

Towards aerodynamically equivalent COVID-19 1.5 m social distancing for walking and running

Questions and Answers

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Question 1: What was the objective of the study?

The starting point was the 1.5 m (or in some countries 2.0 m or 6 ft) social distance that is recommended to be kept between two people standing still to avoid respiratory droplets of person A reaching person B. It is common sense that when person A exhales droplets and person B moves forwards, person B can move into the droplet cloud exhaled by person A. So people movement can affect droplet exposure. The objective of this study therefore was to find out to which extent the social distance of 1.5 m is enough or not for two people walking, running, cycling in each other's vicinity. And if not, how it should be adjusted to yield a similar (non-)droplet exposure risk as for the case of 1.5 m with two people standing still.

Question 2: What it meant by “aerodynamically equivalent social distance” for walking, running, cycling?

The standard social distance is 1.5 m, 2 m or 6 ft (depending on the country). The aerodynamically equivalent social distance is the social distance that two persons need to maintain when walking/running/cycling to have the same level of (non-)droplet exposure risk as in the case of 1.5 m, 2 m or 6 ft for two persons standing still and facing each other.

Question 3: What are the main findings of this study?

First, it was found that the droplets (range 40 μm – 200 μm) exhaled by a moving person are mainly entrained in the slipstream (wake) behind this person. Second, in absence of strong wind, the equivalent social distance for walking/running/cycling can remain 1.5 m (or 2 m or 6 ft) if the two persons are moving side-by-side or in a staggered formation. However, if person B is positioned in the slipstream (or wake) of person A, this person can be exposed to the droplets emitted by person A. Then the equivalent social distances are: 5 m for walking fast (4 km/h), 10 m for running fast (14.4 km/h), 20 m for cycling fast (30 km/h). The social distance to be kept when in the slipstream increases with increasing speed of person B.

Question 4: What are the virological, medical or epidemiological conclusions from your study?

None. This study does not draw any conclusions on the infection risk associated with particular social distances or droplet exposure. We are sharing these results with healthcare authorities and remain at their disposal for further information. It is obvious that no or reduced droplet exposure is better than larger droplet exposure. Therefore, the adjusted and equivalent social distances are to be preferred over the single value of 1.5 m.

Question 5: Why is it important to have these updated and larger social distances in walking, running and cycling?

These distances should not be larger than 1.5 m, except when person B is in the slipstream of person A. Then, the larger social distances are not only common sense but also a matter of consistency. If one now argues that this distance when moving fast (walking, running, cycling) should not be larger than 1.5 m, this logically implies that the 1.5 m when standing still and talking is also too large – which is not the case, as shown by the vast literature since 2002 on travel distance of drops.

Note that organizations like CDC (Center for Disease, Control and Prevention) are asking for additional evidence and technology to give better recommendations in the future.

Question 6: What is the value of this study?

The value of this study is not to indicate that person B moving closely behind person A can inhale the droplets emitted by person A. That is common sense for most people with a minimum fluid dynamics background and/or intuition. The value of this study is to indicate where exhaled droplets go (i.e. in the slipstream) and which specific social distances should be used in walking/running/cycling to be equivalent to 1.5 m standing still.

Question 7: Was this study only done by engineers and not by medical experts?

Not really. The study was done by four engineers (2 x civil, mechanical, aeronautical) but one of these, Thierry Marchal, is also seen as a top medical expert in simulation, formally a e-Health expert to EU authorities, leader of Avicenna Alliance and therefore spokesperson for the discussion with various authorities (<https://youtu.be/Sig5Q7rMFfY>). The medical world is moving towards in silico (computer model) to complement in vitro and in vivo data. These models have been reviewed by other experts such as Marc Horner, co-author of the V&V 40 standard and presented to the US healthcare authorities before sharing them publicly. The medical world is now moving fast towards computer models. Therefore our study fits in these new developments.

Question 8: Should you not have involved virologists, epidemiologists and medical experts?

Not for the scope of this particular study. This study is an aerodynamics study, not a virology study. The only two facts we adopt from virology are two basic and well-established facts: (1) Respiratory droplets are an effective way of transferring this type of viruses (well-established in scientific literature); (2) It is better to not be exposed to other people's saliva droplets than to be exposed to them (common sense).

Question 9: Does it make sense that mostly engineers performed this study?

The role of civil and mechanical engineers in current and previous SARS epidemics should not be underestimated. Engineers have been heavily involved in SARS since the outbreak in 2002 in Asia because the transfer of droplets in the indoor air in hospitals and houses is a key civil and mechanical engineering expertise. Thousands of papers on this topic have been published by civil and mechanical engineers in the peer reviewed literature. Note that the 1.5 m social distance has been defined in the past decades based on studies by engineers, not medical professionals. Engineering is now an important part of all biomedical and pharmaceutical research as illustrated by the fast and growing success of biomedical engineers.

Question 10: Why did you choose to not follow the standard academic procedure to first get the study peer reviewed and only announce results in the media later?

This is an exceptional situation. Even the extremely careful FDA (Food and Drug Administration) has wisely adjusted some guidance to ensure the rapid approval of any device or treatment / vaccine related to COVID-19 (e.g. [Guidance document for ventilators and accessories](#)) without compromising patient safety. Time matters a lot here. So it is important to temporarily adjust processes to make sure new products are reviewed faster. Similarly here, once the results were properly validated, the priority was to share the results with the public to help reduce the risk of propagation of the COVID-19; a few days later the scientific publication was shared in open access to allow all other scientists to review and challenge the approach and contribute to its future extension. The peer review publication will follow next. But we are not on the same time line when there is a pandemic storming the world. We thought that the priority was on people's health.

If we follow the normal procedure, we would first write a research proposal. If we are lucky we receive funding to start within a year. Let us say we can produce all results in one day (never happens). Then we write the article in one day (nearly impossible) and submit for peer review. In our field, this can take months, e.g. 6. So 1.5 years from now we have our peer-reviewed paper. Should we only then communicate to the public, we do not think this would be ethical. We made the choice to do validate our results first, then share the output publicly, before submitting the article for peer review. Not the most comfortable order for us, for multiple reasons, because of no funding, some aggressive and unjustified criticism, more debate on the format than on the study, etc. It appeared more important to us to share this precaution advice to the public.

Note that not following the normal procedure is not so exceptional, it happens frequently in scientific research. Scientists do this all the time, in the form of mass meetings, where often also press is present. These are called scientific conferences and thousands of these events are organized every year worldwide. There, often research is presented without publication at all or where no peer review or no decent peer review is performed for the conference publications...

Of course, we will have our study peer reviewed, because we wish to publish it in a journal, but that did not seem most urgent to us now, certainly because the study confirms common sense and adhering to the guidelines of the study cannot have harmful consequences.

Question 11: Don't you think your advice is dangerous, especially given the study is not yet peer reviewed?

This is not a study related to a treatment. There is no risk in following our guidelines. This is not a situation that can be compared to advising people to take certain medicine that has been insufficiently tested and that can have adverse health effects. There are no adverse effects for you to walk, run or cycle in staggered arrangement instead of inline, except... increased air resistance. We believe that in this exceptional situation increased air resistance should be preferred over potential health risks.

Question 12: One could argue that you are not medical experts and that your guidelines cannot be considered as medical guidance.

The first part is not really correct. Thierry Marchal is not only an engineer but also a top medical expert in simulation, formally a eHealth expert to EU authorities, leader of Avicenna Alliance and therefore spokesperson for the discussion with various authorities (<https://youtu.be/Sig5Q7rMFfy>).

We do not give medical guidance. We report aerodynamic results and suggest guidance in terms of exposure to droplets. We do not draw conclusions in terms of infection risk. This study did trigger an interest from quite some virologists and epidemiologists, which can lead to future collaboration where experts of different disciplines are joining forces.

Question 13: Did you have sufficient past performance to execute this type of study with high quality?

The main investigator, Bert Blocken, has been studying droplets (of micrometer to millimeter sizes) in airflow for more than 20 years, and airflow around cyclists and runners for more than 15 years.

The other lead investigator, Thierry Marchal, has been leading the healthcare activity of a leading simulation company for 14 years and working closely with US and EU authorities for over 5 years, relying on his vast ecosystem to continuously comment on new results and challenge the hypotheses.

Question 14: Should all people that want to exercise outdoors start wearing masks?

That is not unwise if people want to move very closely behind each other. However, there are serious concerns about the shortage of masks and professional masks should primarily be reserved for the healthcare workers. Assuming that masks are not strictly needed when talking at 1.5 m distance, if people follow our aerodynamic recommendations and the updated equivalent social distances when walking/running/cycling in the slipstream, then also in those cases masks would not be strictly needed.

Question 15: Are there other simple rules that people should consider?

When there is substantial cross-wind, the suggestion to stay out of the slipstream remains valid. This means that it is advised to not walk/run/cycle directly behind others but offset to the upwind side.

When overtaking a person, be kind to this person and only when you have reached a certain distance from this person (5 m when this person is walking, 10 m for running, up to 20 m for cycling), move back on the same straight line as this person.

Question 16: How you do react to some media that have given negative feedback on this study?

It is always advisable to challenge any results, question the hypotheses and consult other experts in the field to collect different opinions. We were however surprised by some personal attacks or judgements on the format of the study rather than discussing the content itself or its conclusions. Not contacting the key researchers for further information and constructively challenging them or when seeking a second opinion on this aerodynamics modeling, asking persons that do not have proper aerodynamics expertise, often leads to embarrassing situations and useless polemics.

About the study not being complete: no scientific study is ever complete. There is an infinite number of combinations of runner body geometry, wind speed, wind direction, turbulence, droplet size, relative humidity, etc. We chose to start from the most basic choices: two identical runners, no external wind, typical droplet size from literature, etc. as this situation is not only the most common but could also be a worst case scenario. Evidently further work is needed considering different values for these parameters. We expect that various authorities will be monitoring these future studies once this wave of COVID-19 is over to better understand these phenomena so that we would be ready for a likely future pandemic.

Question 17: Should people not decide to stop exercising outside?

No. The crisis is very large and mental and physical health are important and walking, running and cycling do contribute to both mental and physical health. Our study is intended to indicate how social distancing should be done in those situations. From the beginning, the World Health Organization [WHO](#) and the [CDC](#) have recommended to keep a distance of at least 1 m or 2 m, acknowledging that this is not always possible especially in public transportation. We are obviously not these prestigious organizations but we are providing recommendations using reliable results to minimize the risk of contamination acknowledging that they cannot always be followed.

Question 18: Should walkers turn away until a jogger is 5-10 m away or until a cyclist is 20 m away?

If a runner or cyclist passes a walker, by the time this runner or cyclist is again on the straight line of the walker (i.e. the walker is in the slipstream), the runner is often 10 m away from the walker and the cyclist 20 m (unless the runner or cyclist discourteously moves back into the walker track), which are precisely the distances that are equivalent to the social distance of 1.5 m for two people standing still and talking to each other. Therefore the risk would be minimum. So, no; there is no need for walkers to be afraid of runners or cyclists; more than ever this is a period where solidarity between people and respect of each other are important.

Question 19: Should walkers avoid being in the vicinity of runners and cyclists?

Same answer as for Question 18.

Question 20: Should we wear a mask while exercising or walking in a place where there are runners and cyclists?

This decision belongs to the local authorities wisely advised by scientific experts. We encourage you to consult their advice. From all publications that we have seen, it is never prohibited to wear a mask; however, wearing a mask does not guarantee that you would have a total protection.

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