy. We have therefore intentionally not given a specific value for the overestimation, as this can range from no overestimation to a factor of several thousand, depending on the situation.

Really?

Sometimes I think that Team Bagheri never even really tried. Team Bagheri goes to great length to discuss TOL and all the complexities associated with it, and how (really) their model depends on the validity of their calculated TOL.

As explained in Materials and Methods, the total leakage to the outside during exhalation is $TOL = q_{P,ex}P_{ex} + q_{L,ex}L_{ex}$, where $q_{P,ex}$ and $q_{L,ex}$ are the flow ratios through filter and face seal leaks, respectively, during exhalation... etc, etc.

OK, but then the "reveal" -

In the absence of a suitable measurement procedure and given that available data in the literature are inconclusive on this topic (see Total outward leakage), we assume that the TOL is equal to the TIL (total inward leakage).

Huh?

Other fatal flaws remain that are too numerous to mention here. For example, I can understand why Team Bagheri used some parameters such as an assumed viral load of $10^8.5$ /ml, but if they were looking for an upper bound, why did they select ID63.21 of 200 instead of, say 50 (or even 10?) if they really wanted an "upper-bound" range? I don't know, Team Bagheris doesn't tell us.

Had these authors simply stuck to what their models really were, and what the models showed, and made conclusions based on their models, there would not have been a problem, and the paper may even have had some credible utility. But because the authors pretended that their outputs were speaking to epidemiological issues that they never evaluated, it's my opinion they can't be trusted. If they are willing to fudge here, where else are they willing to fudge?

We find a very low risk of infection when everyone wears a face mask, even if it doesn't fit perfectly on the face.

NO you didn't Team Bagheri you didn't find that - you never even assessed the efficacy of community masking. How can you find something you never sought?

References are found at the end.

Other COVID related discussions by CP Connell

[The Prosecutor's Gambit](#) - How to pull a statistical rabbit from a hat. (December 2022)

[How I became a conspiracy theorist](#). Tiptoeing through the landmines of politically correct common knowledge.

[Ignoring science](#): The legacy of the Left

Evolution of a Scientist: [From Two-Handed Threat to Forked-Tongue Savior](#)

[Holding Science Hostage](#) - How the fearful and powerful corrupt science for political gain.

[Napoleon's Coffee - With or without a mask](#) Getting data to fit the Procrustean Bed.

[How to Peddle Backward](#) - What happened to the 2020 Flu Epidemic? A summary of the US Crude Mortality Rate's refusal to cooperate with the popular narrative.

[WHO thought this was a good idea...](#) (Comments regarding the December 1, 2020, "Mask use in the context of COVID-19".)

[The Failing Mask Cure Aid](#) a review of Bundgaard H, Bundgaard JS, Raaschou-Pedersen DET, et al, "*Effectiveness of Adding a Mask Recommendation to Other Public Health Measures to Prevent SARS-CoV-2 Infection in Danish Mask Wearers, A Randomized Controlled Trial*" (Ann. Int. Med. Nov 18, 2020, <https://doi.org/10.7326/M20-6817>).

[Don't be a Maskhole, Karen](#) A review of Zeng N, Li Z, Ng S, Chen D, Zhou H, *Epidemiology reveals mask wearing by the public is crucial for COVID-19 control*. (Medicine in Microecology, <https://doi.org/10.1016/j.medmic.2020.100015>):

[Masks, and the new Doctor Schnabel von Rom](#): Review of Stadnytskyi V, Bax CE, Bax A, Anfinru P, *The airborne lifetime of small speech droplets and their potential importance in SARS-CoV-2 transmission* (Approved by PNAS May 2020: <https://www.pnas.org/cgi/doi/10.1073/pnas.2006874117>)

[Pathological Science](#) - Zhang et al and the PNAS: Zhang R, Annie Y Zhang L, Wang Y, Molinae M: *Identifying airborne transmission as the dominant route for the spread of COVID-19* (fast-tracked through the PNAS on June 11, 2020)

[Defacing Mask Science](#) - Rossettie S, Perry C, Pourghaed M, Zumwalt M, "Effectiveness of manufactured surgical masks, respirators, and home-made masks in prevention of respiratory infection due to airborne microorganisms" *The Southwest Respiratory and Critical Care Chronicles* 2020;8(34):11–26

[Masks - Don't look behind the curtain](#): Review of Vivek Kumar, Sravankumar Nallamothe, Sourabh Shrivastava, Harshrajsinh Jadeja, Pravin Nakod, Prem Andrade, Pankaj Doshi, Guruswamy Kumaraswamy "On the utility of cloth facemasks for controlling ejecta during respiratory events "

[Size matters!](#) A Brief Description of filtering mechanisms and size.

[Materials v. Masks](#): A review of Konda A, Prakash A, Moss GA, Schmoldt M, Grant GD, Guha S "Aerosol Filtration Efficiency of Common Fabrics Used in Respiratory Cloth Masks" (American Chemical Society, April 2020)

["Junk Science: In Favor of Community Face Masks - a return to Lysenkoism"](#) A review of: Jeremy Howard, Austin Huang, Zhiyuan Li, Zeynep Tufekci, Vladimir Zdimal, Helene-Mari van der Westhuizen, Arne von Delft, Amy Price, Lex Fridman, Lei-Han Tang, Viola Tang, Gregory L. Watson, Christina E. Bax, Reshama Shaikh, Frederik Questier, Danny Hernandez, Larry F. Chu, Christina M. Ramirez, Anne W. Rimo Face Masks Against COVID-19: An Evidence Review NOT PEER-REVIEWED | Posted: 13 May 2020

[Wishful Science](#) - A review of Anna Davies, BSc, Katy-Anne Thompson, BSc, Karthika Giri, BSc, George Kafatos, MSc, Jimmy Walker, PhD, and Allan Bennett, MSc *Testing the Efficacy of Homemade Masks: Would They Protect in an Influenza Pandemic?* (Disaster Med Public Health Preparedness. 2013;7:413-418)

[If Manikins Could Fly...](#) A Review of Eikenberry SE, Mancuso M, Iboi E, Phan T, Eikenberry K, Kuang Y, Kostelich E, Gumel AB "To mask or not to mask: Modeling the potential for face mask use by the general public to curtail the COVID-19 pandemic" (*Infectious Disease Modelling* 5 (2020) pp. 293-308)

[Review of](#) Cheng VC, Wong S, Chuang V, So S, et al "The role of community-wide wearing of face mask for control of coronavirus disease 2019 (COVID-19) epidemic due to SARS-CoV-2" (*Journal of Infection* April 30, 2020;16:13)

[Gassed Masks!](#) Reactivation of viruses and deoxygenation during mask wearing.

[Masking the Truth](#) - A discussion of aerosols and droplets

[We R0 New York City](#) - A discussion of the basic reproduction number.

The epidemic of ignorance: Lessons from "Flattening the Curve" April 14, 2020

Think Tanks! The Dangers of Group-Think April 13, 2020

¹ Connell CP "Pathological Science - Zhang et al and the PNAS" (July 2020)

<https://www.linkedin.com/pulse/pathological-science-zhang-et-al-pnas-caoimh%C3%ADn-p-connell/>

² Westa JD, Bergstrom CT "*Misinformation in and about science*" PNAS 2021 Vol. 118 No. 15, October 11, 2020

³ Haber N, Grabowski MK, Larremore DB, Wada N, Goodman SN (et al), June 18, 2020 letter to the Proceedings of the National Academy of Sciences calling for a retraction of " Zhang R, Annie Y Zhang L, Wang Y, Molinae M: Identifying airborne transmission as the dominant route for the spread of COVID-19 (PNAS June 11, 2020)"

⁴ Connell CP, Mould Hazards in Marijuana Grow Operations (2012) http://forensic-applications.com/moulds/NJH_Mould_Rebuttal.pdf

⁵ Connell CP "Literature Review Number 7 of the COVID-19 Series: Masks and Respiratory Protection for Health Care Professionals" (July 2020) <https://www.linkedin.com/pulse/defacing-mask-science-caoimh%C3%ADn-p-connell/>

⁶ Yes - I really meant to say it that way.

⁷ Jeremy Howard, Austin Huang, Zhiyuan Li, Zeynep Tufekci, Vladimir Zdimal, Helene-Mari van der Westhuizen, Arne von Delft, Amy Price, Lex Fridman, Lei-Han Tang, Viola Tang, Gregory L. Watson, Christina E. Bax, Reshama Shaikh, Frederik Questier, Danny Hernandez, Larry F. Chu, Christina M. Ramirez, Anne W. Rimoin, Face Masks Against COVID-19: An Evidence Review NOT PEER-REVIEWED | Posted: 13 May 2020