

Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our [Editorial Policies](#) and the [Editorial Policy Checklist](#).

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed
☐	☒ The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement
☒	☐ A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☒	☐ The statistical test(s) used AND whether they are one- or two-sided <i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i>
☒	☐ A description of all covariates tested
☒	☐ A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒ A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☒	☐ For null hypothesis testing, the test statistic (e.g. F , t , r) with confidence intervals, effect sizes, degrees of freedom and P value noted <i>Give P values as exact values whenever suitable.</i>
☐	☒ For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☒	☐ For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☒	☐ Estimates of effect sizes (e.g. Cohen's d , Pearson's r), indicating how they were calculated

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

Policy information about [availability of computer code](#)

Data collection	No software was used for data collection
Data analysis	The model was implemented in MATLAB (version R2024a) using the Statistics and Machine Learning Toolbox. The GitHub repository containing the code to reproduce the results of this study is available at https://github.com/becanfora/COVID-NL-Counterfactual .

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio [guidelines for submitting code & software](#) for further information.

Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our [policy](#)

The raw contact data used in this study are freely available at Zenodo: [\url{https://zenodo.org/records/10370353}](https://zenodo.org/records/10370353).
All datasets analyzed and generated in this study is available on [\url{https://github.com/becanfora/COVID-NL-Counterfactual}](https://github.com/becanfora/COVID-NL-Counterfactual) [\cite{canfora2024code}](#), with the exception of the raw data on train mobility, which was obtained under a confidentiality agreement with the Dutch Railways (NS). However, we will include synthetic

train mobility data so all our codes can be run from this folder. Requests for train mobility data should be addressed to Jan Banninga (jan.banninga@ns.nl) from NS. The researchers only had access to fully anonymized datasets and had no access to personally identifiable information.

Research involving human participants, their data, or biological material

Policy information about studies with [human participants or human data](#). See also policy information about [sex, gender \(identity/presentation\), and sexual orientation](#) and [race, ethnicity and racism](#).

Reporting on sex and gender	Not applicable.
Reporting on race, ethnicity, or other socially relevant groupings	Not applicable.
Population characteristics	Not applicable.
Recruitment	Not applicable.
Ethics oversight	Not applicable.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☒ Life sciences ☐ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see [nature.com/documents/nr-reporting-summary-flat.pdf](https://www.nature.com/documents/nr-reporting-summary-flat.pdf)

Life sciences study design

All studies must disclose on these points even when the disclosure is negative.

Sample size	As this is a retrospective computational modeling study, the sample size (n) was not predetermined statistically, but is defined entirely by the total number of age- and region-stratified empirical data points (infections, hospitalizations, and seroprevalence) assimilated into the model per period. Based on daily data stratified by three age groups and twelve regions, the precise sample sizes are: CP1: n = 5331 (74312 infections + 74312 hospitalizations + 13 seroprevalence) CP2: n = 7632 (106312 infections + 106312 hospitalizations) CP3: n = 6120 (85312 infections + 85312 hospitalizations) CP4: n = 5688 (79312 infections + 79312 hospitalizations) These observations provided sufficient spatial and temporal resolution to accurately parameterize the models for each period, which were iteratively updated using an Ensemble Adjustment Kalman Filter with 300 ensemble members.
Data exclusions	No data were excluded from the analyses.
Replication	Not applicable. No experiment was performed for this study. Replication is not relevant for a mathematical modeling study.
Randomization	Not applicable. No experiment was performed for this study. Randomization is not relevant for a mathematical modeling study.
Blinding	Not applicable. No experiment was performed for this study. Blinding is not relevant for a mathematical modeling study.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involvement in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☒	☐ Clinical data
☒	☐ Dual use research of concern
☒	☐ Plants

Methods

n/a	Involvement in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Plants

Seed stocks

Not applicable.

Novel plant genotypes

Not applicable.

Authentication

Not applicable.