

Infection Risk and Indoor Air Quality in Schools of Canton Grisons

First WHO/Europe Indoor Air Conference

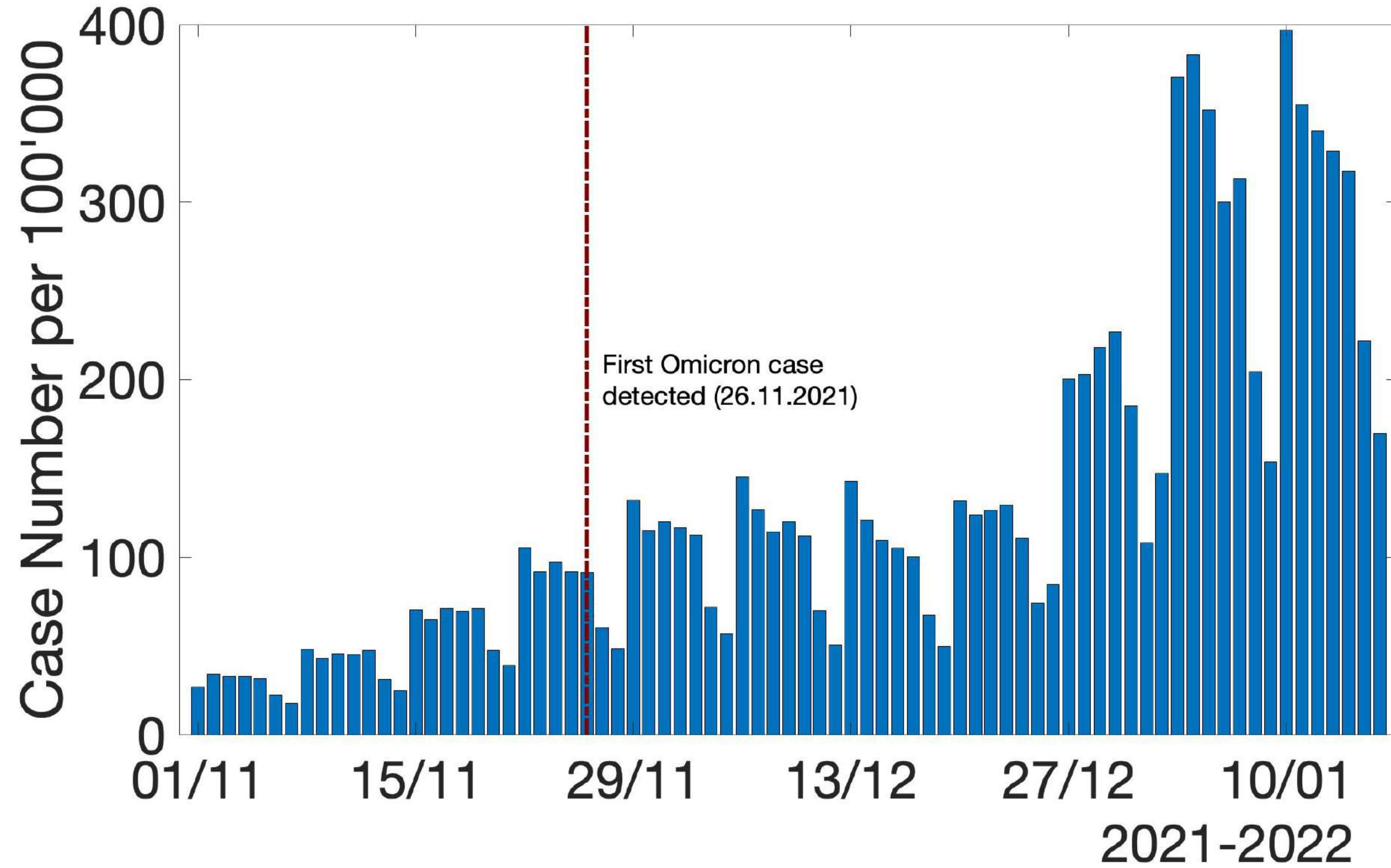
**20 September 2023
Bern, Switzerland**

Hossein Gorji¹, Alexa Caduff², Ivan Lunati¹

1. *Laboratory of multi-scale studies in building physics, Empa, Switzerland*
2. *Department of Justice, Security, and Health, Canton Grisons, Switzerland*

Epidemiological Background

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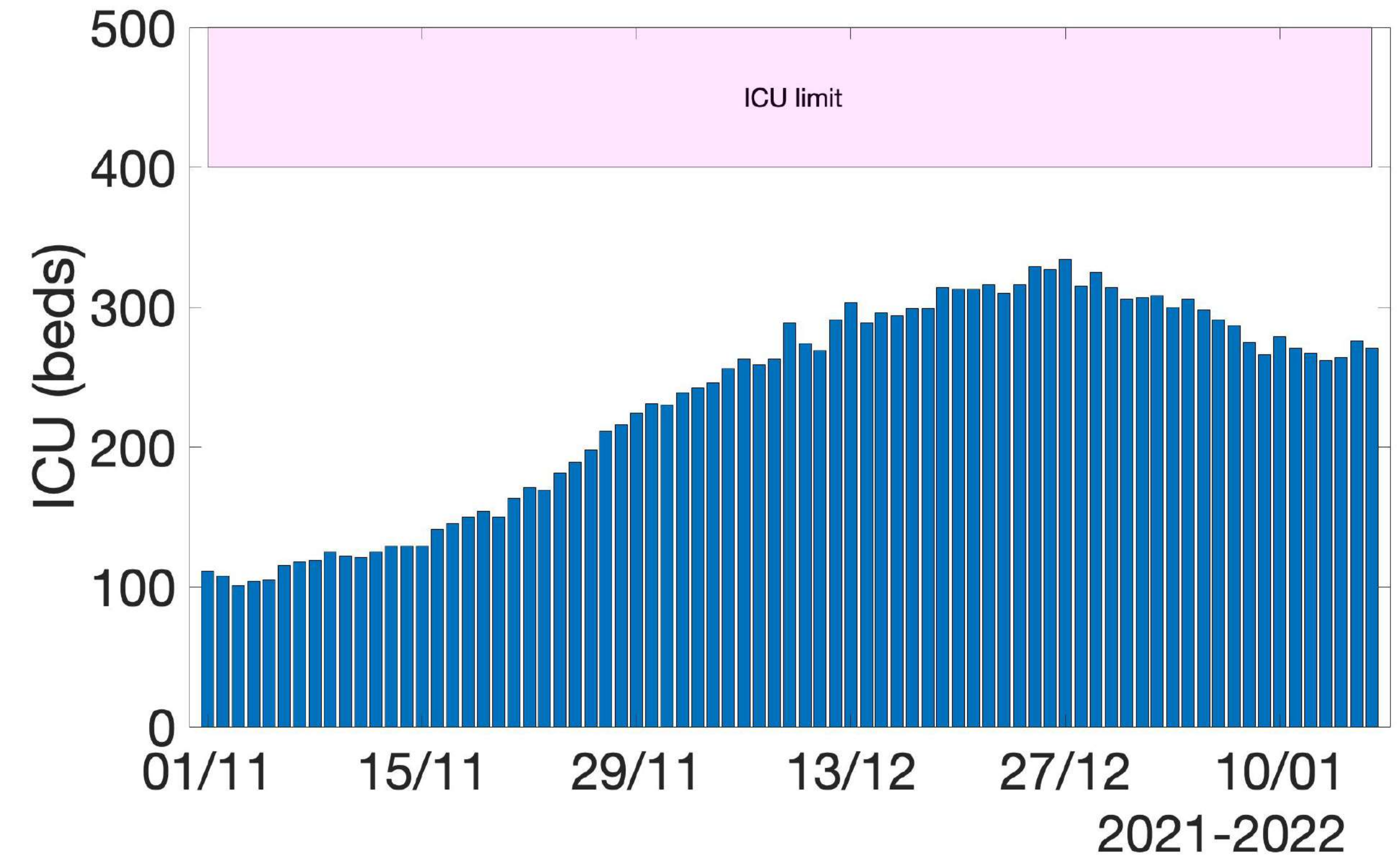
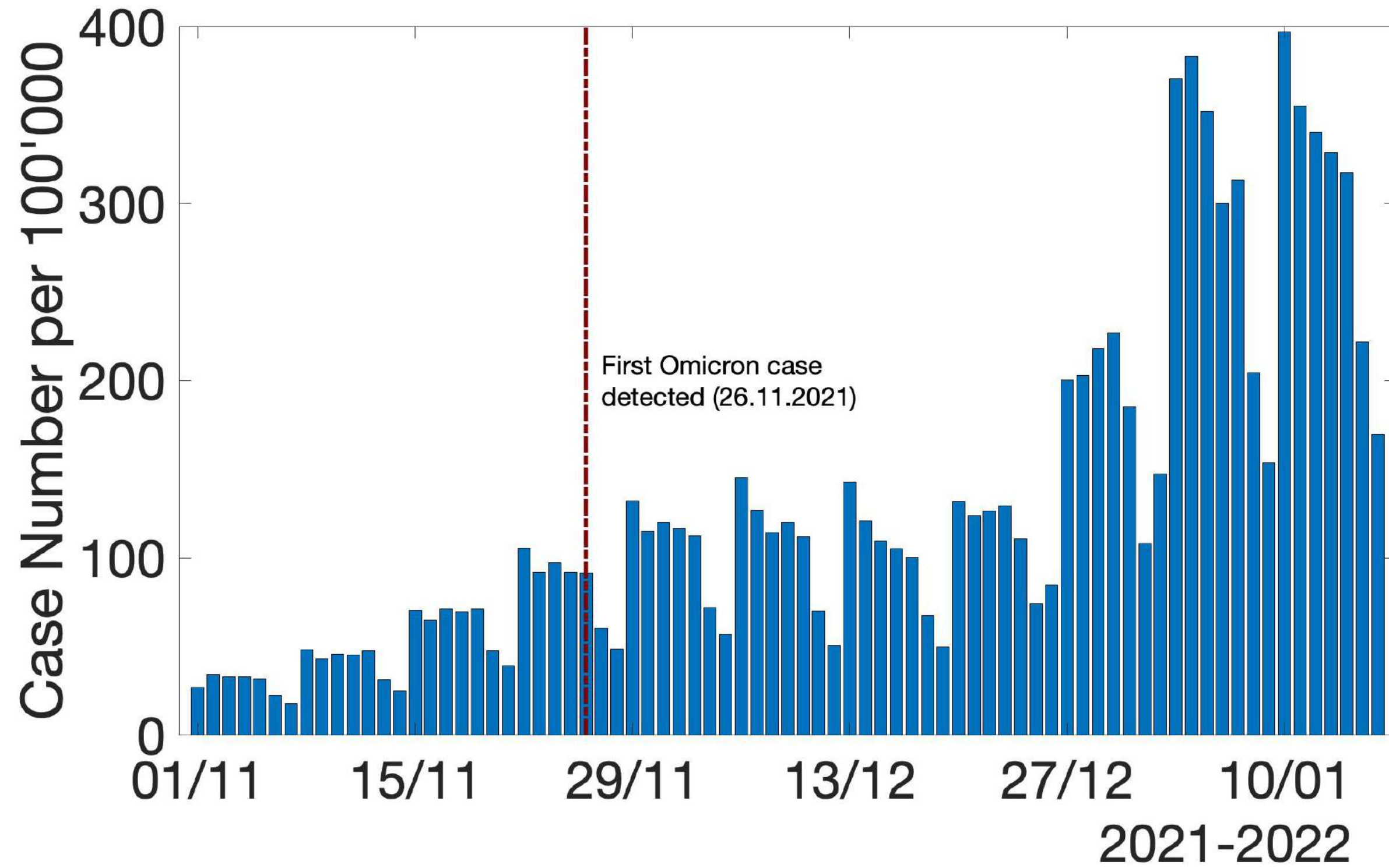


Epidemiological Background



Empa

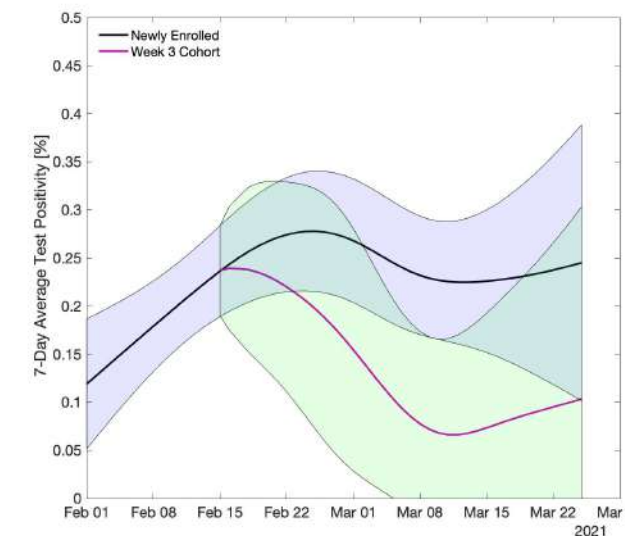
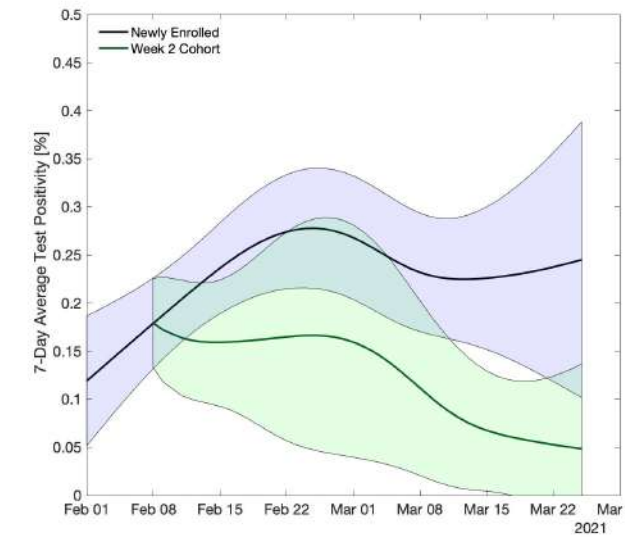
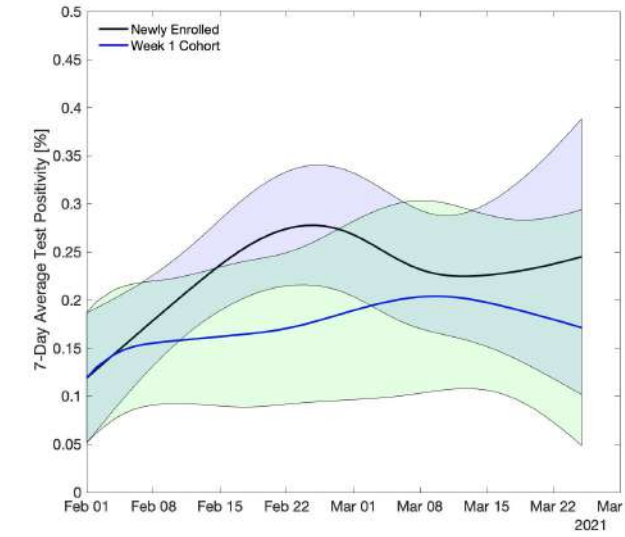
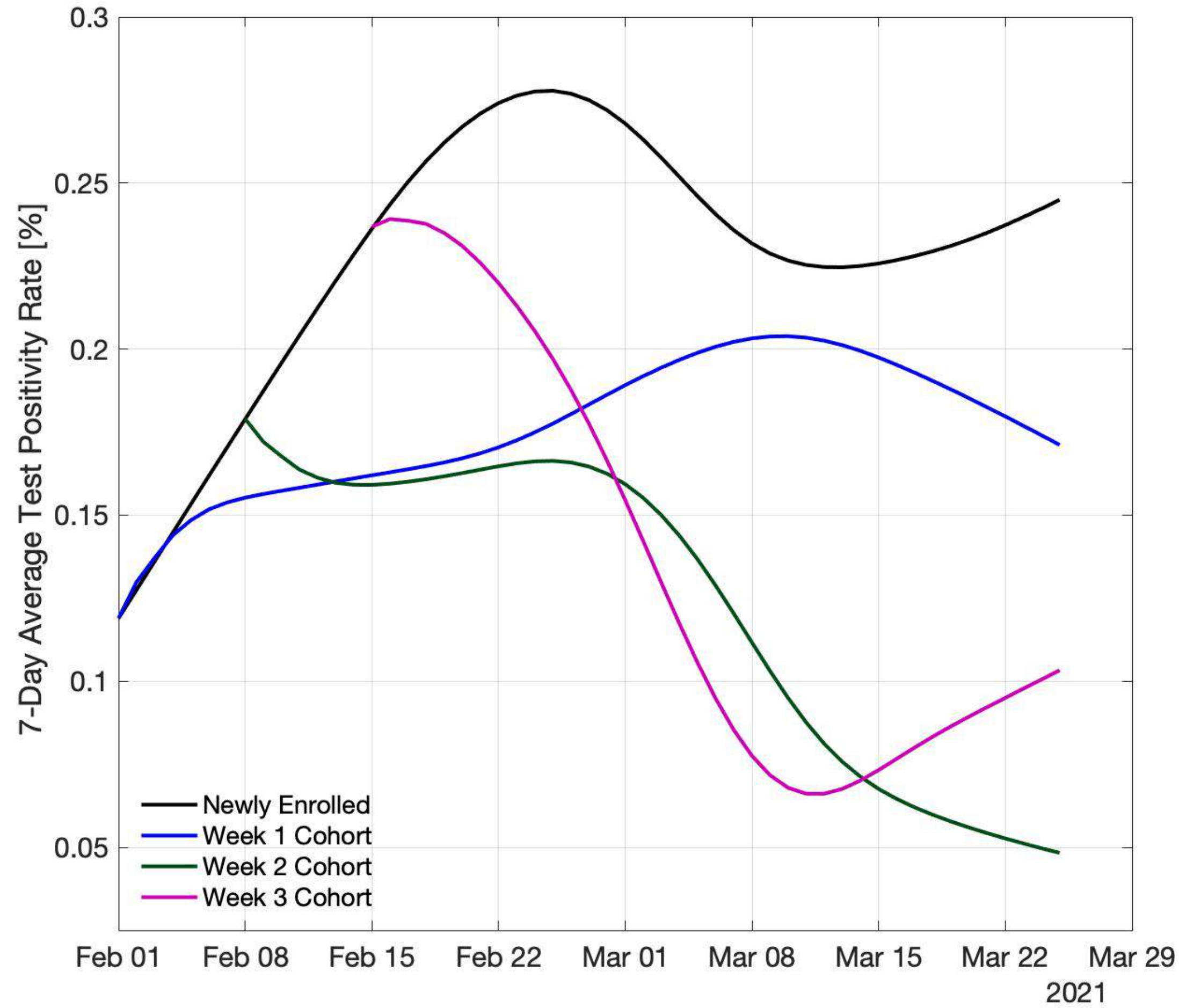
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Repetitive Testing

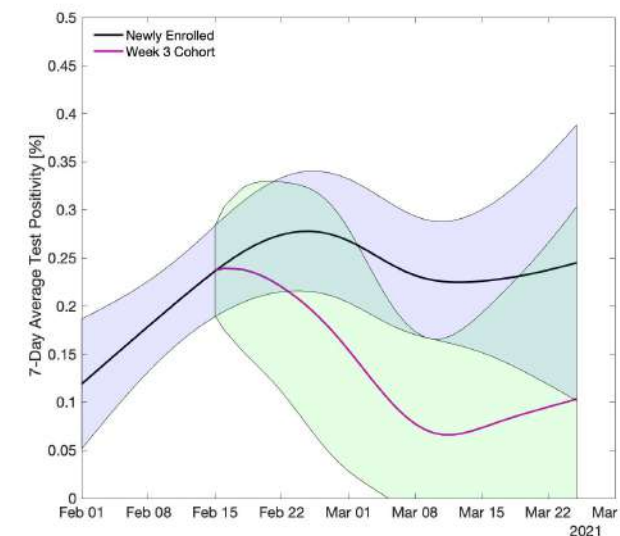
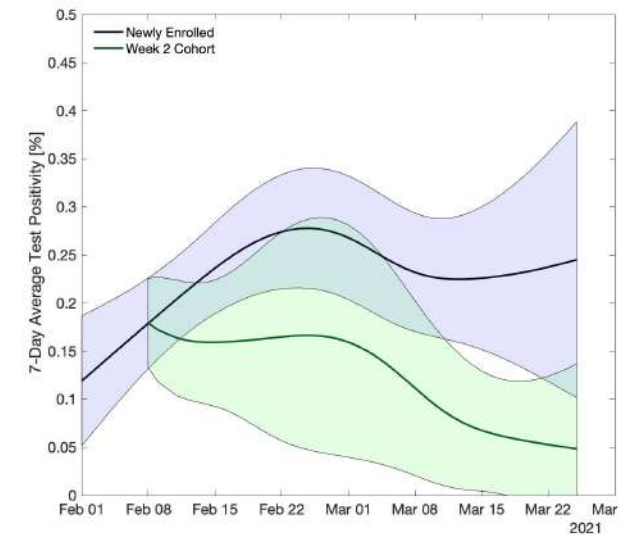
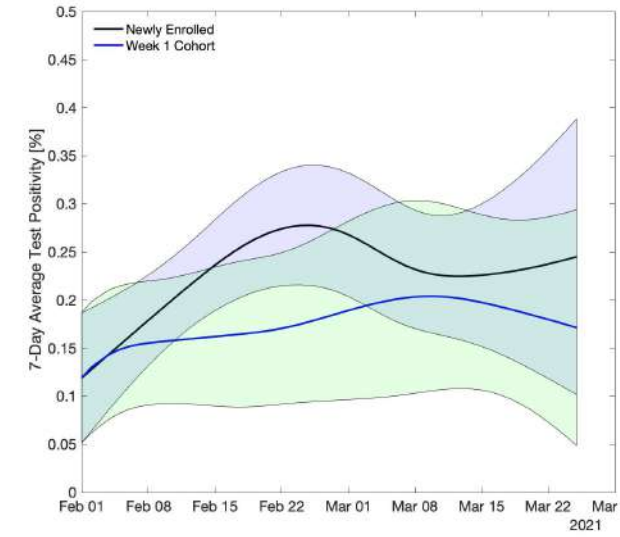
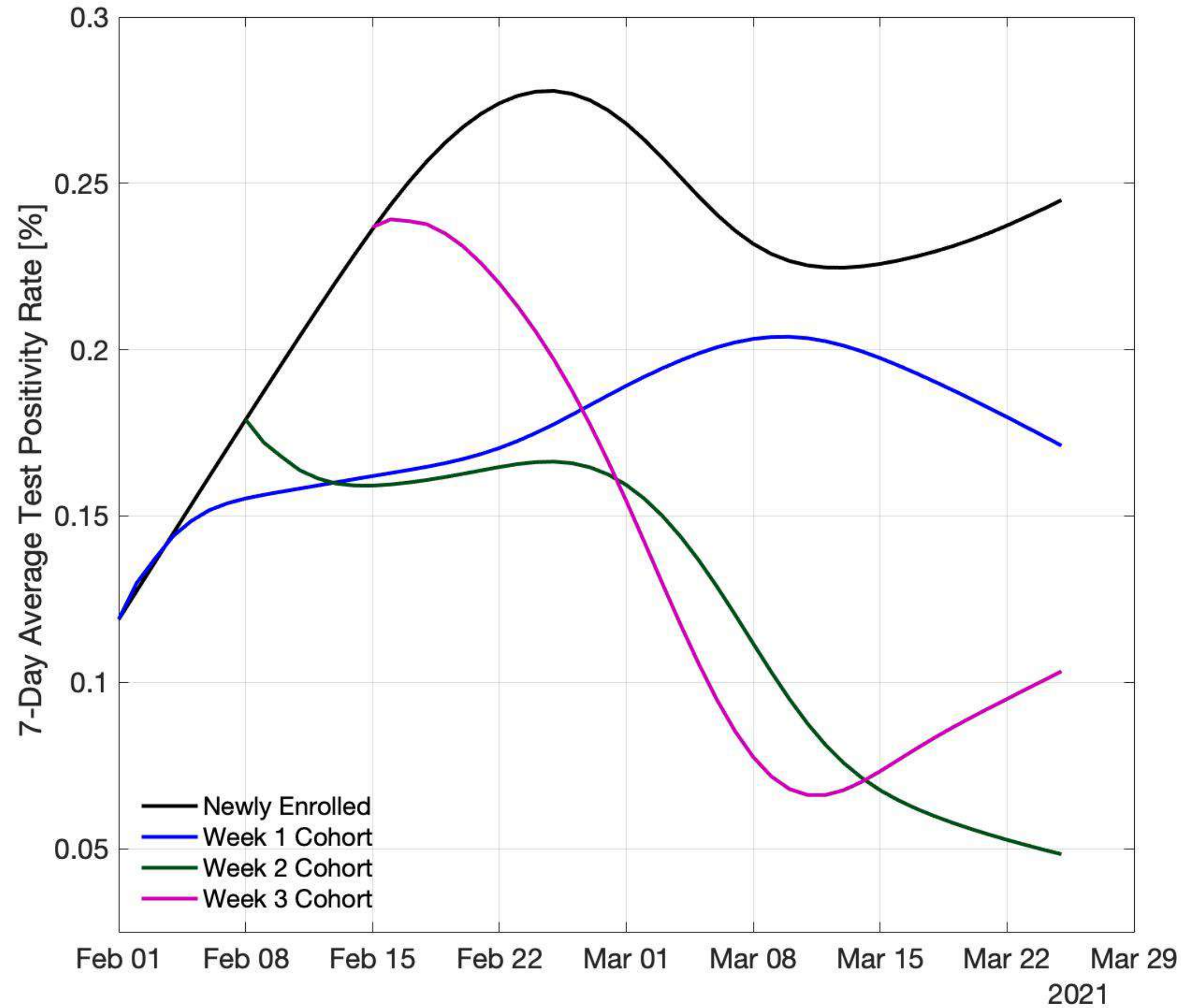
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Gorji, Lunati, et al. Scientific Reports (2022)

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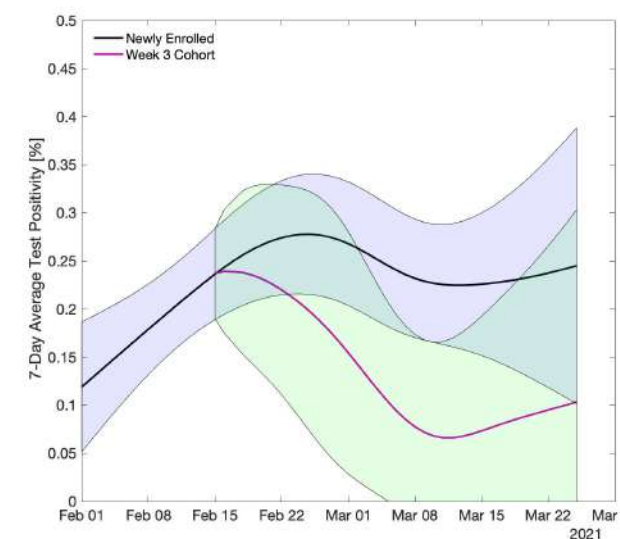
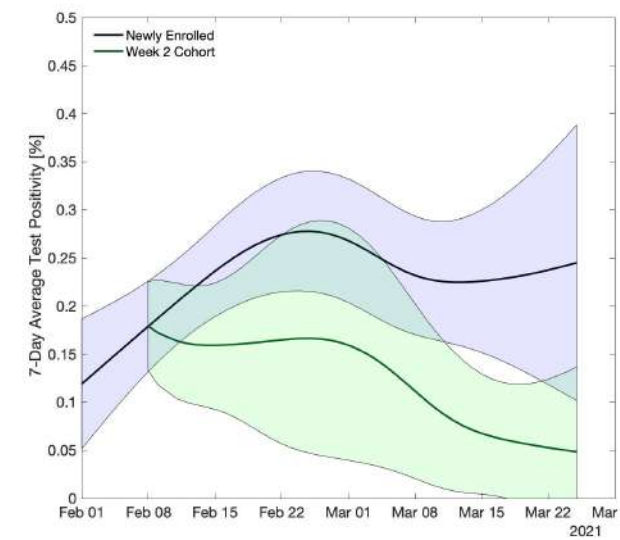
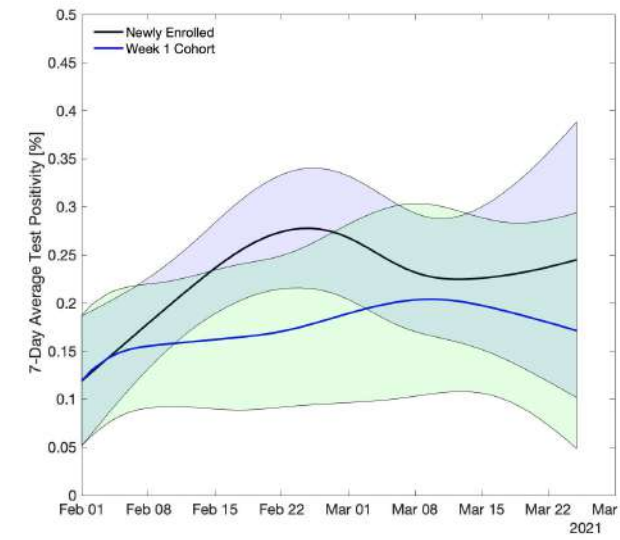
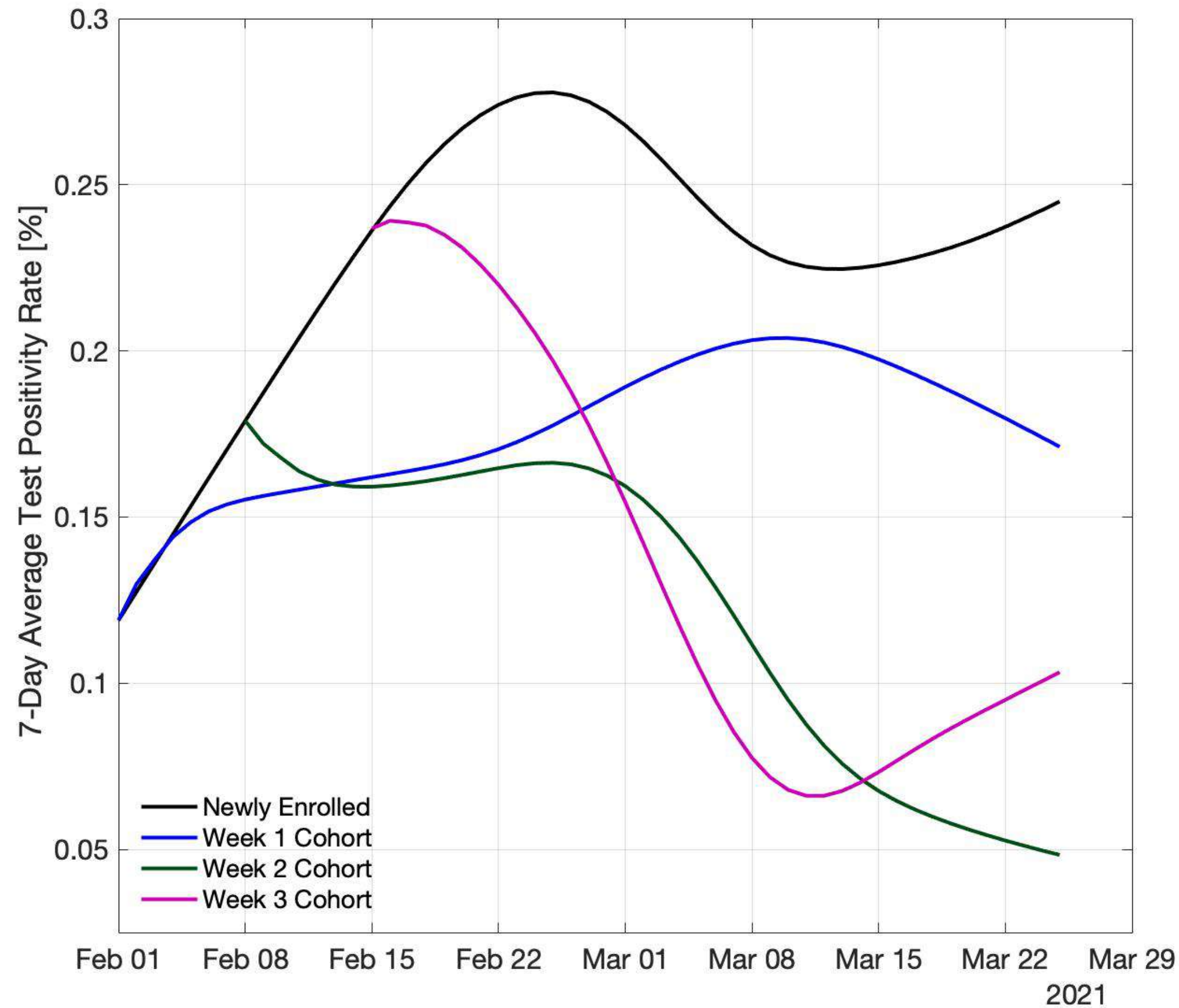


Saliva based RT-PCR tests were offered on a weekly basis to all employees of businesses as well as students. The mitigation turned out impactful in reducing the incidence, while limiting the socio-economical toll of extreme measures.

Gorji, Lunati, et al. Scientific Reports (2022)

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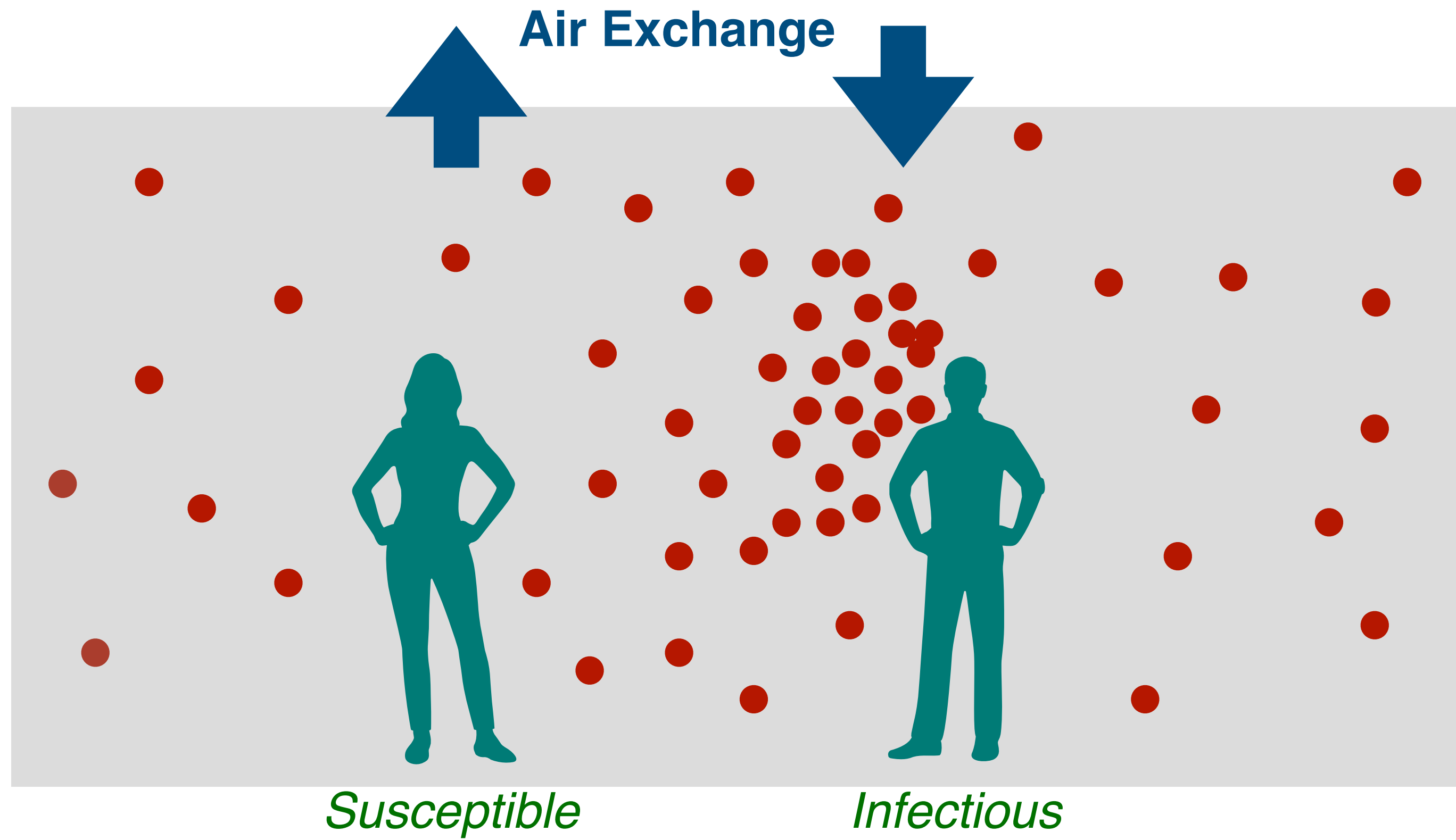
However it was unclear if further measures are needed as the case numbers were increasing and the health system was operating close to the surge limit.

Gorji, Lunati, et al. Scientific Reports (2022)

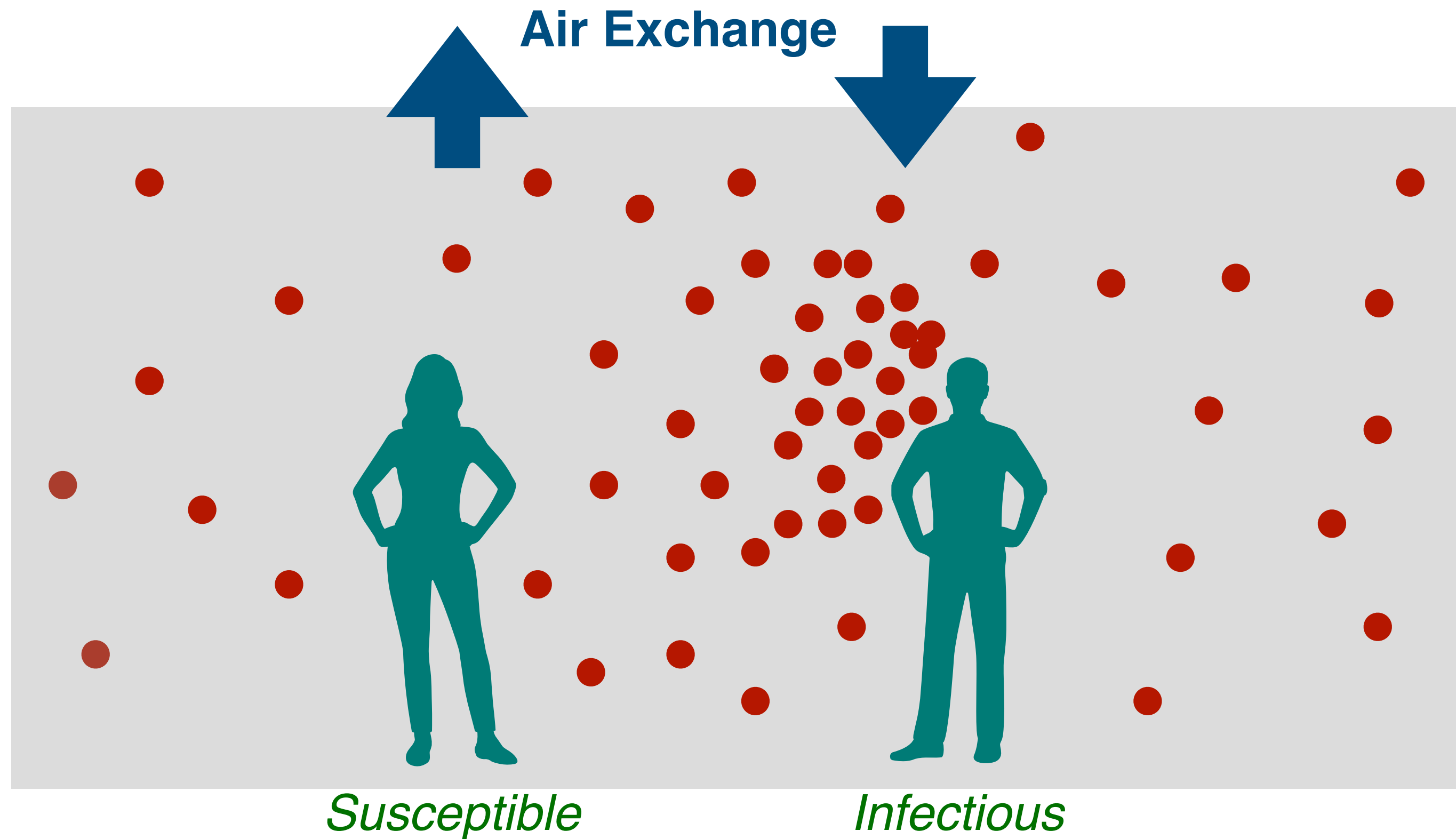
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Proxy for Air Exchange Rate

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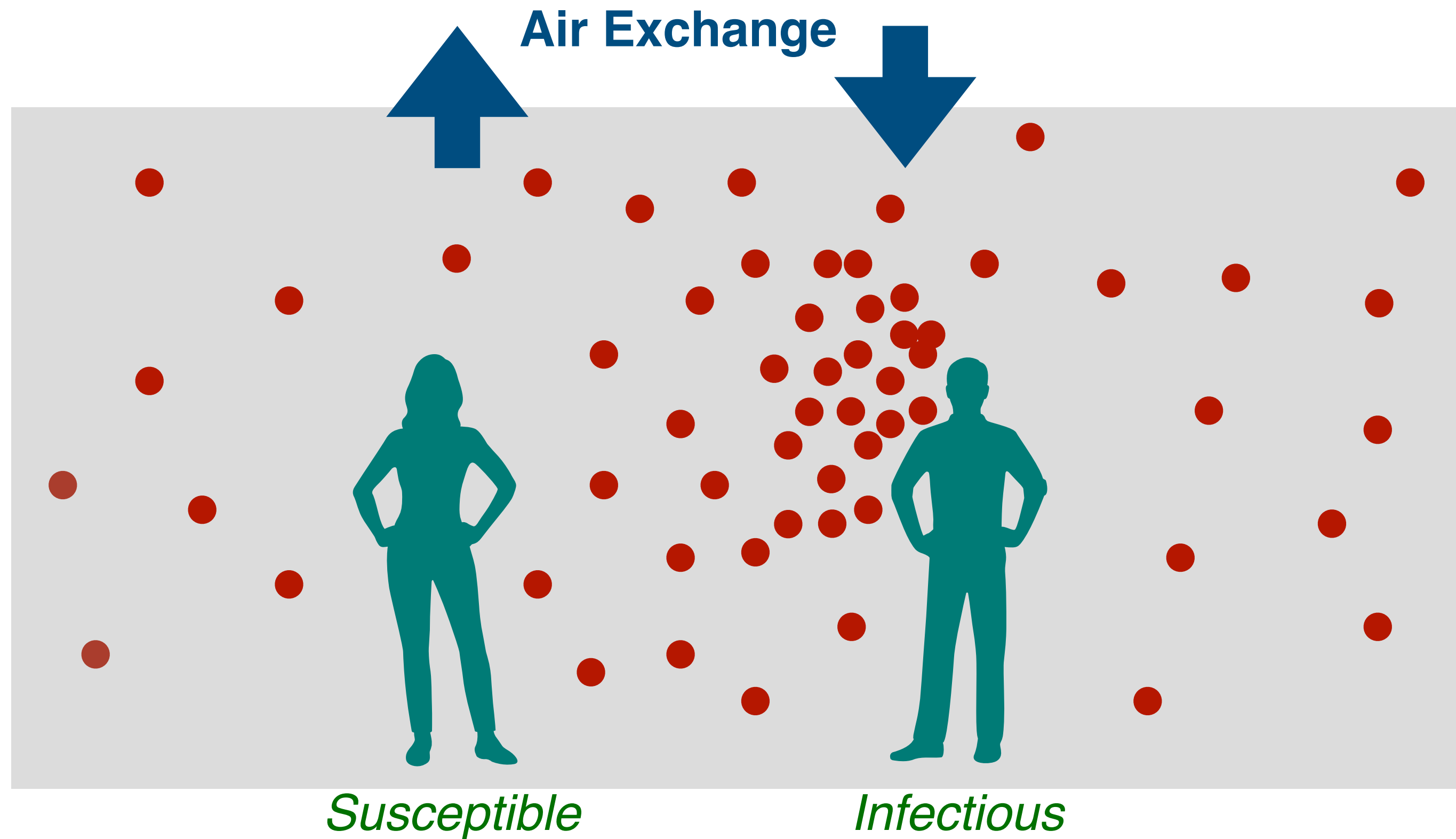


Proxy for Air Exchange Rate



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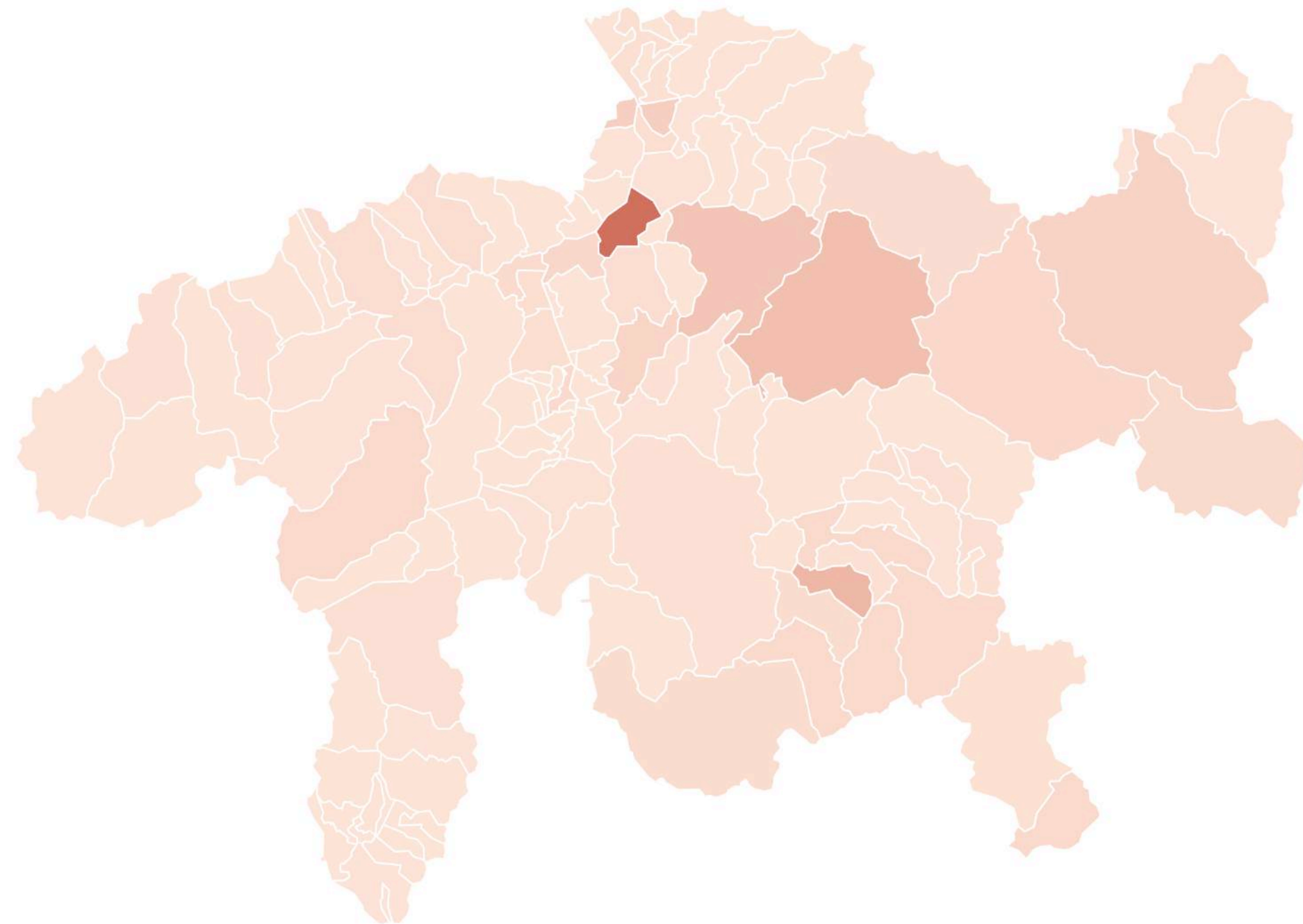
Obviously the risk primarily depends on the number of infectious individuals, however, the indoor air can significantly facilitate or reduce the transmission.

Learning Spaces

Combining school testing and indoor air monitoring

Learning Spaces

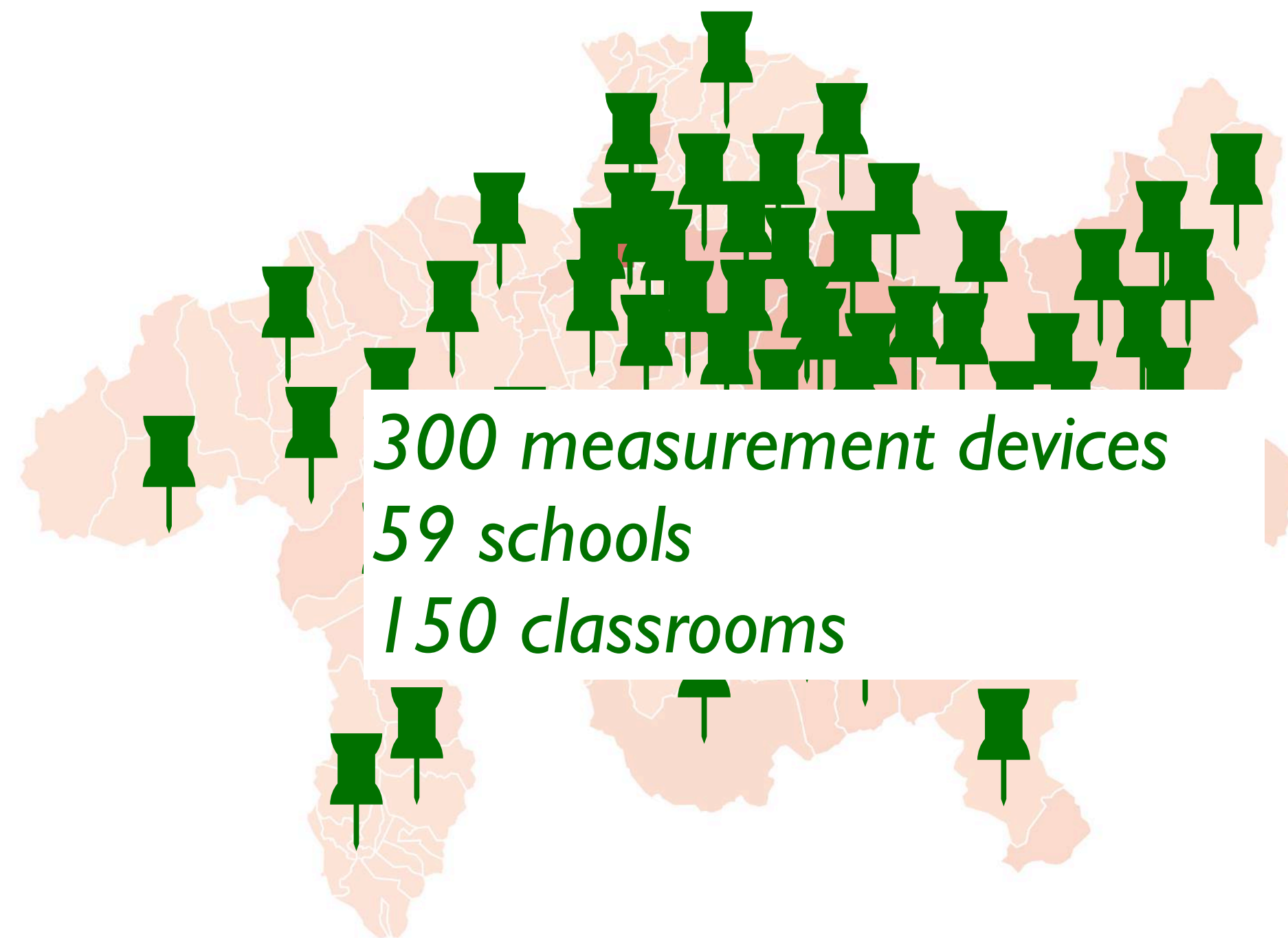
Combining school testing and indoor air monitoring



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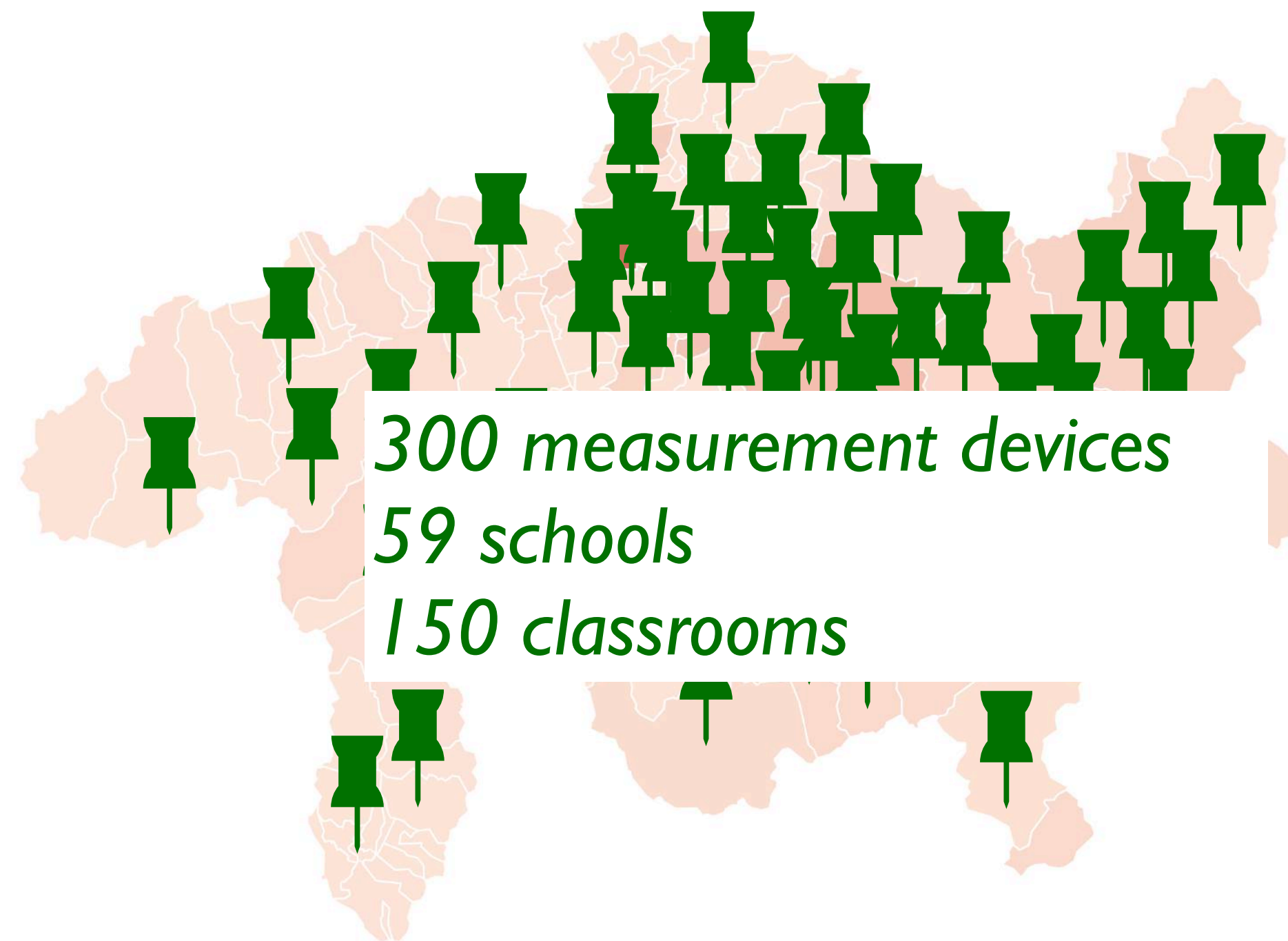
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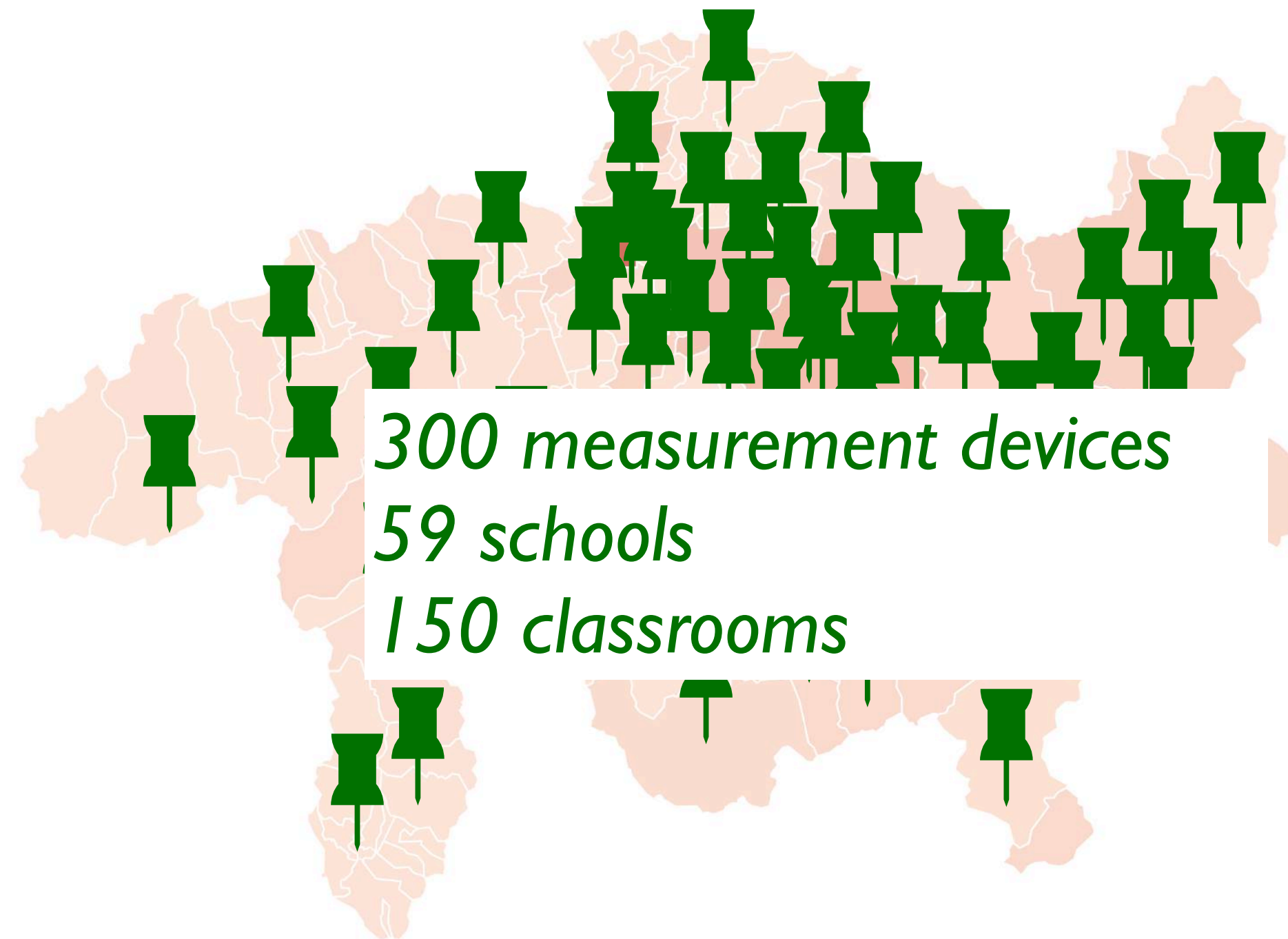
Combining school testing and indoor air monitoring



What is the impact of indoor air on school outbreaks?

Learning Spaces

Combining school testing and indoor air monitoring



What is the impact of indoor air on school outbreaks?

What should be considered as *safe level* for CO₂ concentration?

Sample Data

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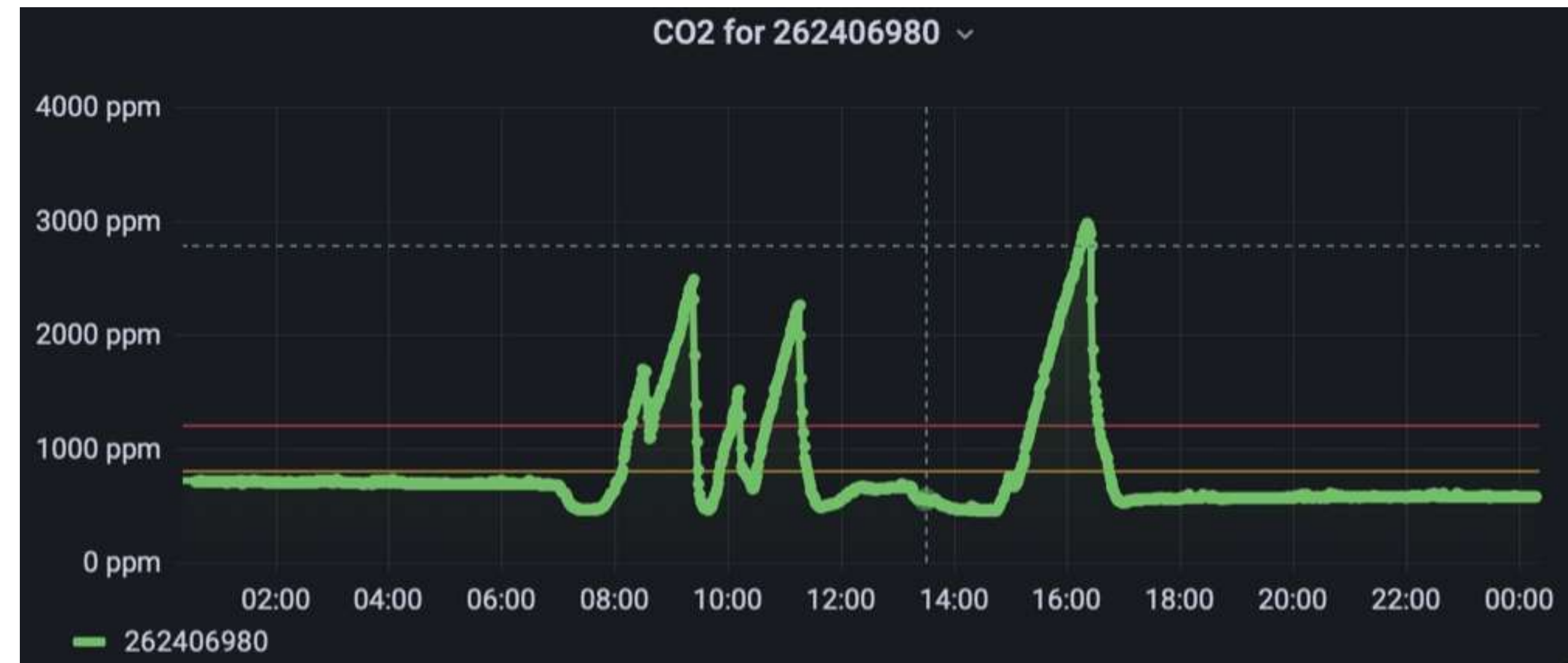
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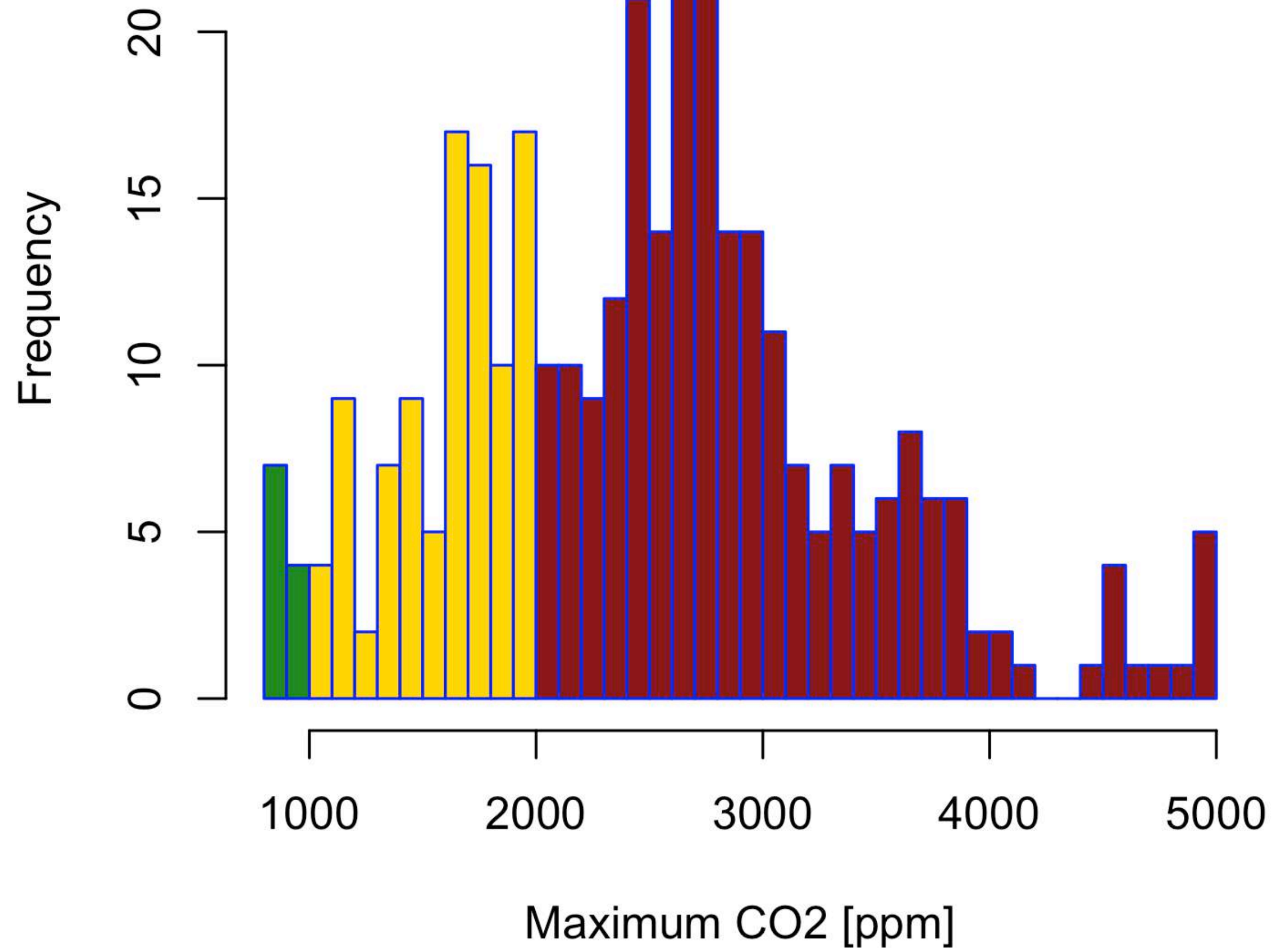
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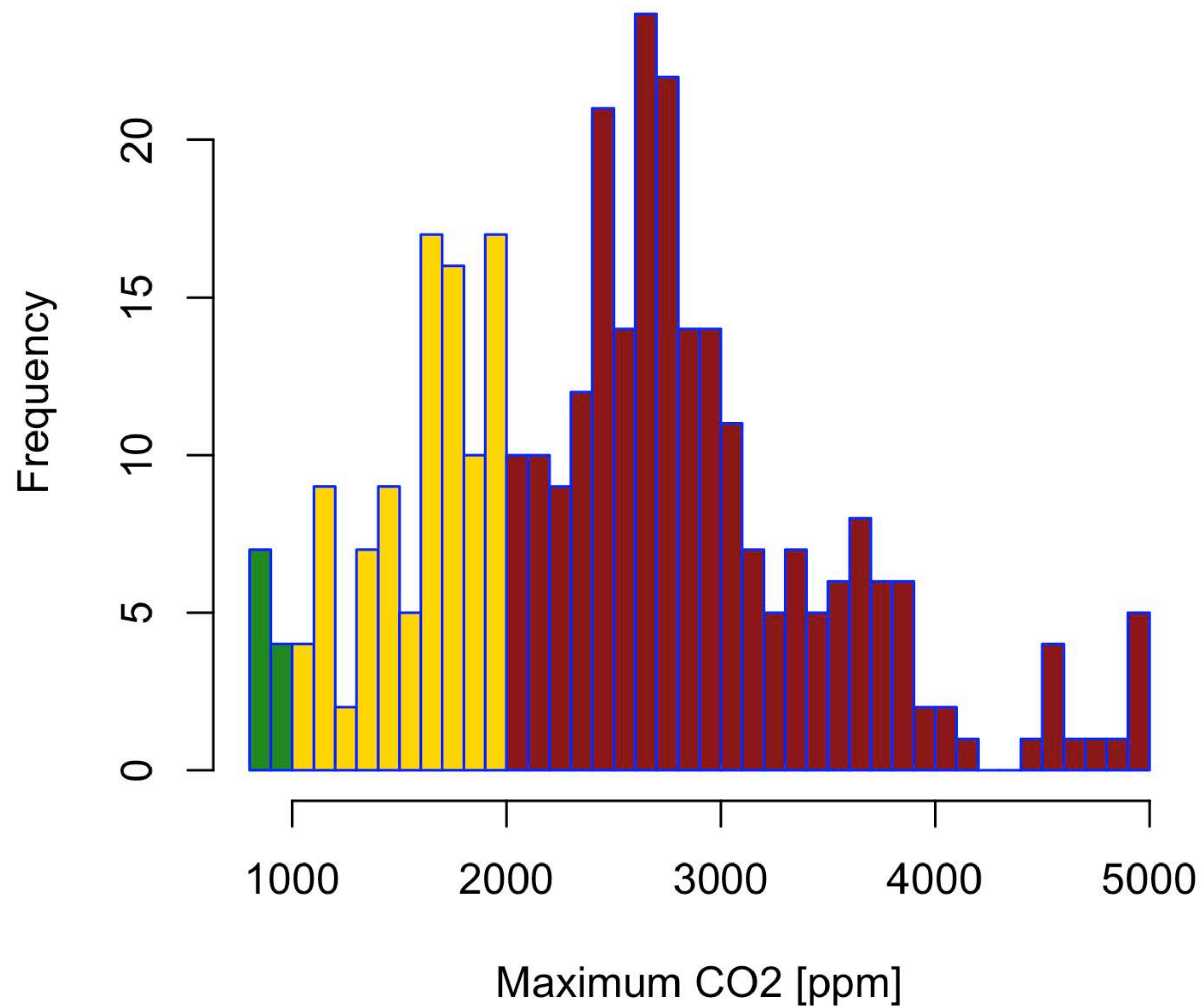
Descriptives

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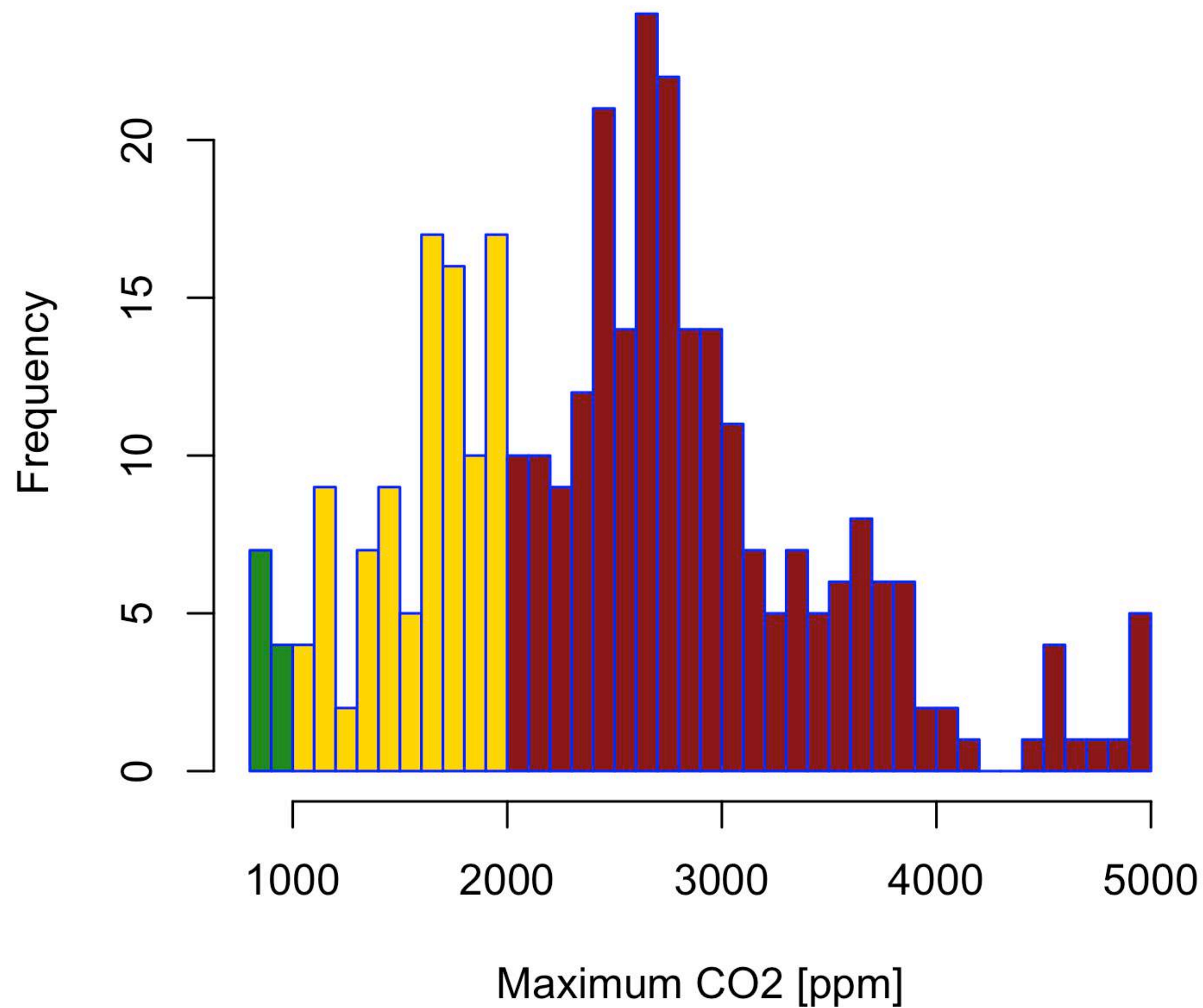
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For each interval, the histogram shows the number of sensors that reached a certain maximum CO₂ concentration. The CO₂ level exceeds **2'000 ppm** in **almost 60%** of the classrooms.

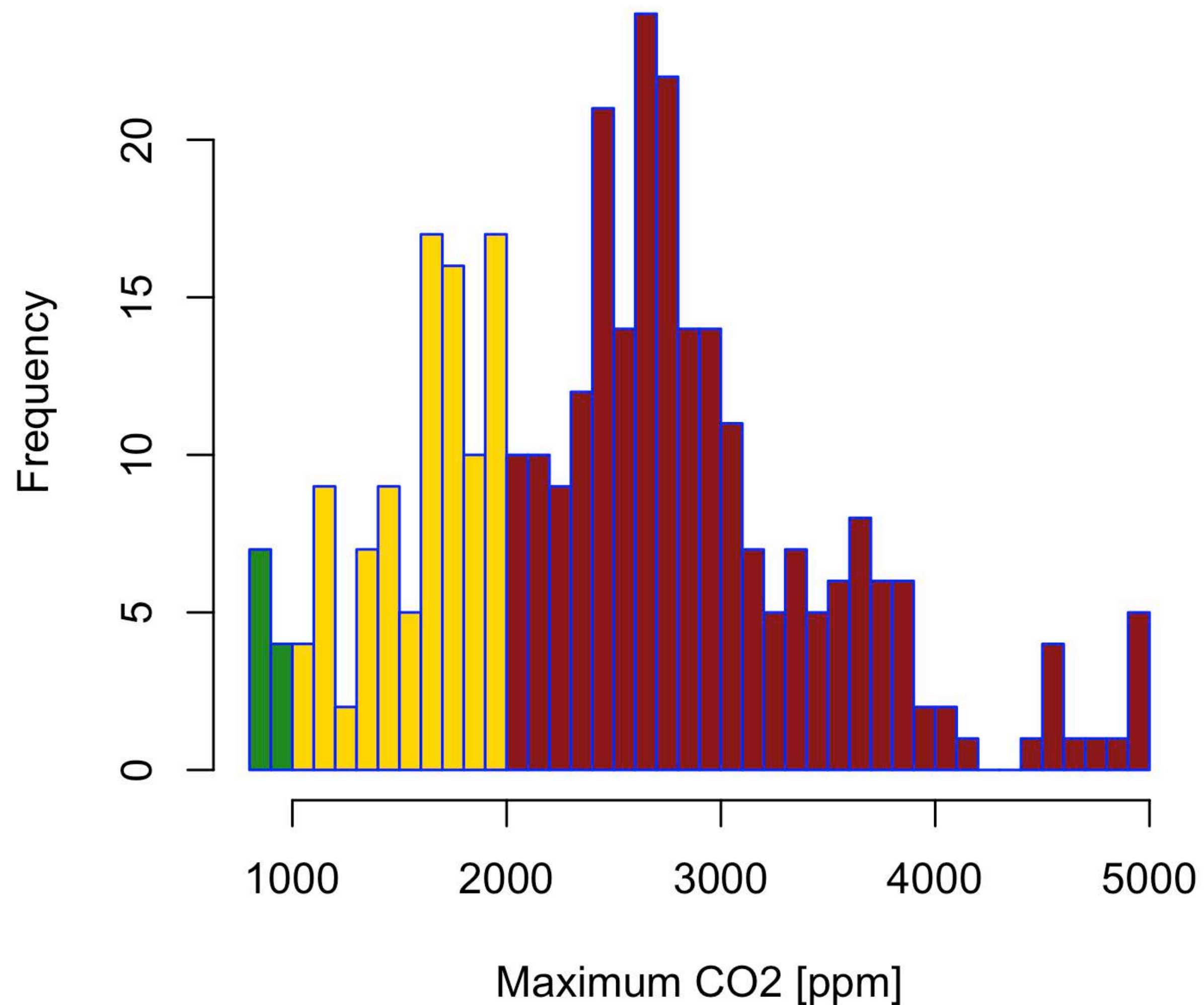
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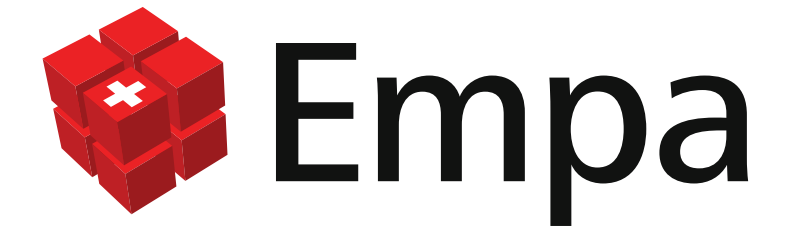


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Most authoritative references converge on a value of **800 to 1'000 ppm** being recommended during a pandemic (Swiss National COVID-19 Science Task Force).

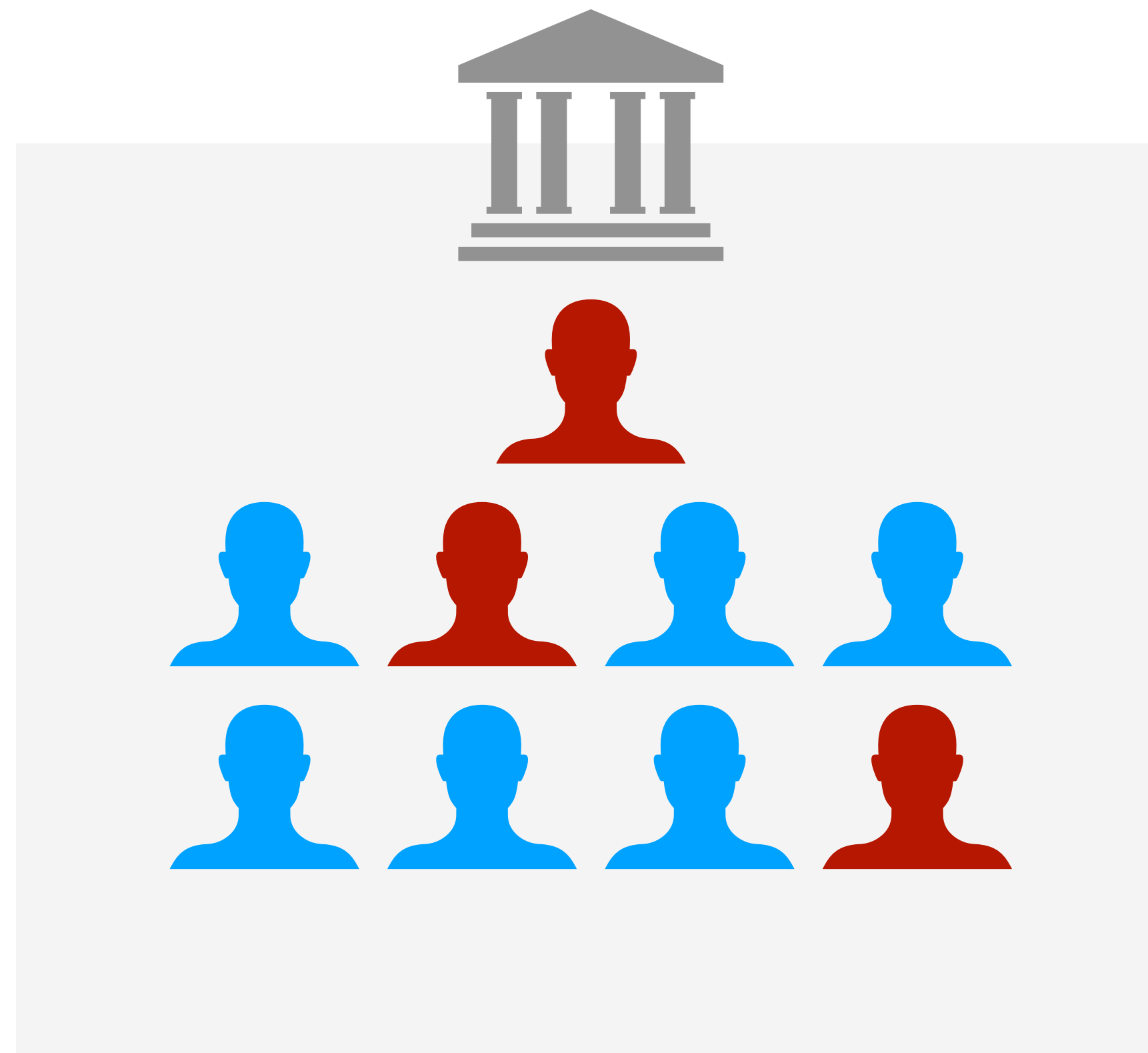
Strategy for Infection Risk Estimation



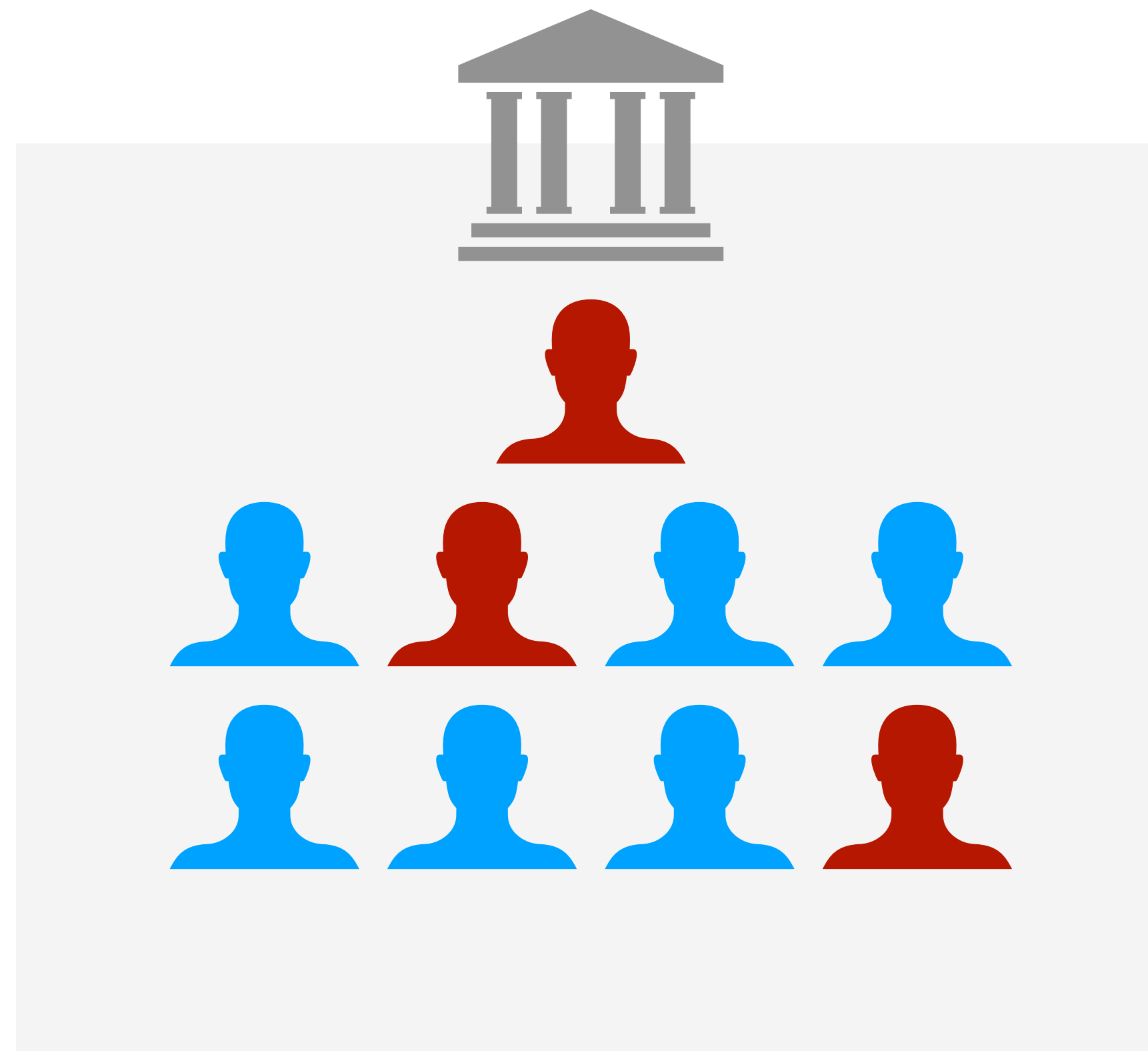
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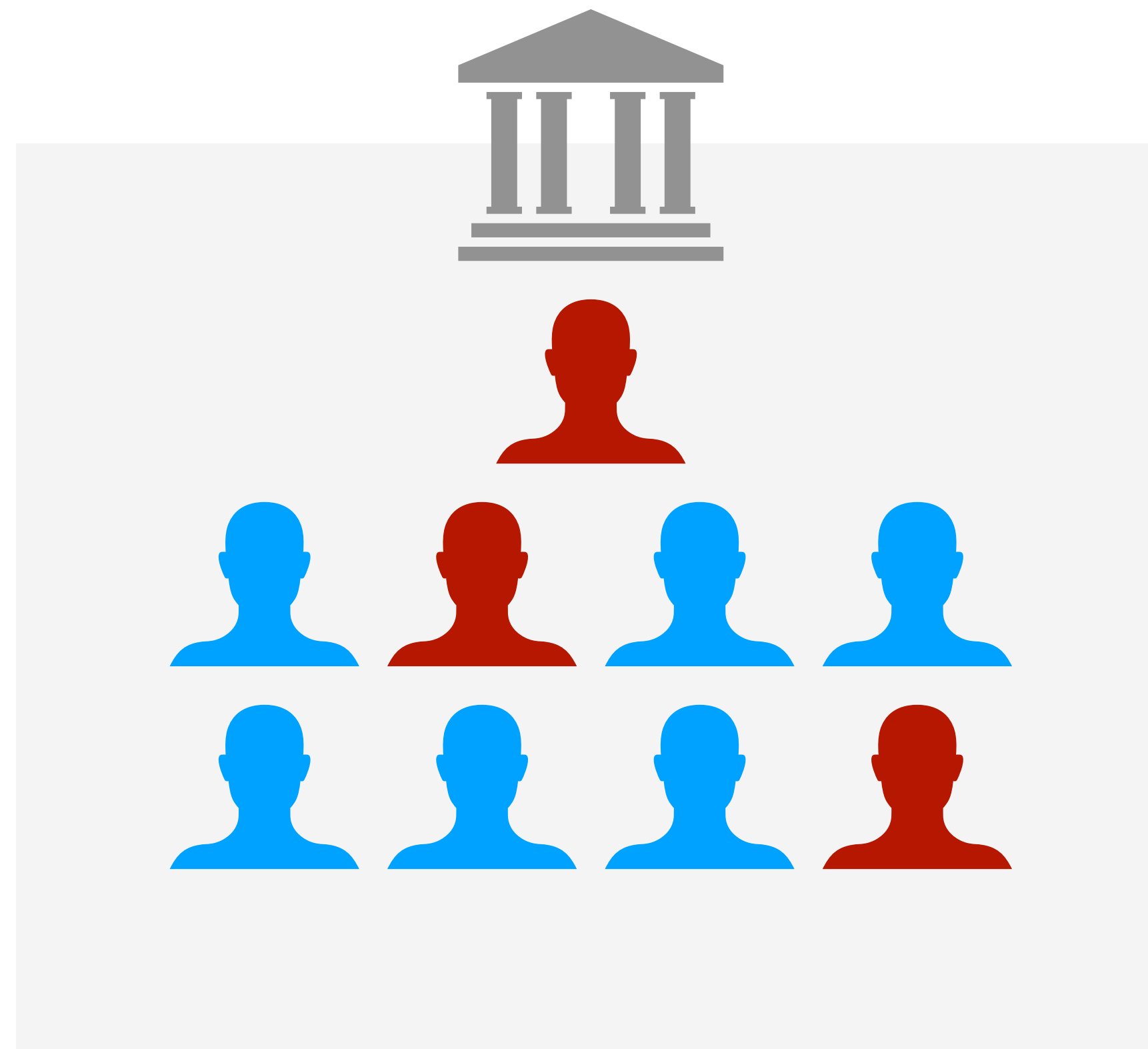


Strategy for Infection Risk Estimation



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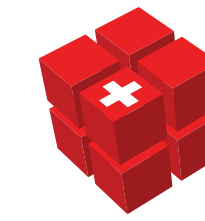
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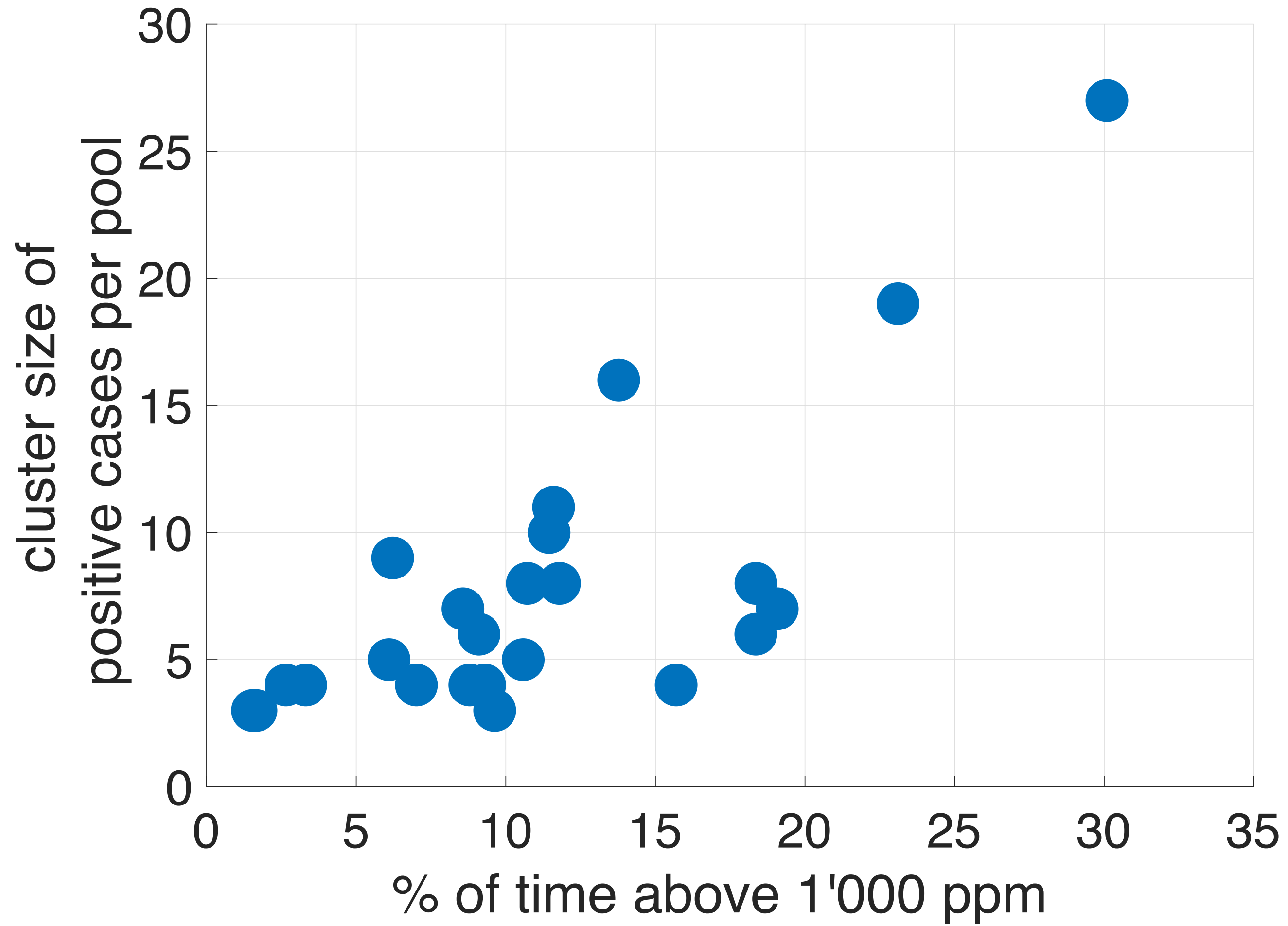
Students were tested in pools of (typically) same size, on a weekly basis. We identify positive cases in a pool as a cluster, once the number of positives, at a given time, is three or more.

Infection Risk



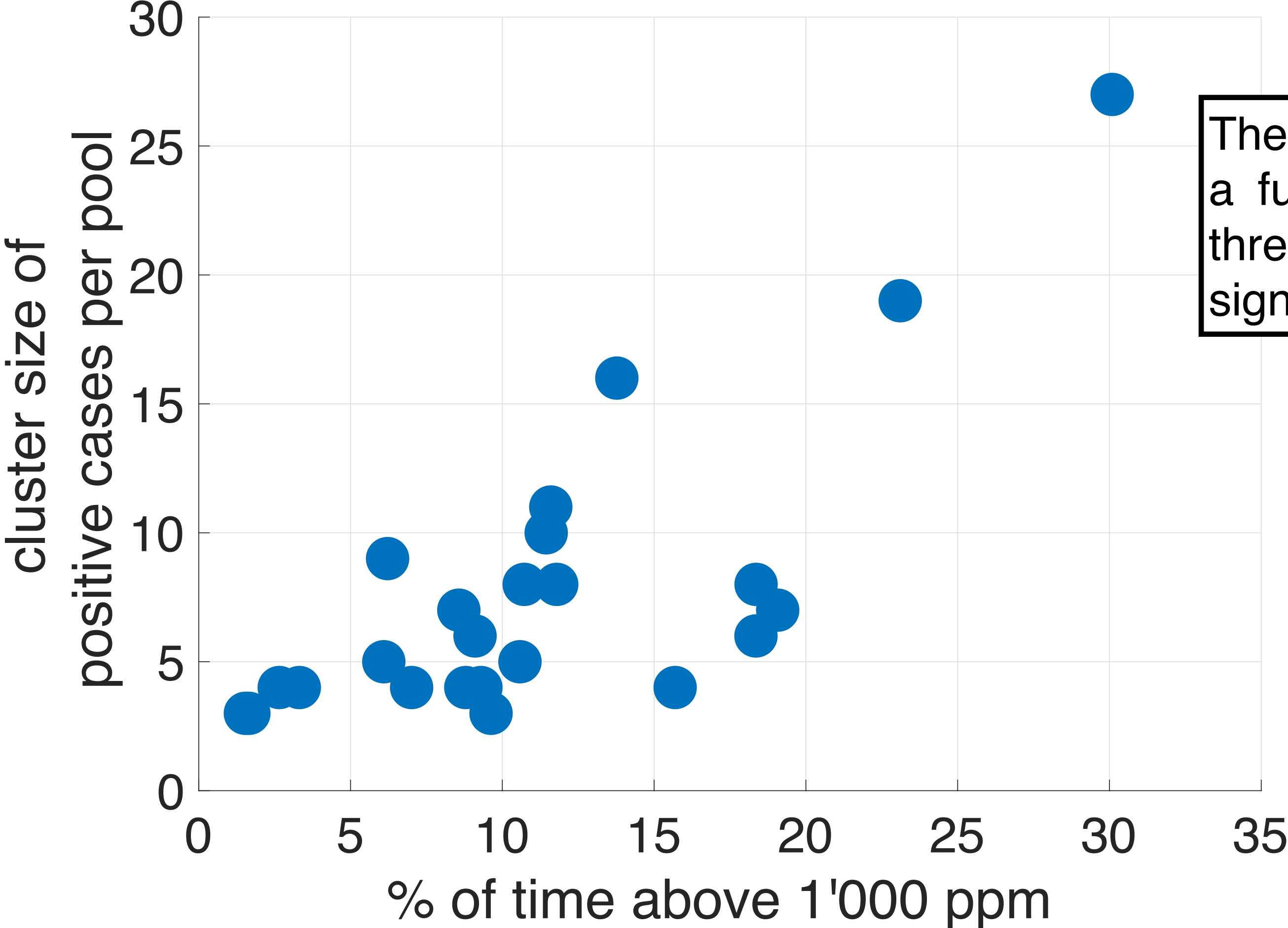
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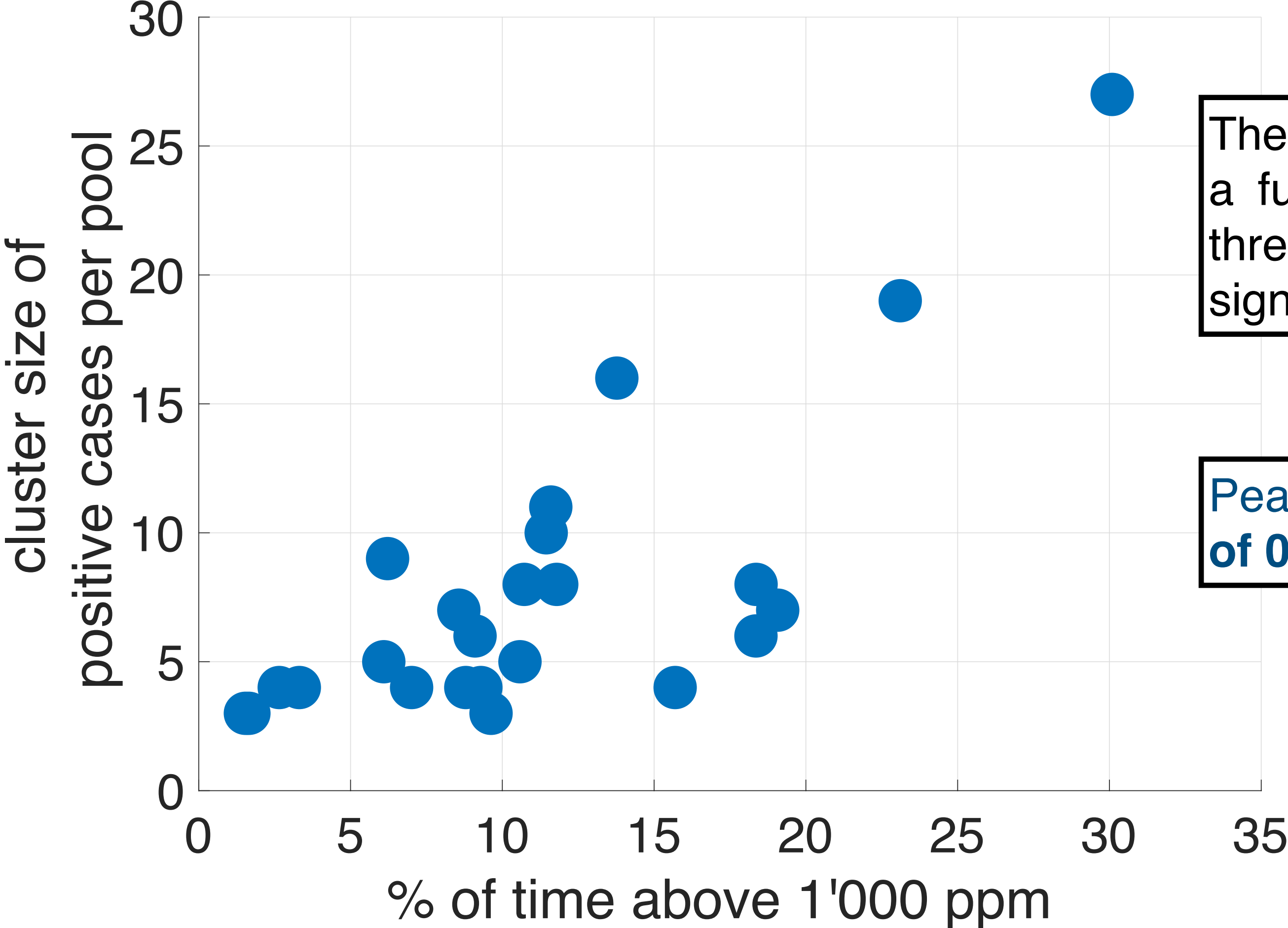
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Infection Risk



The plot shows the cluster of positive cases per pool as a function of the time duration spent above the CO₂ threshold value of 1'000 ppm. We observe statistically significant correlation between the two.

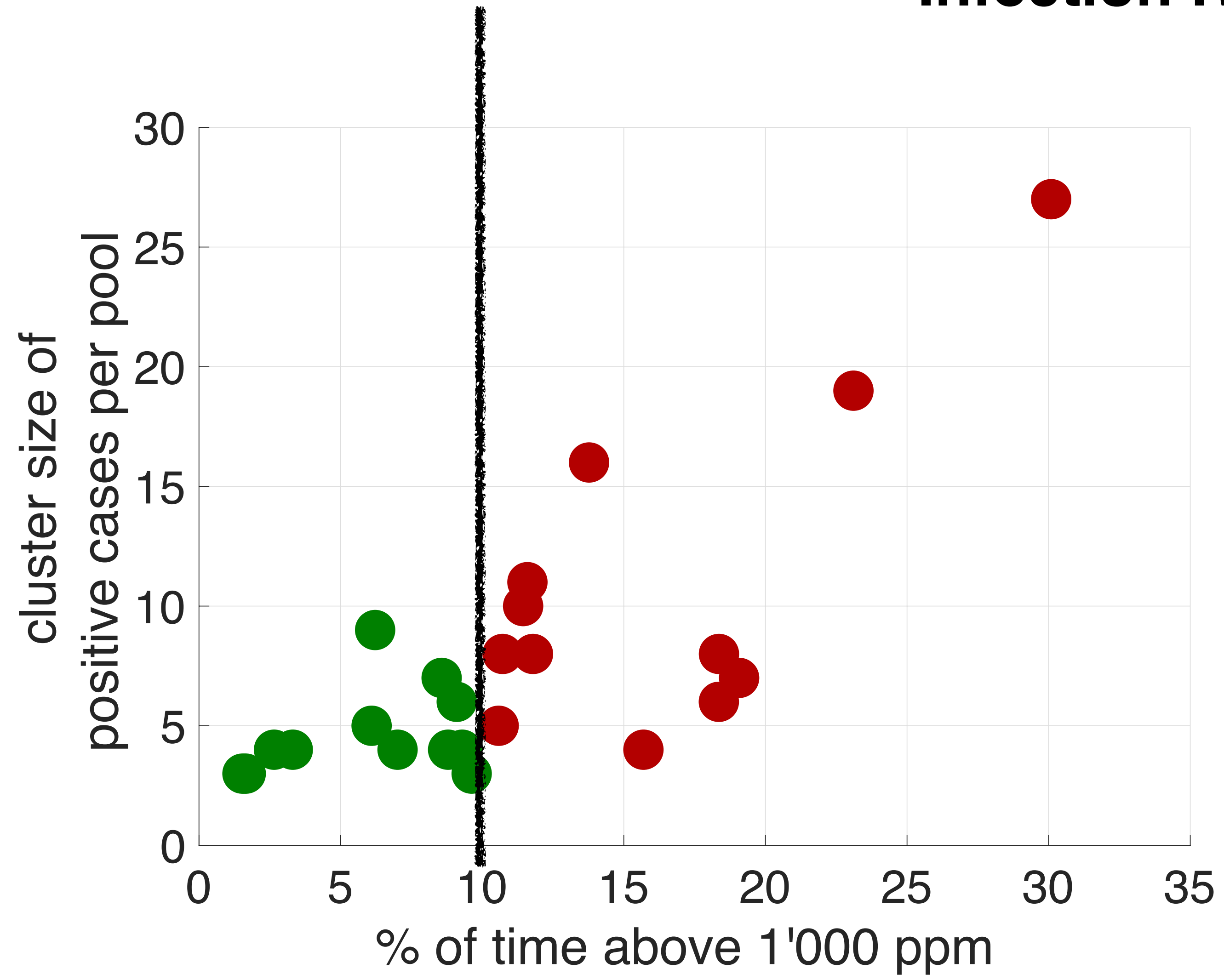
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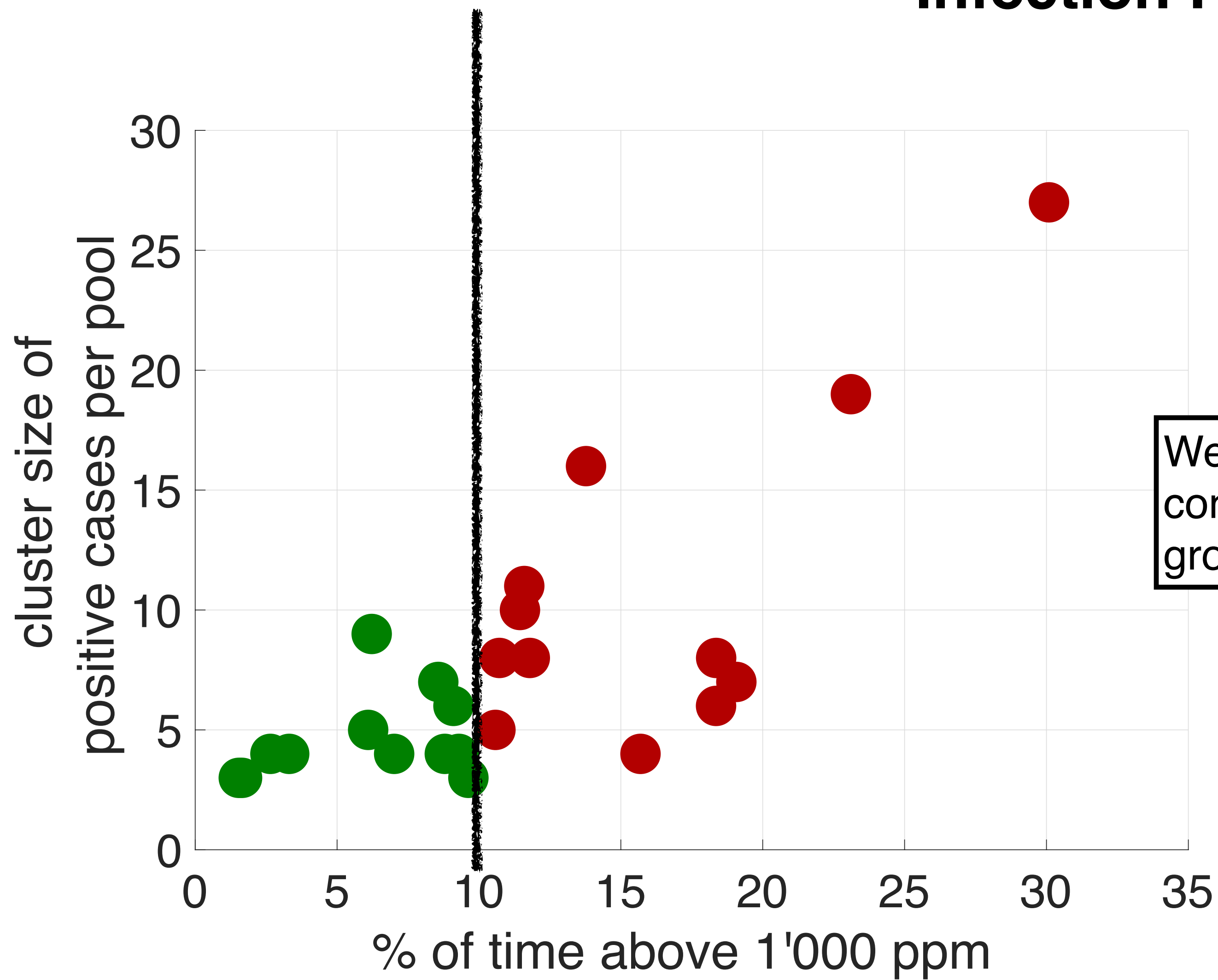
Pearson's correlation coefficient of **R=0.76** and **p value of 0.000016** are estimated.

Infection Risk



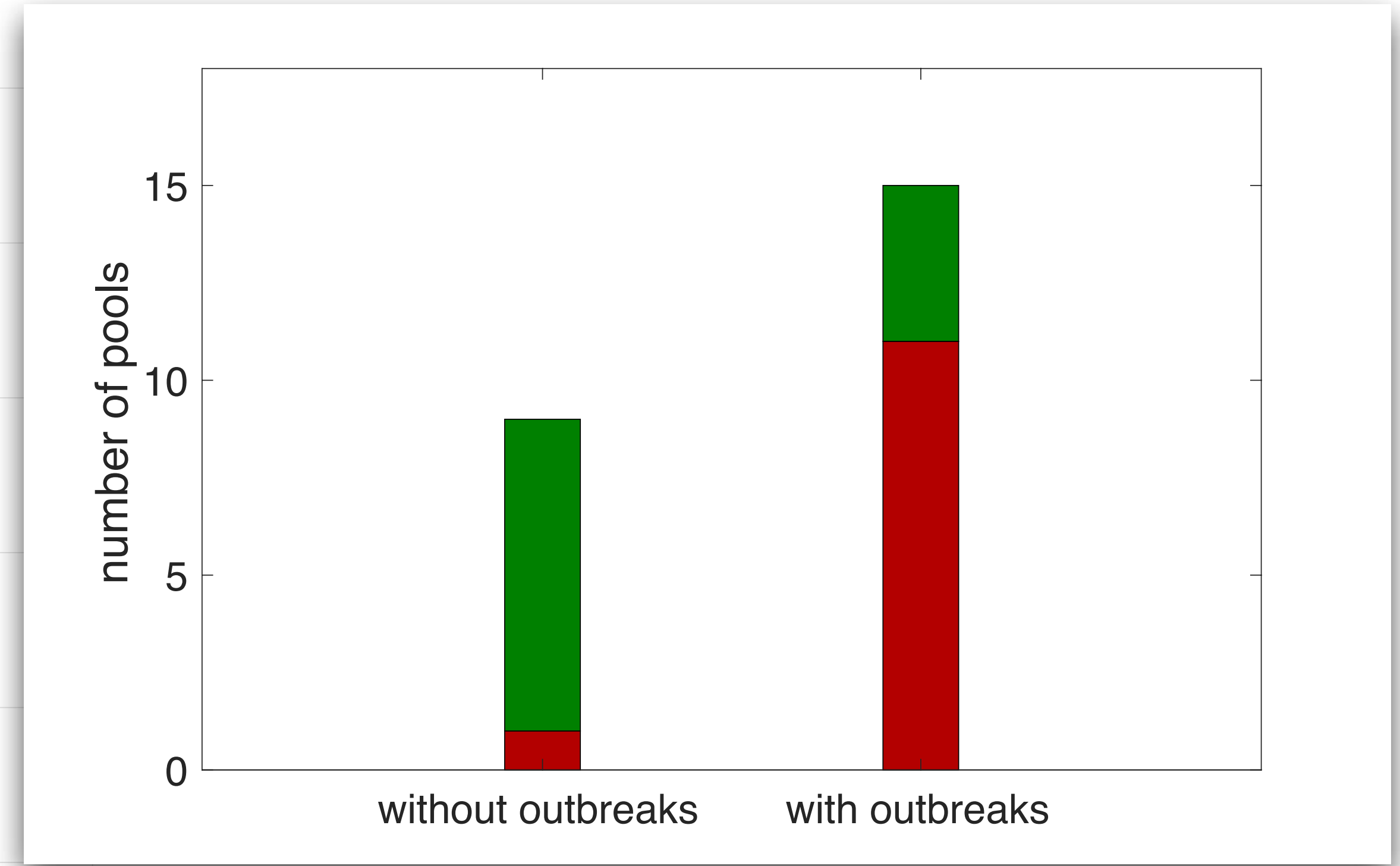
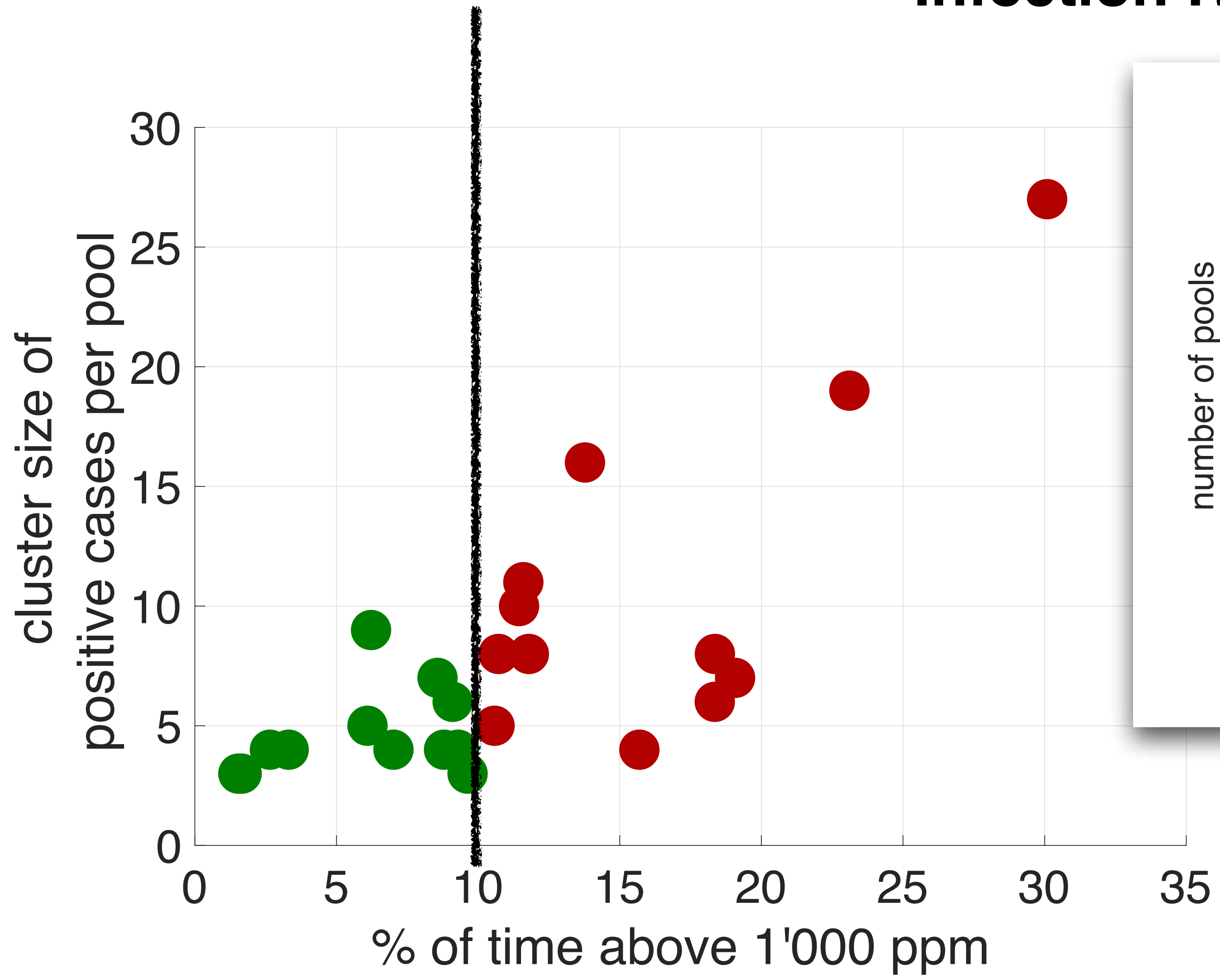
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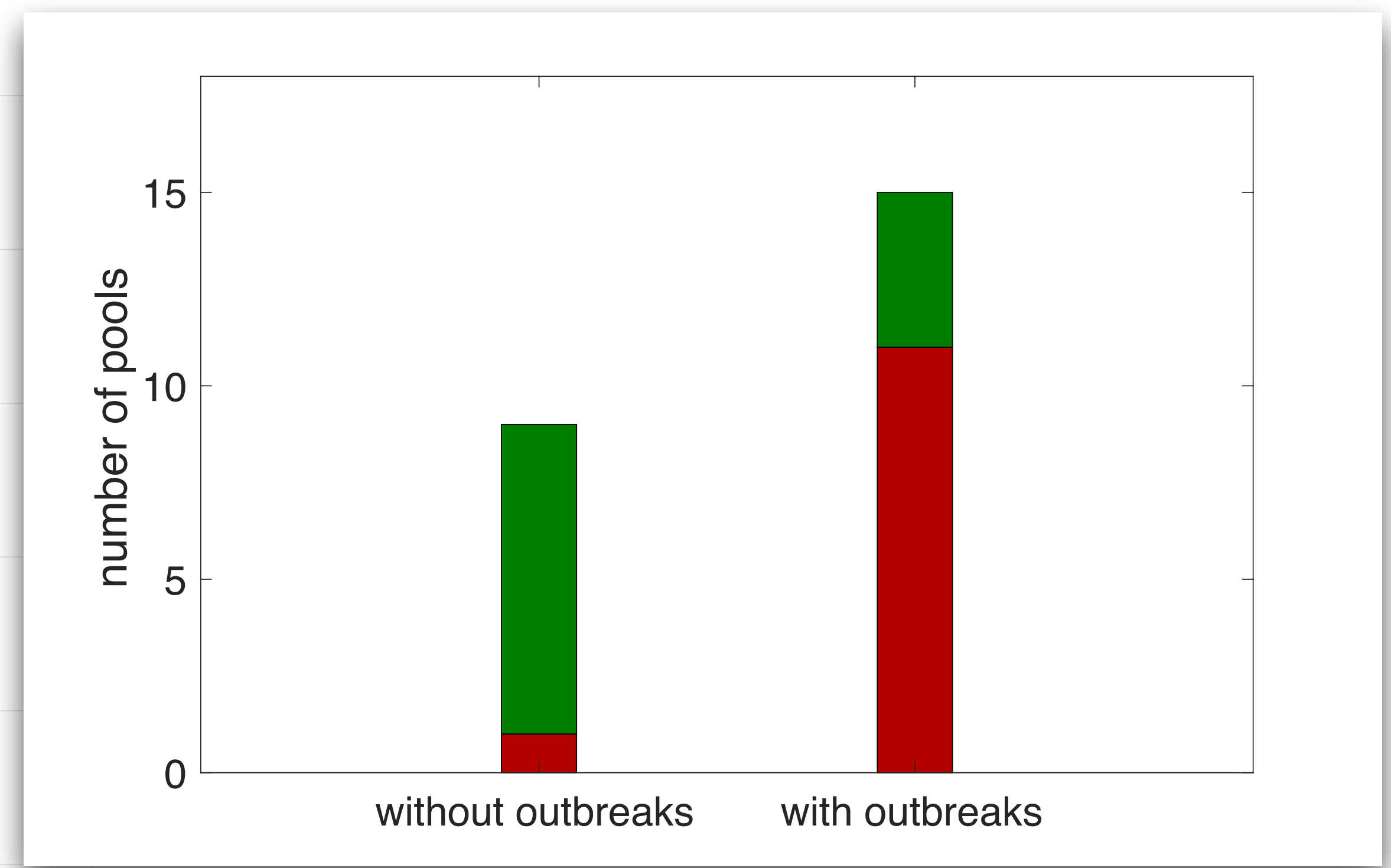
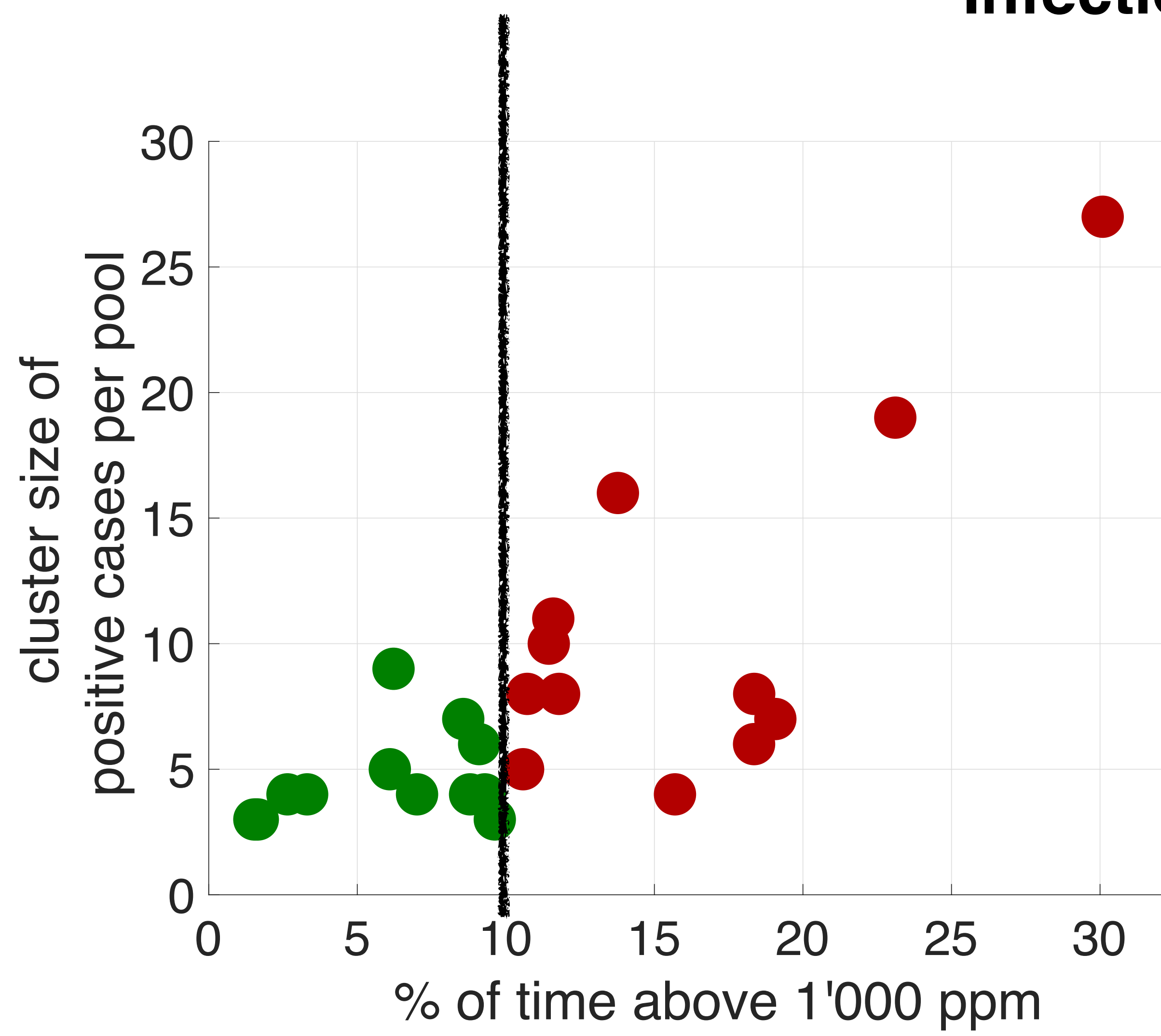


We split the schools with respect to their CO₂ concentration. We perform statistical tests on the two groups.

Infection Risk



Infection Risk



The risk of outbreak (cluster size larger than 4) is found to be **63% lower** in schools with better ventilation (green). The **p-value is 0.0048** (Wald test).

Comparison with Other Studies

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From spontaneous to strategic natural window ventilation: Improving indoor air quality in Swiss schools

Claudia C. Vassella^a, Jeremy Koch^{a,1}, Alexander Henzi^b, Alexander Jordan^{b,2}, Roger Waeber^{a,*}, Reto Iannaccone^{a,3}, Roland Charrière^a

^a Federal Office of Public Health, Consumer Protection Directorate, Indoor Pollutants Unit, CH-3003 Bern, Switzerland

^b Institute of Mathematical Statistics and Actuarial Science, University of Bern, CH-3012 Bern, Switzerland

High CO₂ values have been reported for schools in Switzerland. The **median is reported 1'600 ppm** in the control group.

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Increasing ventilation reduces SARS-CoV-2 airborne transmission in schools: A retrospective cohort study in Italy's Marche region

Giorgio Buonanno^{1,2}, Luca Ricolfi^{3,4}, Lidia Morawska² and Luca Stabile^{1*}

¹Department of Civil and Mechanical Engineering, University of Cassino and Southern Lazio, Cassino, Italy, ²International Laboratory for Air Quality and Health, Queensland University of Technology, Brisbane, QLD, Australia, ³Department of Psychology, University of Turin, Turin, Italy, ⁴David Hume Foundation, Turin, Italy

Introduction: While increasing the ventilation rate is an important measure to remove inhalable virus-laden respiratory particles and lower the risk of infection, direct validation in schools with population-based studies is far from definitive.

High CO₂ values have been reported for schools in Switzerland. The **median is reported 1'600 ppm** in the control group.

The study reports a **74% reduction in the risk of infection**, in schools with mechanical ventilation compared to the natural one, in Italy.

Conclusion & Outlook

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- There is an urgent need to improve our understanding on the link between indoor air and population-scale epidemiology: This entails coordinated efforts between different organisations of public health and education.

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- Our study points to the unacceptable CO₂ level in considered schools during heating season. This can be readily improved by interventions such as better regulating the natural ventilation, moving to mechanical ventilation, etc.

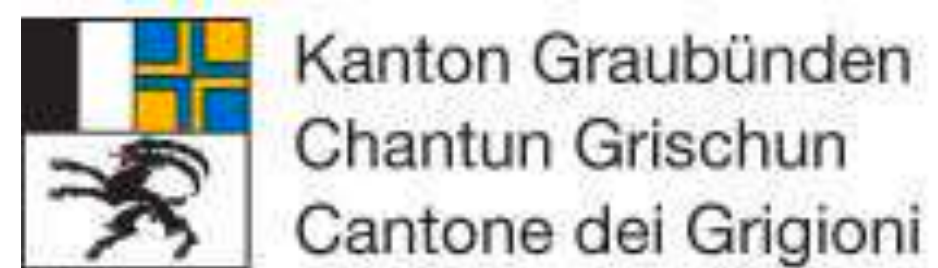
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- Our study points to the unacceptable CO₂ level in considered schools during heating season. This can be readily improved by interventions such as better regulating the natural ventilation, moving to mechanical ventilation, etc.
- Carbon dioxide sensors available on the market are useful tools to get an idea about the air exchange quality of the indoor environment. However in order to quantitatively analyse the outputs and support evidence-based policies, extra data handling modules need to be integrated and validated in the sensor devices.

Acknowledgments



Martin Bühler



Roger Vonbank



Thank you!