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Public Health and Social Measures: Filling the Knowledge Gap

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Why does it matter?

- National Public Health Institutes provide strategic information to policy makers during public health emergencies
  - COVID-19 pandemic one example
- The Robert Koch Institute: multiple-layers model
  - Monitoring of the epidemiological situation
  - Analysis of containment measures
  - Secondary data analysis
  - Review, evaluation, and synthesis of published evidence
- Information was extensively used and contributed to decision-making

But...

- Dynamic pandemic situation means:
- Need for evidence paralleling the dynamic situation

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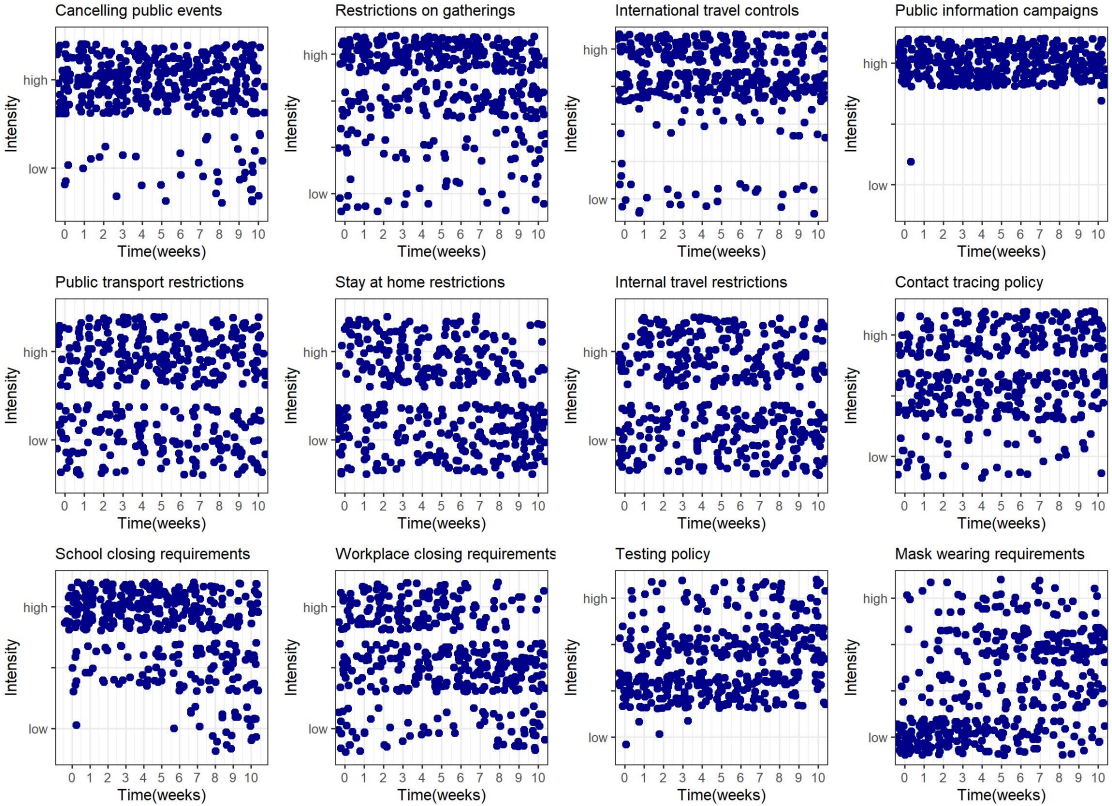
  - **Secondary data analysis**
  - **Review, evaluation, and synthesis of published evidence**

Effectiveness and comparative effectiveness of non-pharmaceutical interventions

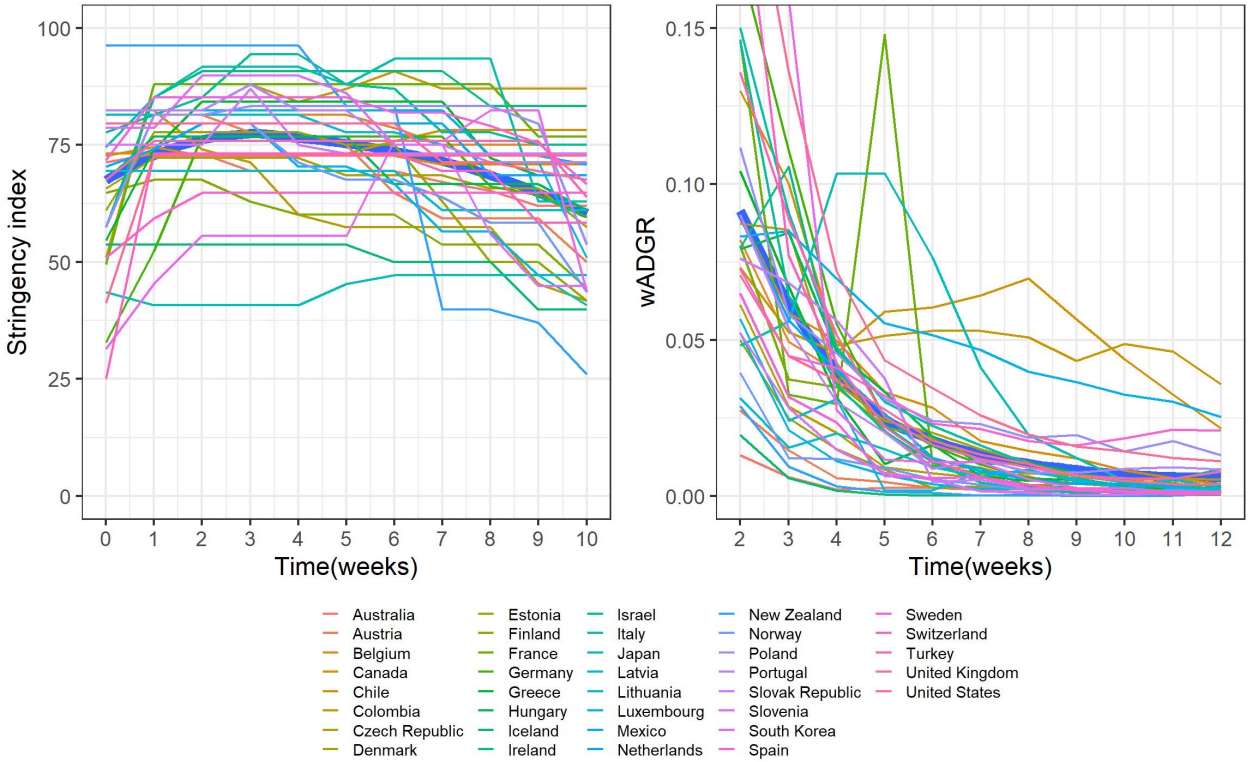
The impact of non-pharmaceutical interventions (NPIs) on COVID-19 epidemic growth in the 37 OECD member states

- Impact of a broad set of NPIs on epidemic growth
- Data from international COVID-19 policy trackers
- Multilevel longitudinal analysis
- Several model estimation procedures

Implementation of the policies over time in 37 OECD countries (1st wave)



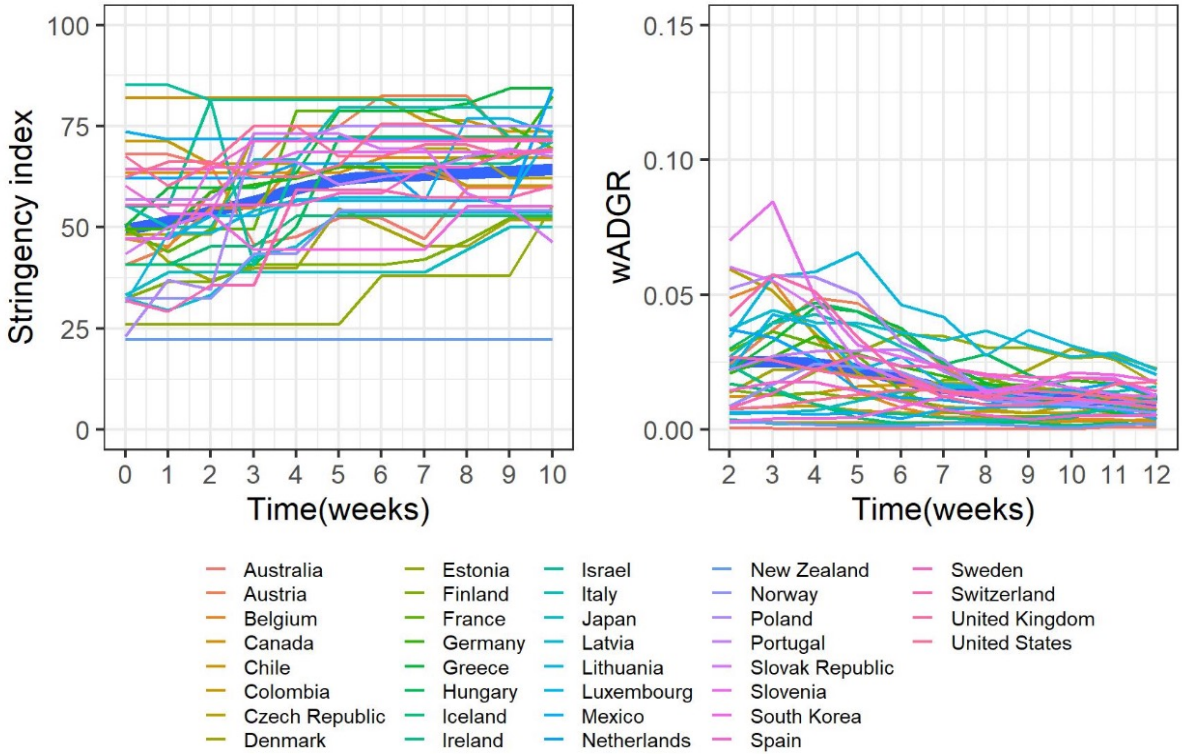
Intensity of policies over time/ epidemic growth, 1st wave



Intensity of policies over time/ epidemic growth, 1st wave

- Restriction on gatherings
- Work closing requirements
- School closing requirements
- Mask wearing requirements
- Number of COVID-19 test per 1000 pop

Things did not go the same way for the 2nd wave



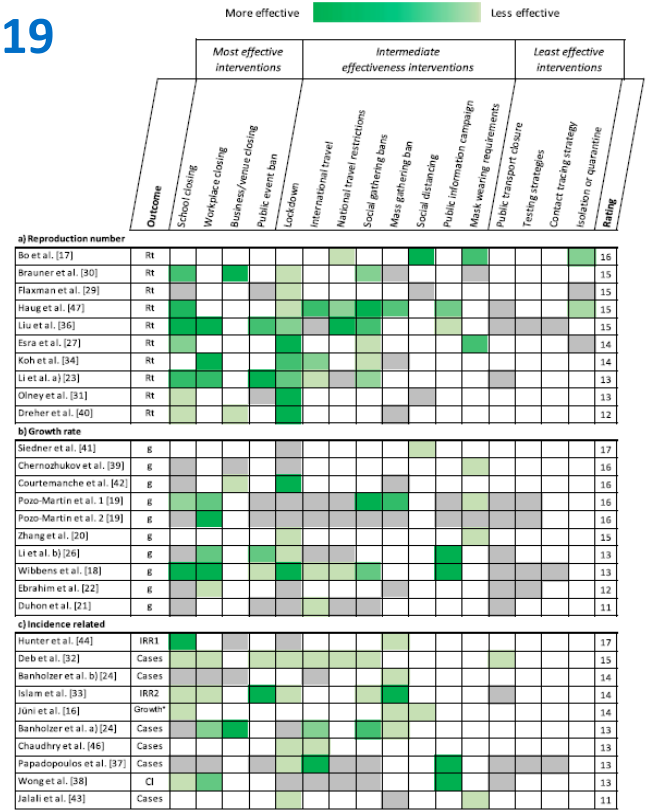
Things did not go the same way for the 2nd wave

- Work closing requirements remained solid
- Testing policies were significant predictors of an increase in epidemic growth
- All others did not seem to have an impact

Systematic review of empirical studies comparing the effectiveness of non-pharmaceutical interventions (NPIs) against COVID-19

- Systematic review (peer-reviewed and not peer-reviewed literature)
- Up to April 2021
- Any empirical studies comparing the effectiveness (in terms of morbidity or mortality) of at least two NPIs in any geographical setting
- Assessed and ranked 34 papers by quality using risk of bias tools:

1. School closing, work closing, public events bans were the most effective interventions
2. Public information campaigns and mask wearing requirements were also effective interventions
3. There was no evidence of the effectiveness of public transport closures, testing strategies, contact tracing, isolation and quarantine



Mendez-Brito A, El Bcheraoui C, Pozo-Martin F. Systematic review of empirical studies comparing the effectiveness of non-pharmaceutical interventions against COVID-19. Journal of Infection. 2021;83(3):281-93.

What's the role of NPHIs?

- Provision of strategic information to policy makers during public health emergencies
- Scoping review shows that research is often not a mandate in NPHIs (Myhre *et al.* 2021)
  - "NPHIs work collaboratively with international organisations, academia, NGOs, and engage in collaborative relationships with sister institutes on research projects"
- Evidence review around the pact for Pandemic Readiness
  - Public health emergency workforce is limited
  - Availability vs competence
- Research is prioritized but funding targets solution pills/shots

NPIs/Social measures are complex interventions

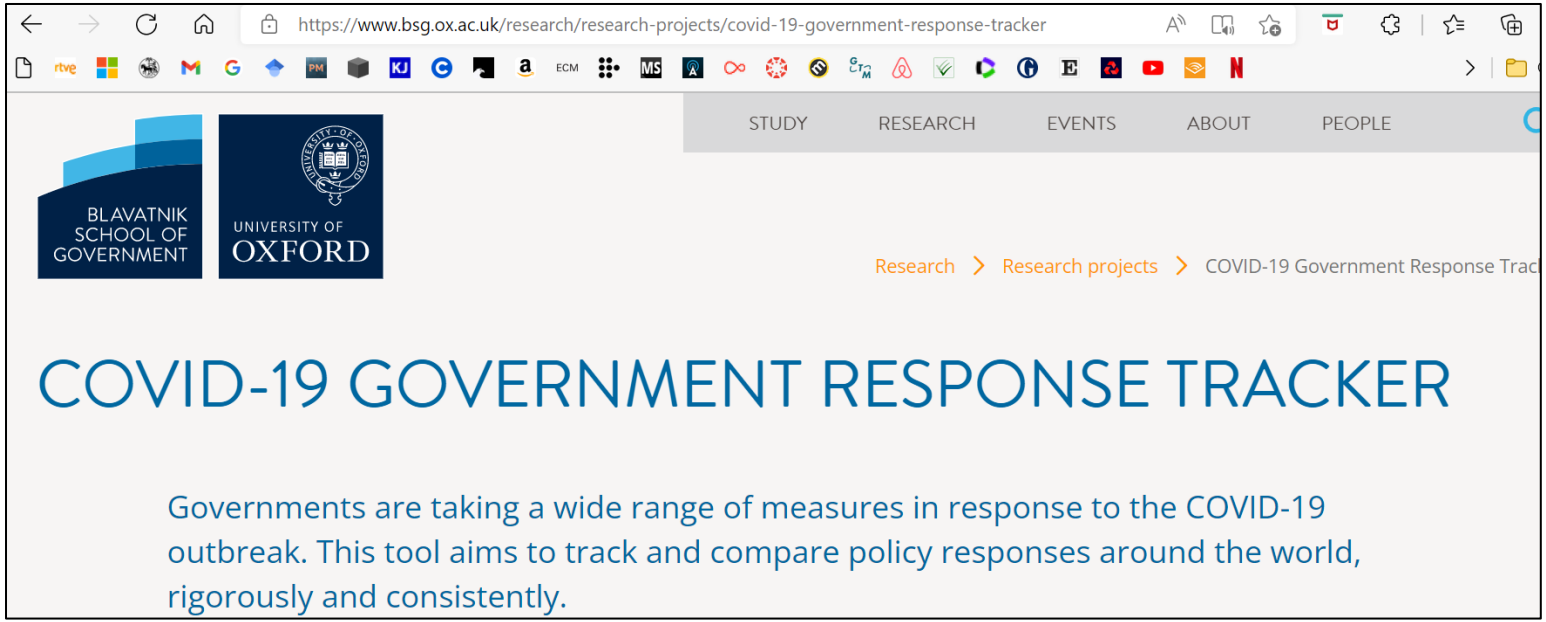
- Mostly observational studies
- By August 2021 (Hirt *et al.* 2022)
  - <41 RCTs for NPIs (>4000 for pharmaceutical interventions)
- Public health research is a core function of NPHIs
  - Evaluate public health interventions

NPIs/Social measures are complex interventions

- Mostly observational studies
- By August 2021 (Hirt *et al.* 2022)
  - <41 RCTs for NPIs (>4000 for pharmaceutical interventions)
- Public health research is a core function of NPHIs
  - Evaluate public health interventions
- Evaluating NPIs through pure RCTs is not enough (UK Medical Research Council, 2021)
  - How does the intervention interact with its context?
  - What is the underpinning program theory?
  - How can diverse stakeholder perspectives be included in the research?
  - What are the key uncertainties?
  - How can the intervention be refined?
  - What are the comparative resource and outcome consequences of the intervention?

Extra slides

Main source* of data for intensity of NPIs over time:



*Except for mask wearing requirements

Methods: Longitudinal analysis

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Policy regressors = intensity of…

1. School closing requirements
2. Workplace closing requirements
3. Cancelling of public events
4. Restrictions on gatherings
5. Public transport restrictions
6. Stay at home requirements
7. Internal travel restrictions
8. Public information campaigns
9. Mask wearing requirements
10. Testing policy*
11. Contact tracing policy

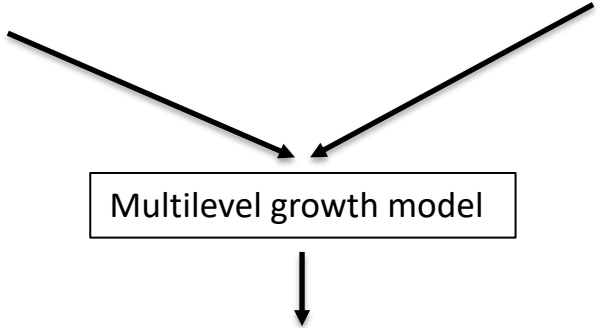
\+

Delay in policy implementation

STRINGENCY INDEX

Control variables:

1. Sociodemographic Index
2. GDP per capita (PPP)
3. % of population living in urban areas
4. % of total GDP spent in health
5. Average size of household
6. Palma ratio (measure of inequality)
7. Democracy index
8. Temperature



*Proxy variable: Total number of PCR tests per thousand population

***Calculation of the average daily growth rate in the cumulative number of weekly cases (wADGR).**

The average daily growth rate in the cumulative number of weekly cases (wADGR) is expressed as:

$N_t = (N_{t-1})(1 + wADGR_t)^7$,

where N_t is the cumulative number of cases at the end of week *t* and N_{t-1} is the cumulative number of cases at the end of week *t-1*. Solving for wADGR:

$$(N_t/N_{t-1}) = (1 + wADGR_t)^7 ;$$

$$1 + wADGR_t = \sqrt[7]{(N_t/N_{t-1})} ;$$

$$wADGR_t = \sqrt[7]{(N_t/N_{t-1})} - 1$$

To illustrate with an example, if at the end of the fourth week of the epidemic there are 250 cases ($N_4 = 250$) and at the end of the fifth week of the epidemic there are 300 cases ($N_5 = 300$):

$$wADGR_5 = \sqrt[7]{(N_5/N_4)} - 1;$$

$$wADGR_5 = \sqrt[7]{(300/250)} - 1 = 0.026 = 2.6\%$$

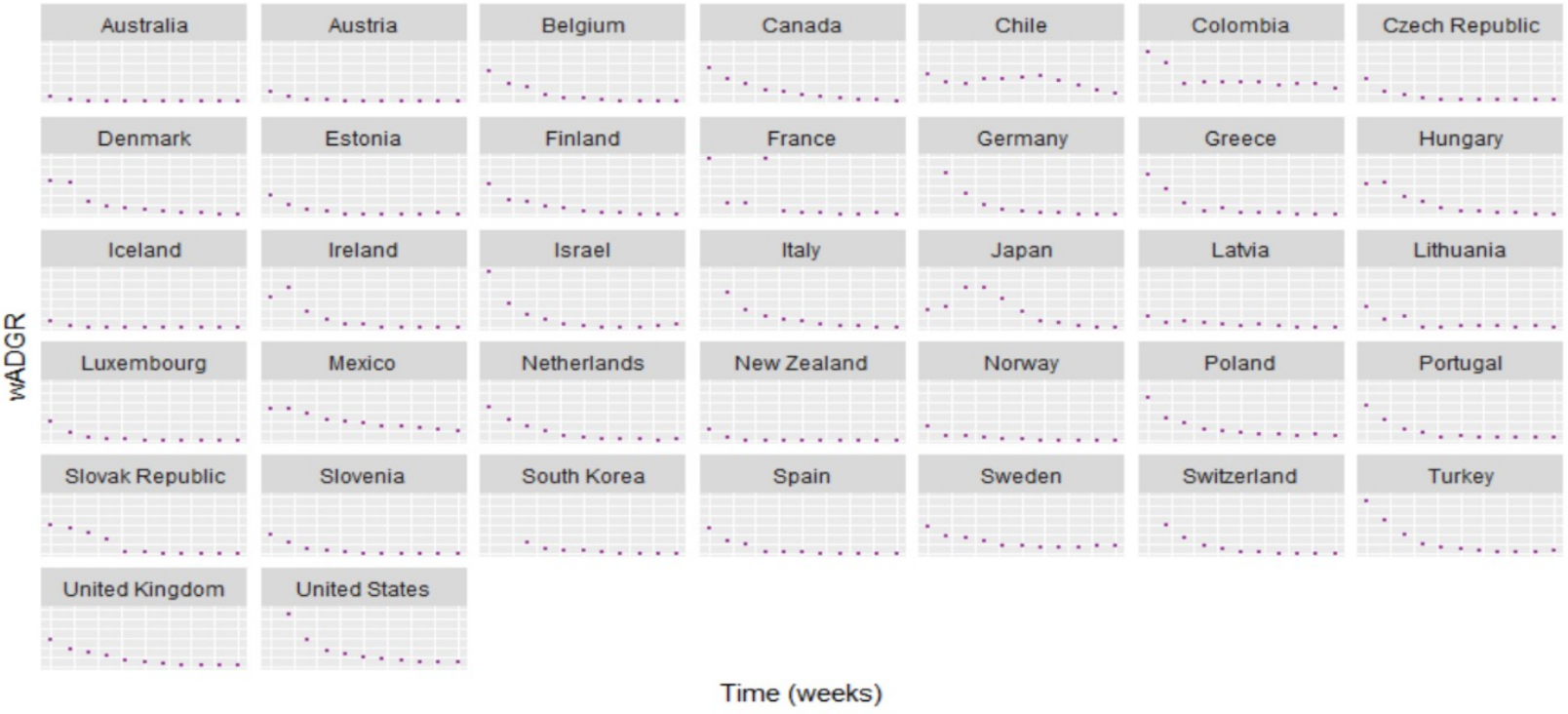
The average daily growth rate in the cumulative number of cases in week 5 is 2.6%.

Intensity of NPIs is measured on a categorical ordinal scale:

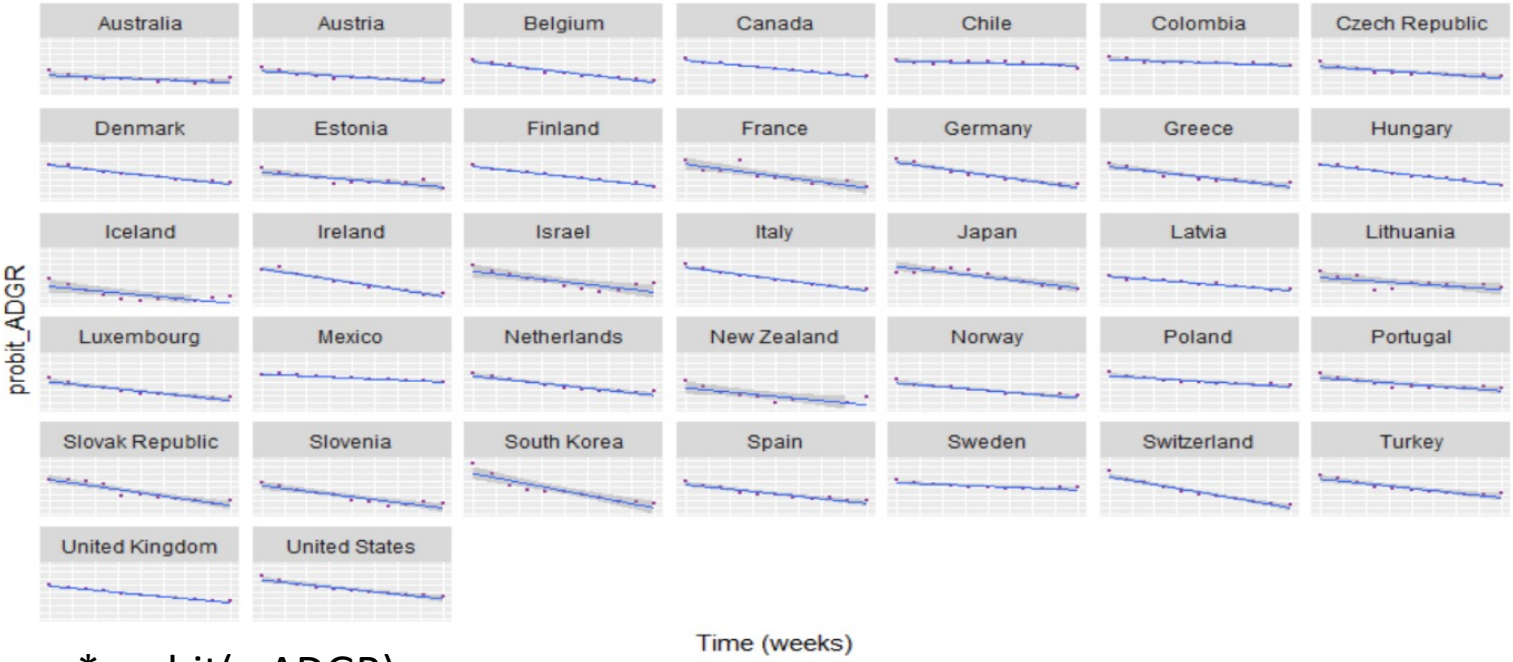
School closing requirements	0 - No measures or recommend closing 2 - Require closing (only some levels or categories, e.g. just high school, or just public schools) 3 - Require closing all levels
Workplace closing requirements	0 - No measures or recommend closing (or work from home) 2 - require closing (or work from home) for some sectors or categories of workers 3 - require closing (or work from home) all-but-essential workplaces (e.g. grocery stores, doctors)
Public events cancelling requirements	0 – No measures or recommend cancelling 2 – Require cancelling
Restrictions on gatherings	0 - No restrictions 1 - Restrictions on gatherings of more than 100 people 2 - Restrictions on gatherings of between 11 and 100 people 3 – Restrictions on gatherings of 10 people or less
Public transport restrictions	0 – No measures 1 – Recommend closing (or significantly reduce volume/ route/ means of transport available) or require closing (or prohibit most citizens from using it)

Stay at home requirements	0 – No measures or recommend not leaving house 1 - require not leaving house with exceptions for daily exercise, grocery shopping, and 'essential' trips or require not leaving house with minimal exceptions (e.g. allowed to leave only once a week, or only one person can leave at a time, etc.)
Restrictions on internal movement	0 – No measures or recommend not to travel between regions/ cities 2 – internal movement restrictions in place
International travel controls	0 - No measures 1 - Screening 2 - Quarantine arrivals from high-risk regions 3 - Ban on arrivals from some regions 4 - Ban on all regions or total border closure
Public health information campaigns	0 -No COVID-19 public information Campaign 1 - public officials urging caution about COVID-19 2 - coordinated public information campaign (e.g. across traditional and social media)

Changes in the wADGR over time (1st wave)



First approach: linearise the wADGR* and use linear mixed effects longitudinal model



*probit(wADGR)

Multilevel growth model

Linear mixed model for longitudinal data with probit (wADGR) as outcome:

[NPI coefficients not so easy to interpret] !!!

We decided to use another model:
Beta regression generalised linear mixed model with a probit link function.
Outcome: ADGR.

Allows for the calculation of the average marginal effects (AME), the average reduction in the growth rate that is attributable to the effect of each policy

Results (initial phase): Final model results

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Results from mGLMM		Average Marginal Effects
Regressors	**Coefficients (95%CI)**	
- Intercept	-0.46 (-0.71, -0.21)	
- Time	-0.13 (-0.15, -0.11)	
- Restrictions on gatherings: gatherings of more than 100 people not permitted	-0.35 (-0.51, -0.19)	-2.58%
- Restrictions on gatherings: gatherings of between 11 and 100 people not permitted	-0. 39 (-0.54, -0.34)	-2.78%
- Restrictions on gatherings: gatherings of fewer than 10 people not permitted	-0.39 (-0.42, -0.27)	-2.81%
- Workplace closing: require closing (or work from home) for some sectors or categories of workers	-0.24 (-0.34, -0.13)	-1.51%
- Workplace closing: require closing (or work from home) of all-but-essential workplaces (e.g. grocery stores, doctors)	-0.29 (-0.40, -0.18)	-1.78%
- School closing: require closing of only some levels or categories, e.g. just high school, or just public schools	-0.16 (-0.30, -0.02)	-1.12%
- School closing: require closing of all levels	-0.25 (-0.40, -0.11)	-1.65%
- Mask-wearing: recommended	-0.08 (-0.18, 0.01)	-0.45%
- Mask-wearing: required in specific public places country-wide or in specific geographical areas	-0.08 (-0.15, -0.005)	-0.44%
- Mask-wearing: required country-wide in all public places or in all public places where social distancing is not possible	-0.19 (-0.32, -0.07)	-0.96%
- Total number of tests performed per thousand population	-0.004 (-0.007, -0.001)	-0.02%

Results (Oct-Dec 2020): Final model results

Results from mGLMM		Average Marginal Effects
Regressors	**Coefficients (95%CI)**	
- Intercept	-1.38 (-1.90, -0.74)	
- Time	-0.03 (-0.05, -0.02)	
- Workplace closing: require closing (or work from home) for some sectors or categories of workers	-0.01 (-0.06, 0.05)	-0.03%
- Workplace closing: require closing (or work from home) of all-but-essential workplaces (e.g. grocery stores, doctors)	-0.18 (-0.25,-0.11)	-0.66%
- Testing anyone showing COVID-19 symptoms	0.28 (0.16, 0.39)	0.89%
- Open public testing (e.g. “drive through” testing available to asymptomatic people	0.26 (0.12, 0.40)	0.83%
- Percentage of total population living in urban areas	-0.01 (-0.020, -0.004)	-0.05%

- https://www.med.uio.no/helsam/english/research/projects/Covid-19-Research-Non-Pharmaceutical-Interventions/
- https://www.tandfonline.com/doi/full/10.1080/17441692.2021.1910966

Effectiveness of contact tracing interventions in the context of the COVID-19 pandemic: a systematic review*

- Systematic review of literature until 06/21
- Any empirical or mathematical modelling study comparing the effectiveness in terms of health outcomes (morbidity/ mortality) of at least two contact tracing interventions
- Assessed and ranked 76 papers by quality using both existing and novel risk of bias tools

Evidence from empirical studies	Evidence from mathematical modelling studies
1. Ecological studies show: - no impact of contact tracing when compared to other NPIs (such as restrictions on gatherings or workplace closing) 2. Retrospective cohort studies show that: - Contact tracing can be more effective than symptomatic surveillance - digital contact tracing can be more effective than manual contact tracing	Some elements which can aid the success of contact tracing include: 1. In reopening scenarios, contact tracing with high coverage accompanied by limited social distancing; 2. For digital contact tracing, high levels of contact tracing app adoption; 3. To avoid the negative effects of school closures, contact tracing in schools; 4. Bidirectional contact tracing 5. Contact tracing of non-household contacts and of all individual contacts