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Marc Artzrouni

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CovidRisk: An evidence-based online COVID-19 risk calculator

BRIEF ARTICLE

Marc Artzrouni, PhD

Department of Mathematics (UMR-CNRS 5142)

University of Pau and Pays de l'Adour, France

Marc.Artzrouni@univ-pau.fr

ABSTRACT

We propose an [online app](https://bit.ly/2KQKNmd) (bit.ly/2KQKNmd) which calculates the risks of COVID-19 infection for a person coming into contact with a group of individuals characterized by a specified prevalence rate. The user provides the size of the group, the number (and duration) of contacts and the level of precautions. For a well-documented September 2020 White House event the app predicts that with an assumed 3% prevalence rate one's risk of infection was almost 5 % and seven of the 150 guests would become infected - as actually happened. The tool, destined to the general public, can thus quantify the risks of infection in special populations (social gatherings, prisons, etc), but also in general ones (stores, stadiums, etc.).

INTRODUCTION

In the same way you have an intuitive grasp of the risks you take when driving a car (flat tire, accident, etc.), it would be nice to have *orders of magnitudes* for the risk of becoming infected with SARS-CoV-2 during a subway ride, in a family gathering, or while shopping in a supermarket. We present here a simple online tool destined to the public which provides answers to these questions.

METHODS

Others have provided sophisticated online tools to estimate "geolocalized" probabilities of at least one person being infected in a group of individuals.¹ We complement these efforts here with "CovidRisk", a simple [online app](https://bit.ly/2KQKNmd) (bit.ly/2KQKNmd) which provide three transmission metrics for a person moving randomly within a group of individuals characterized by its COVID-19 prevalence level. You input in the app the size of the group, the number of contacts you will have within the group, the duration of each contact and the level of precautions (low, average, or high levels of mask wearing, social distancing, etc.). The tool calculates:

1. Your individual chance of getting infected (probability of transmission) during a *contact with an infected person* in the group.
2. Your *overall chance* of infection during the event.
3. The expected number of new infections if all members in the group mingle in the same way you do.

The assumed infection prevalence will depend on the event. You may hypothesize a 5 or 10% risk of infection in a *special population* e.g. in a prison or meat packing plant. On the other hand you will need a *population-level* prevalence if you are in a supermarket or at a

stadium. We show in the “Model” tab of the app that such prevalences can be approximated as $1/100^{\text{th}}$ the *daily incidence rate* per 100,000. An alternative is a local level “positivity rate”. Both statistics suffer from “ascertainment bias” but could be used as lower and upper bounds, respectively: the former underestimates the prevalence because of lack of testing and the latter overestimates it because it is symptomatic people who tend to be tested.

RESULTS

We illustrate the calculation with the super-spreader event that took place at the White House during a reception on September 26, 2020 to announce Judge Amy Coney Barrett’s nomination to the Supreme Court. Approximately 150 guests attended, with many hugs and handshakes but few masks². We assume each guest spent 120 minutes mingling 12 minutes with each one of 10 randomly chosen attendees. Other parameter values and the results appear in Table 1. The table below shows that a baseline scenario with 3% prevalence (i.e. 4 or 5 infected among the 150 guests) and few precautions produce an overall probability of infection close to 5%. The predicted average number of new infections is 7.12, in line with the seven suspected infections reported after the event.² The two other scenarios proposed in the table illustrate the favorable effect of a prevalence decreasing to 1% and of precautions improving to an “average” level (some mask wearing, etc).

As another example we give online (MODEL tab, Section 4) the risk of becoming infected in a supermarket in North Dakota, the U.S. state with the highest incidence of Covid-19 as of November 12, 2020. Using the method described above we interpret this daily incidence of 175/100,000 as a prevalence of roughly 1.75%. Multiplying this number by

four to account for the "ascertainment bias" we obtain a prevalence of 7%. We assume there are 50 people in the store and that you spend one minute interacting with each one of ten workers/customers while observing an average level of precautions. The app calculates that your chance of becoming infected if you are unlucky enough to be in contact with an infected person is 0.77% with an overall risk of becoming infected of 0.54%. (Although it is not always the case the latter can be smaller than the former because an overall risk takes into account the fact that you may be lucky and not bump into any infected person). An average of only 0.24 people are expected to become infected in the store. Although this may seem low, it means that the same event taking place in 100 different stores would result in an average 24 infections.

DISCUSSION

The CovidRisk app has limitations due to the model's simplifying assumptions, namely the uniform mixing and person-to-person transmission only, which precludes transmission via surface contacts or travelling aerosol droplets. Given these assumptions and the uncertainties concerning the prevalence level the results should be viewed as orders of magnitudes only – although arguably the model has been validated at least in the one case of the well-documented event at the White House on Sept 26.

PUBLIC HEALTH IMPLICATIONS

The numerical examples provided above tentatively suggest that gatherings where people mingle for extended periods with few or no precautions entail high risks of transmission - unlike quick trips to a store, even in a state with a high level of prevalence. When driving to a social event, a store or a stadium during the COVID-19 pandemic, you not only have

an intuitive grasp of your chance of a flat tire - you can now have some idea of your risk of infection and of the approximate number of new cases during the event.

Table 1. CovidRisk results for White House Sept 26 event.

Scenario	Prevalence (input)	Precautions (input)	Overall prob infection	Average number new infections
Baseline	3%	low	4.92%	7.12
Lower prevalence	1%	low	1.66%	2.46
More precautions	3%	average	2.60%	3.77

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