Nr.	Useful?	Source / *journal*	Authors	Publication date
1	Yes	Nature Human Behaviour	Haug et al.	Dec-2020
2	Yes	Science	Brauner et al.	15-Dec-2020
3	Yes	Nature	Askitas et al.	21-Jan-2021

4	**Yes**	MedRxiv Preprint	Patel et al.	10-Jan-2021
5	**Yes: clear paper, takes period up to June 2020 into account. NPI however are grouped in broad categories.**	BMC Medicine	Liu et al (from Centre for Math. Modelling of Infectious Diseases, London School of Hygiene & Tropical Medicine, London)	2021 (< 6 Feb 2021)

6	**Probably. Caveats of method?**	Eur J Clin Invest	Bendavid et al	24-12-2020
7	**Not very recent; confusing as both RTC, obs. studies as modelling and lab studies were included. Despite the title papers on viral resp. infections in general or influenza were included as well.**	Frontiers in Medicine	Coclite et al	12-1-2021
8	**Slightly more recent, but targeted respiratory infections in general.**	Eurosurveillance- **preprint already summarized, search updated until June 19.**	Brainard et al	10/12/20

9	**Not very new. I wonder whether predictions were right.**	Mathematical Biosciences	Ngonghala et al	18-Aug-20
10	**Not included in summary because of repetition of similar papers**	Plos One	Wibbens et al.	29-Dec-2020
11	Yes. Earlier lockdown (6 pm) seemed to lead to more infections than lockdown at 8 pm.	J Infection	Dimeglio et al	4 Feb 2021

12	Yes. With lockdown and night curfew the total number of infections remained the same, with increasing transmission in households.	Acta Biomed	Signorelli et al	<4 Feb 2021
13	Yes. Here curfew and lockdown did reduce infections.	Eurosurveillance / Rapid communication	Spaccaferri et al	17 Dec 2020
14	Slightly, confirmation of what is known.	Pediatr Infect Dis J	Kuitunen et al	18 June 2020
15	Yes. Infection prevention measures at school may not be very effective, at least what appears from rhinovirus surge after lifting lockdown.	Lancet Respiratory Medicine	Poole et al	22 Oct 2020
16	Yes. When including studies with zero events in both arms results are different.	J Clin Epidemiology	Xiao et al	27 Jan 2021

Title	DOI	Aim paper
Ranking the effectiveness of worldwide COVID-19 government interventions	https://doi.org/10.1038/s41562-020-01009-0	To quantify the impact of 6,068 hierarchically coded NPIs implemented in 79 territories on the effective reproduction number, Rt, of COVID-19
Inferring the effectiveness of government interventions against COVID-19	https://doi.org/10.1126/science.abd9338	To estimate the effectiveness of NPIs, ranging from limiting gathering sizes, business closures, and closure of educational institutions to stay-at-home orders
Estimating worldwide effects of non-pharmaceutical interventions on COVID-19 incidence and population mobility patterns using a multiple-event study	https://doi.org/10.1038/s41598-021-81442-x	To study the average dynamic effect of each NPI on the incidence of COVID-19 and on people's whereabouts by developing a statistical model that accounts for the contemporaneous adoption of multiple interventions

The Joint Impact of COVID-19 Vaccination and Non-Pharmaceutical Interventions on Infections, Hospitalizations, and Mortality: An Agent-Based Simulation	https://doi.org/10.1101/2020.12.30.20248888	To simulate the comparative and joint impact of COVID-19 vaccine efficacy and coverage with and without non-pharmaceutical interventions (NPIs) on total infections, hospitalizations, and deaths
The impact of **non-pharmaceutical interventions** on SARS-CoV-2 transmission across 130 countries and territories	https://doi.org/10.1186/s12916-020-01872-8	We estimate the effectiveness of 13 categories of NPIs in reducing SARS-CoV-2 transmission.

Assessing **mandatory stay-at-home and business closure** effects on the spread of COVID-19	https://doi.org/10.1111/eci.13484	We evaluate the effects on epidemic case growth of more restrictive NPIs (mrNPIs), above and beyond those of less-restrictive NPIs (lrNPIs).
Face mask use in the community for reducing the spread of COVID-19: a systematic review.	https://doi.org/10.3389/fmed.2020.594269	Provide evidence on the effectiveness of wearing face masks in the community to prevent SARS-CoV-2 transmission.
Community use of **face masks and similar barriers** to prevent respiratory illness such as COVID-19: a rapid scoping review		Provide evidence on the effectiveness of wearing face masks in the community to prevent resep. Illness such as SARS-CoV-2.

Could **masks** curtail the post-lockdown resurgence of COVID-19 in the US	https://doi.org/10.1016/j.mbs.2020.108452	We designed a mathematical model for addressing the key question of whether or not the universal use of face masks can halt a resurgence (and possibly avert a second wave, without having to undergo another cycle of major community lockdown) in the states of Arizona, Florida, New York and the entire US. We also predict the effect of lifting the lockdown with three scenarios: mild, moderate and high lifting (hardly a lockdown) and of increasing the percentage of testing (detection rate).
Which COVID policies are most effective? A Bayesian analysis of COVID-19 by jurisdiction	https://doi.org/10.1371/journal.pone.0244177	To report on the results of a Bayesian analysis on which policies are most important to infection control
Side effect of a 6 p.m curfew for preventing the spread of SARS-CoV-2: A modeling study from Toulouse, France	https://doi.org/10.1016/j.jinf.2021.01.021	Assess effect of stricter curfew

SARS-CoV-2 transmission in the Lombardy Region: the increase of household contagion and its implication for containment measures	10.23750/abm.v91i4.10994	This study aimed at the identification of the settings linked to SARS-CoV-2 transmission through the analysis of clusters and small outbreaks detected by the Lombardy Region surveillance system during the **second epidemic wave.**
Early assessment of the impact of mitigation measures to control COVID-19 in 22 French metropolitan areas, **October to November 2020**	10.2807/1560-7917.ES.2020.25.50.2001974	Describe possible effects of curfew and lockdown implemented to control the COVID-19 pandemic second wave in 2020.
Effect of Social Distancing Due to the COVID-19 Pandemic on the Incidence of Viral Respiratory Tract Infections in Children in Finland During Early 2020	10.1097/INF.0000000000002845	Our aim was to assess the immediate effects of national lockdown orders due to COVID-19 on pediatric emergency room (ER) visits and RTIs in hospitals and nationwide in Finland.
Physical distancing in schools for SARS-CoV-2 and the resurgence of rhinovirus	https://doi.org/10.1016/S2213-2600(20)30502-6	Evaluate lock down effect on rhinovirus incidence
Double-zero-event studies matter: a re-evaluation of physical distancing, face masks, and eye protection for preventing person-to-person transmission of COVID-19 and its policy impact	https://doi.org/10.1016/j.jclinepi.2021.01.021	Re-analysis of studies included by Chu in review, **including** studies with zero cases.

NPI	Setting
6,068 NPIs, coded on 4 levels, incl. 8 broad themes: - social distancing - travel restriction - healthcare and public health capacity - risk communication - resource allocation - case identification, contact tracing and related measures - environmental measures	79 territories worldwide
7 commonly used NPIs between the 22nd of January and the 30th of May 2020. All NPIs aimed to reduce the number of contacts within the population	34 European and seven non-European countries
i) international travel controls, ii) closure of public transport, iii) cancelation of public events, iv) restrictions on private gatherings, v) closure of schools, vi) closure of workplaces, viii) restrictions on internal movement and viii) stay-at-home requirements	175 countries worldwide

Six vaccination scenarios were simulated with NPIs (i.e., reduced mobility, school closings, face mask usage) maintained and removed during the period of vaccine distribution	State of North Carolina, USA
Almost all (13 categories). The ordered scale was converted into binary, with 2 scenarios: zero vs any effort and zero vs maximum effort. Note that these 18 NPI categories are broad, so many specific policy interventions (e.g. facial covering mandates) are not independently coded in the database.	Global

"Lock down" (mandatory stay-at-home and business closure) i.e. more restrictive NPIs, is compared with less restrictive NPI.	10 countries incl NL
Face mask use in the community (non-household setting)	
face mask use in the community (non-household setting)	

face mask use earlier implementing lock down detection rate extent of lifting lock down	USA
School closing, workplace closing, cancel public events, restrictions on gatherings, close public transport, stay-at-home requirements, restrictions on internal movement, international travel controls, public information campaigns, testing, and contact tracing	40 countries and U.S. states
6 and 8 pm curfew	Toulouse, France

Night curfew, partial closure of schools and businesses, smart working	Lombardy, Italy
curfew and lockdown	France (22 metropolitan areas)
Lockdown (school closure)	Two Finnish hospitals
Lockdown (physical distancing in schools)	Southampton hospital, UK
Face masks, eye protection, and physical distancing	

Model assumptions/effectiveness calculations

- Main results based on the Complexity Science Hub COVID-19 Control Strategies List (CCCSL); the findings were validated with two external datasets
- To estimate Rt and growth rates of the number of COVID-19 cases, time series were used of the number of confirmed COVID-19 cases in the 79 territories considered
- 4 different statistical approaches were used to quantify the impact of a NPI, M, on the reduction in Rt
- A normalized score for each NPI category is obtained by rescaling the result within each method to range between zero (least effective) and one (most effective) and then averaging this score
- Sensitivity check of the results with respect to the removal of individual continents from the analysis

- NPI implementations were recorded when the measures were implemented nationally or in most regions of a country (affecting at least three-fourths of the population)
- The effectiveness of NPIs was estimated with a Bayesian hierarchical model. Case and death data (taken from the Johns Hopkins CSSE COVID-19 Dataset) were used from each country to infer the number of new infections at each point in time, which is itself used to infer the (instantaneous) re-production number Rt over time. NPI effects were then estimated by relating the daily reproduction numbers to the active NPIs, across all days and countries
- Range of sensitivity experiments to check whether potential confounders could be falsely attributed to the observed NPIs

- Publicly available data on several NPIs, collected by the OxCGRT, was used
- The data on daily confirmed COVID-19 cases was obtained from the ECDC for each country
- A multiple-event model was used to study the causal effect of eight lockdown policies on the daily incidence of COVID-19. The sample was restricted to the set of countries that acted before the first 300 COVID-19 cases

- An agent-based stochastic network was employed with a susceptible-exposed-infectious-recovered (SEIR) framework for the transmission and progression of SARS-CoV-2 infections
- Key model assumptions include (i) only hospitalized individuals can transition to death, and (ii) only symptomatic individuals can become hospitalized
- The simulation spanned 18 months (548 days) and was calibrated and validated using the number of lab-confirmed cases and reported hospitalizations and deaths as of November 1, 2020
- In the simulations, vaccines were distributed uniformly to adults (20 years and older) over a 6-month period, independent of previous disease or age
- Limited mobility (i.e., physical distancing) was estimated with SafeGraph mobility data. Data reflected the stay-at-home order in place from March 24 to May 8, 2020 for non-essential workers as well as reductions in distancing over time
- Voluntary isolation and quarantine were also modelled, where an agent with symptomatic infection isolated at home with all members of the household until the agent recovered. Based on mobility data and computational experiments, this occurred with 60% probability initially and then decreased by 15 percentage points each week until 15%
- Face mask usage among agents began at 0% and increased at a constant rate to 70% when face masks were mandated statewide in June. Masks were assumed to reduce susceptibility to infection and infectivity to others by 50% each
- Vaccination scenarios were simulated with NPIs maintained and removed

We used panel (longitudinal) regression to estimate the effectiveness of 13 categories of NPIs in reducing SARS-CoV-2 transmission using data from January to June 2020. First, we examined the temporal association between NPIs using hierarchical cluster analyses. We then regressed the time-varying reproduction number (Rt) of COVID-19 against different NPIs. We examined different model specifications to account for the temporal lag between NPIs and changes in Rt, levels of NPI intensity, time-varying changes in NPI effect, and variable selection criteria.
We also explore whether this relationship is modulated by definitions of policy interventions and population characteristics in different countries.

The effect of an NPI on Rt may vary over time as a result of the evolving epidemic dynamics or time-varying factors such as public compliance. To examine this effect, we split up the time series of NPIs and Rt values into two parts: before and after peak NPI intensity (a sensitivity analysis).

We constructed two time-series: (i) the full time series and (ii) the truncated
time series up to the time of peak SI (stringency index=summary measure for intensity of NPI), on average 13 April 2020.

We propose an approach that balances the strengths of empirical analyses while taking into consideration underlying epidemic dynamics. We compare epidemic spread in places that implemented mrNPIs to counterfactuals that implemented only less-restrictive NPIs (lrNPIs). In this way, it may be possible to isolate the role of mrNPIs, net of lrNPIs and epidemic dynamics.

We first estimate COVID-19 case growth in relation to any NPI implementation in subnational regions of 10 countries: England, France, Germany, Iran, Italy, Netherlands, Spain, South Korea, Sweden and the United States. Using first-difference models with fixed effects, we isolate the effects of mrNPIs by subtracting the combined effects of lrNPIs and epidemic dynamics from all NPIs. We use case growth in Sweden and South Korea, 2 countries that did not implement mandatory stay-at-home and business closures, as comparison countries for the other 8 countries (16 total comparisons).

Review and meta-analysis (until April 22)

Rapid scoping review (until June 19)

See Overview papers PPM for public

- Data on weekly COVID infections and deaths by country and U.S. state is drawn from the Johns Hopkins University COVID dashboard. Data on weekly expected deaths is imported from The Economist dataset
- Weekly levels were incorporated in the Oxford COVID-19 Government Response Tracker (OxCGRT) database. The level of each policy is assessed daily on a scale that can include up to 4 stages. The lowest level of restriction is level 1 and the greatest level is level 4
- The analysis includes all countries and U.S. states with at least 5 million residents for which The Economist reports excess deaths weekly
- The model assumes that, in most jurisdictions, just a minority of the population has been infected, and that herd immunity (i.e., more than 50% of the population has been infected) is remote in all jurisdictions
- The primary variable of interest is Δgp, which represents the marginal effect p, of each implemented policy, on reducing the weekly growth rate of infections

A discretized version of a susceptible infectious and recovered (SIR)-type model, already published earlier in same journal.

Descriptive
In the current analysis we compare single outbreaks' data in the Lombardy region, collected before (19-25th October 2020) and after (2-8th November 2020) the
introduction of "regional-level" containment measures on 22nd October 2020, during the second epidemic wave of COVID-19, and analyse the reported setting
of transmission. These measures included nighttime curfew from 11pm to 5am, distance learning (for high schools), increase of smart working and closure of non-essential businesses and preceded those adopted by the Italian government by about 10 days.

Data are compared, as far as possible, with the estimates in the spring of 2020.

Descriptive
On 17 October, a curfew was implemented from 9 p.m. to 6 a.m. in the nine most affected metropolitan areas. Reinforced measures such as limiting public and private social gatherings, closing bars and/or restaurants, or prohibiting alcohol sales in public areas had already been put in place in these nine metropolitan areas since 23–25 September. One week later, on 24 October, the curfew was extended to nine additional
metropolitan areas where viral transmission was also critically increasing. Finally, on 30 October a nationwide lockdown was implemented. This was switched to a national curfew on 15 December 2020, which is still ongoing as at 17 December.

Descriptive

Descriptive
Compare rhinovirus incidence in 2019 with 2020 after lockdown on March 23, 2020.

N.a.

Results

- Among the six full-consensus NPI categories in the CCCSL, the largest impacts on Rt are shown by small gathering cancellations (normalized score 83%, ΔRt between -0.22 and –0.35), the closure of educational institutions (73%, and estimates for ΔRt ranging from -0.15 to -0.21) and border restrictions (56%, ΔRt between - 0.057 and –0.23) **(Figure 1)**
- The consensus measures also include NPIs aiming to increase healthcare and public health capacities (increased availability of personal protective equipment (PPE): 51%, ΔRt - 0.062 to -0.13), individual movement restrictions (42%, ΔRt -0.08 to -0.13) and national lockdown (including stay-at-home order in US states) (Δ25%, Rt -0.008 to - 0.14)
- 14 additional NPI categories were found consensually in three of the methods. These include mass gathering cancellations (53%, ΔRt between −0.13 and −0.33), risk-communication activities to inform and educate the public (48%, ΔRt between –0.18 and –0.28) and government assistance to vulnerable populations (41%, ΔRt between −0.17 and −0.18)
- Among the least effective interventions were found: government actions to provide or receive international help, measures to enhance testing capacity or improve case detection strategy (which can be expected to lead to a short-term rise in cases), tracing and tracking measures as well as land border and airport health checks and environmental cleaning
- Sensitivity check indicates substantial variations between world geographical regions in terms of NPI effectiveness

- Under the default model settings, the percentage reduction in Rt (with 95% prediction interval) associated with each NPI was: limiting gatherings to 1000 people or less: 23% (0 to 40%); to 100 people or less: 34% (12 to 52%); to 10 people or less: 42% (17 to 60%); closing some high-risk face-to-face businesses: 18% (−8 to 40%); closing most nonessential face-to-face businesses: 27% (−3 to 49%); closing both schools and universities in conjunction: 38% (16 to 54%); and issuing stay-at-home orders (additional effect on top of all other NPIs): 13% (−5 to 31%) (**Figure 2**)
- In combination, the NPIs in this study reduced Rt by 77% (67 to 85%). Across countries, the mean Rt without any NPIs (i.e., the R0) was 3.3. Starting from this number, the estimated Rt likely could have been brought below 1 by closing schools and universities, high-risk businesses, and limiting gathering sizes to at most 10
- Results were stable to a range of unobserved factors

- The most effective interventions in containing the spread of COVID-19 are those aiming at reducing contacts in large groups, such as canceling of public events and restrictions on private gatherings, or reducing contacts with high frequency, such as school and workplace closures. Compared to the reference pre-intervention period, a unit increase in the value of intensity of canceling of public events or restrictions on private gatherings leads to a decrease of about 12% in the number of daily infections 6 weeks after the intervention was implemented. For school and workplace closures, the corresponding effect is around 12% and 15%, respectively **(Figure 3)**.
- Stay-at-home requirements, generally introduced as a last resort, take more time to bring incidence below the reference period, and when they do, their effect becomes negative and significantly different from zero over a limited number of days
- International travel controls become effective at reducing incidence about 10 days after their introduction, for a duration of about two and a half weeks, after which they cease to be effective
- Restrictions on internal movement and public transport closures have a negligible impact over the entire eventtime window. This is explained by the earlier introduction of other types of restrictions, which lowered the use of public transport and de facto reduced internal movement.

- In a simulation of 10,490,000 people, a 50% efficacious vaccine at 25% coverage with NPIs removed (F0) resulted in almost 31% infected after 18 months. Over the 11-month period from the onset of vaccination, 2,231,134 new infections occurred in this worst-case scenario. In contrast, the best-case 90% efficacious vaccine at 75% coverage with NPIs maintained (A1) resulted in 450,575 new infections, for a 19% absolute risk reduction. When NPIs were removed, risk reductions ranged from 9% (E0) to 18% (A0) with increasing vaccine efficacy and coverage. All vaccination scenarios with NPIs had lower risks than without NPIs counterparts; these differences tended to increase with lower vaccine efficacy and coverage **(Figure 4)**.
- All vaccination scenarios with NPIs had lower risks than without NPIs counterparts; these differences tended to increase with lower vaccine efficacy and coverage. Maintaining NPIs with the worst-case vaccination scenario reduced infections by 15% compared to this scenario without NPIs . In contrast, risk reductions for Scenarios A1 and A0 were similar (19% and 18%, respectively), suggesting NPIs had a smaller impact under best-case vaccination.
- Similar patterns for the joint impact of vaccination and NPIs were observed for mortality risks and hospitalizations. A total 15,166 deaths (0.1% of the population) resulted from worst-case vaccination without NPIs (F0), whereas best-case vaccination with NPIs (A1) resulted in 6,789 total deaths

There was strong evidence for an association between two NPIs (school closure, internal movement restrictions) and reduced Rt. Another three NPIs (workplace closure, income support, and debt/contract relief) had strong evidence of effectiveness when ignoring their level of intensity, while two NPIs (public events cancellation, restriction on gatherings) had strong evidence of their effectiveness only when evaluating their implementation at maximum capacity (e.g. restrictions on 1000+ people gathering were not effective, restrictions on < 10 people gathering were). Evidence about the effectiveness of the remaining NPIs (stay-athome requirements, public information campaigns, public transport closure, international travel controls, testing, contact tracing) was inconsistent and inconclusive. We found temporal clustering between many of the NPIs. Effect sizes varied depending on whether or not we included data after peak NPI intensity.

Implementing any NPIs was associated with significant reductions in case growth in 9 out of 10 study countries, including South Korea and Sweden that implemented only lrNPIs (Spain had a nonsignificant effect). After subtracting the epidemic and lrNPI effects, we find no clear, significant beneficial effect of mrNPIs on case growth in any country. In France, for example, the effect of mrNPIs was +7% (95% CI: −5%-19%) when compared with Sweden and + 13% (−12%-38%) when compared with South Korea (positive means pro-contagion). The 95% confidence intervals excluded 30% declines in all 16 comparisons and 15% declines in 11/16 comparisons.

For reducing infection rates, the estimates of cluster-RCTs were in favor of wearing face masks vs. no mask, but not at statistically significant levels (adjusted OR 0.90, 95% CI 0.78–1.05). Similar findings were reported in observational studies (unadjusted RR 0.55-0.90, dep. on study type). Mathematical models indicated an important decrease in mortality when the population mask coverage is near-universal, regardless of mask efficacy.

Mask wearing reduced primary infection by 6% (odds ratio (OR): 0.94; 95% CI: 0.75–1.19 for RCTs) to 61% (OR: 0.85; 95% CI: 0.32–2.27; OR: 0.39; 95% CI: 0.18–0.84 and OR: 0.61; 95% CI: 0.45–0.85 for cohort, case–control and cross-sectional studies respectively).
RCTs suggested lowest secondary attack rates when both well and ill household members wore masks (OR: 0.81; 95% CI: 0.48–1.37). While RCTs might underestimate effects due to poor compliance and controls wearing masks, observational studies likely overestimate effects, as mask wearing might be associated with other risk-averse behaviours. GRADE was low or very low quality.

- Five of the policies have relatively large impact when fully implemented at their highest levels: Workplace closing, restrictions on internal movement, stay-at-home requirements, public information campaigns, and school closings. Four of the five are associated with lower growth of infections even at relatively low levels, but public information campaigns (H1) are most impactful at the highest recorded level (which in this case is level 2, i.e., coordination across traditional and social media) **(Figure 10)**
- Constraints on the movements of adults through C2 (workplace closings for all but essential workers), C7 (restrictions on internal movements), and C6 (stay-at-home requirements with exceptions for daily exercise, grocery shopping, and 'essential' trips) have the greatest marginal impact at intermediate levels
- The largest marginal effect of school closing (C1) is at level 2 (closing of some categories, such as universities and/or high schools) while a level 3 policy (closing of all schools) provides and additional but lower marginal benefit
- Testing policy and contact tracing are not strongly associated with COVID controlling for the 40 jurisdictions in this study
- The set of core policies lead to COVID control only for jurisdictions with strong policy compliance

The January 1–January 15, 2021 period makes it possible to assess adherence to the curfew during the end-of-year holidays. The circulation of the virus among Toulouse inhabitants was reduced by 38% by the 8 pm curfew. On Jan 15 the curfew became stricter: 6 pm. The 6 p.m curfew was intended to keep the circulation of SARSCoV-2 under control after the Christmas/New Year period but it had exactly the opposite effect in the Toulouse urban area; it reduced the stress on virus spread by 2% (35% reduction in virus spread instead of 38%). This could be because the more restrictive evening curfew results in larger groups of people in shops and supermarkets before they all hurried to get home.

Comparing the data of outbreak investigation (single outbreaks were defined as> 1 infection attributable to the same chain of infection after an epidemiological investigation) before and after the introduction of restrictive measures we observed a significant decrease of infections in workplaces, social gatherings, coffee shops, restaurants, and sports centers; contagion in schools decreased from 9.8% to 3.4%, in hospitals environments and nursing homes from 5.2% to 2%. However, domestic infections increased instead from 72.8% to 92.7%. The second setting at high risk of contagion
are schools, in a period during which about half of the students were still on distance learning (3,4%). In the two periods analyzed the number of new cases was stable (approximately 55,000 per week).

Of note: Householdlevel transmission, more frequent during lockdown periods, is intended not only as contagion between cohabitants, but also as contagion between members of the same family in other circumstances; therefore it includes gatherings for events such as birthday parties, funerals and other family gatherings.

A considerable decrease in incidence of COVID-19 cases and hospital admissions was observed 7 to 10 days after mitigation measures were put in place, occurring earlier in metropolitan areas which had implemented these first. Other factors may have also contributed to the observed positive evolution, notably school holidays from 17 October to 1 November, whose start coincided with the announcement of the first curfew.
Non-targeted metropolitan areas demonstrated a decrease in COVID-19 cases earlier than expected, this could be the result of the intense communication on the severity of the epidemic in the whole country.

A major decrease in the rate of daily median pediatric ER visits was detected in both hospitals in the study during the nationwide lockdown compared with before the lockdown (Mikkeli, 19 vs. 7,
P < 0.001; Kuopio, 9 vs. 2,5, P < 0.001). The influenza season was shorter (8 weeks from peak to no cases), and the weekly rate of new cases decreased faster compared with the previous 4 influenza seasons (previously 15–20 weeks from peak to no cases). A similar decrease was also seen in RSV cases. No pediatric cases of COVID-19 were found in participating hospitals during the study period.

There was a drop in the rate of detection of all respiratory viruses including rhinovirus following the nationwide lockdown on March 23, 2020. Detection of rhinovirus remained low after the easing of national lockdown on the May 10, 2020, compared with the previous year. Around 2 weeks after the concurrent re-opening of state primary and secondary schools in early September, there was a sharp increase in the number of detections similar to that seen in 2019. As these infections are mainly transmitted by children the authors conclude that infection control measures at schools do not effectively prevent rhinovirus transmission, and therefore maybe not SARS-CoV2 either.

In a recent timely systematic review, Chu et al assessed the effectiveness of face masks, eye protection, and physical distancing for preventing COVID-19. Because the sample sizes are not large, especially in some studies of COVID-19, this review contains a considerable number of studies with zero counts of infection events, creating challenges in estimating effect sizes. If zero counts appear in both groups, this double-zero-event study (DZS) is omitted from the analyses, as implied in the forest plots in Chu et al. Specifically, at least 9 out of 44 studies in this review are DZS with 1784 subjects. An omission of information about the rare outcome in DZS or
artificial correction of the zero counts could impact the conclusions

Author's conclusions

- The most effective NPIs include curfews, lockdowns and closing and restricting places where people gather in smaller or large numbers for an extended period of time. This includes small gathering cancellations (closures of shops, restaurants, gatherings of 50 persons or fewer, mandatory home working and so on) and closure of educational institutions
- The effectiveness of individual NPIs is heavily influenced by governance and local context (combination of socio-economic features and NPIs already adopted). Because of this heterogeneity the impact of a specific NPI cannot be evaluated in isolation

- Several NPIs were associated with a clear reduction in Rt. Furthermore, some NPIs outperformed others
- Business closures and gathering bans both seem to have been effective at reducing COVID-19 transmission. Closing most nonessential face-to-face businesses was only somewhat more effective than targeted closures, which only affected businesses with high infection risk, such as bars, restaurants, and nightclubs. Limiting gatherings to 10 people or less was more effective than limits of up to 100 or 1000 people and had a more robust effect estimate.
- Whenever countries introduced stay-at-home orders, they essentially always also implemented, or already had in place, all other NPIs in this study. Issuing a stay-at-home order had a small effect when a country had already closed educational institutions, closed nonessential businesses, and banned gatherings

- Canceling public events and enforcing restrictions on private gatherings, as well as closing schools and workplaces, had the largest effects on curbing the pandemic
- Stay-at-home requirements were used as a policy of last resort and helped to slow down the growth of daily incidence
- International travel controls had an early and short-lived effect on the incidence of COVID-19
- Restrictions on internal movement and public transport closures did not lead to decreases in the COVID-19 incidence. This latter finding does not imply that restricting internal movement or public transport is epidemiologically irrelevant. It rather suggests that once policies such as workplace and school closures, canceling of public events and restrictions on private gatherings -that restrict the activities which generate most of public transportation and internal mobility- have been imposed, the remaining travelers are so few and so sparsely distributed that the probability of infection during travel is low.

The study suggests that, for a population of 10.5 million, about 1.8 million infections and 8,000 deaths could be prevented with more efficacious COVID-19 vaccines, higher vaccination coverage, and maintaining NPIs, such as distancing and face mask usage. Moreover, the findings highlight the importance of continued adherence to NPIs while the population is vaccinated, particularly under scenarios of lower vaccine efficacy and coverage.

Understanding the impact that specific NPIs have had on SARS-CoV-2 transmission is complicated by temporal clustering, time-dependent variation in effects, and differences in NPI intensity.
However, the effectiveness of school closure and internal movement restrictions appears robust across different model specifications, with some evidence that other NPIs (workplace closure, income support, debt/contract relief, public events cancellation, restriction on gatherings)may also be effective under particular conditions. This provides empirical evidence for the potential effectiveness of many, although not all, actions policy-makers are taking to respond to the COVID-19 pandemic.

While small benefits cannot be excluded, we do not find significant benefits on case growth of more restrictive NPIs. Similar reductions in case growth may be achievable with less-restrictive interventions.

The findings of this systematic review and meta-analysis support the use of face masks in a community setting. Robust randomized trials on face mask effectiveness are needed to inform evidence-based policies.

Wearing face masks may reduce primary respiratory infection risk, probably by 6–15%. It is important to balance evidence from RCTs and observational studies when their conclusions widely differ and both are at risk of significant bias. COVID-19-specific studies are required.

- A core set of socially tolerable policies lead to COVID control only in those jurisdictions that have unusually high levels of compliance. The socially tolerable core policies alone are meaningful and significant, but insufficient by themselves for preventing escalating growth in infections in 90% of the jurisdictions analyzed. For these jurisdictions, one or more from a set of additional high-impact but difficult-to-tolerate policies must be implemented to achieve COVID control
- For the jurisdictions covered in this analysis, the policies with the greatest marginal impact for achieving COVID control mainly involve restrictions on adults through workplace closings and stay-at-home requirements, although targeted school closings are also in the group of additional high-impact policies. The impact of testing and contact tracing has been lower than the impact of other policies

By including DZS, with physical distance of 2 m, the effect of eye protection on reducing infection risk was no longer statistically significant, and the reduced risk of physical distancing might not be statistically significant when using N95 respirators.

Comments

- The time window is limited to March–April 2020, where the structure of NPIs is highly correlated due to simultaneous implementation
- The stringency of NPI implementation was not taken into account, nor the fact that not all methods were able to describe potential variations in NPI effectiveness over time
- To compute Rt, time series of the number of confirmed COVID-19 cases was used. This approach is likely to over-represent patients with severe symptoms and may be biased by variations in testing and reporting policies among countries

- Only the effects that NPIs had between January-30 May 2020 were analyzed: NPI effectiveness may change over time as circumstances change
- NPI effectiveness may depend on the context of implementation, such as the presence of other NPIs, country demographics, and specific implementation details
- Rt may have been reduced by unobserved NPIs or voluntary behavior changes such as mask-wearing

- The estimated effects of the lockdown interventions without controlling for concurrent interventions are biased, suggesting that all policies are almost equally effective in reducing the incidence of COVID-19. Only when there is controlled for confounding due to the contemporaneous presence of other interventions, differences were found in the effectiveness of each policy, which are masked when all policies are either treated separately or as a group
- The estimates refer to an average effect of lockdown policies on COVID-19 incidence across countries, without excluding the possibility of heterogeneous effects in single cases in which these policies had been implemented following a different timing

- The unique population characteristics for the studied state, including population demographics, prevalence of diabetes, rurality, mobility and adherence to NPIs, influence the transmission of infections and COVID-19 morbidity and mortality
- The model framework assumed only hospitalized individuals can transition to death, so mortality estimates of the early phase of the pandemic may be inaccurate since many deaths occurred in nursing homes and outside the hospital

Authors: In some cases, the sequential order in which NPIs are implemented may make it more or less likely that particular NPIs capture the effects of other NPIs or they may have interactive effects on each other. For example, the back-sampling process used in Abbott et al. [41] may attribute true Rt reduction to NPIs occurring later. Thus, we verify NPIs rated as being supported by strong statistical evidence by checking their sequential ordering in COVID-19 response strategies: Most of these NPIs were not implemented particularly early or late in the sequence of NPIs. Complete school closure and mandatory public events cancellations are moderately left-skewed, indicating that they tend to occur first. Some (non-maximum) levels of income support and debt/contract relief are right-skewed, making it possible that their observed effects are statistical artefacts or are dependent on the imposition of earlier NPIs.
Many more caveats are discussed in the paper, eg. interactions between NPI were not included in the models.

While it is hard to draw firm conclusions from these estimates, they are consistent with a recent analysis that identified increased population-level transmission and cases in Hunan, China, during the period of stay-at-home orders, attributed to increased intra-household density and transmission.

The authors acknowledge that the effectiveness of NPIs depends on individual behaviour (compliance higher in S.Korea) which helps explain why the degree of NPI restrictiveness does not seem to explain the declinein case growth rate. Furthermore: reductions in social activities that led to reduction in case growth were happening prior to implementation of mrNPIs because populations in affected countries were internalizing the impact of the pandemic in China, Italy and New York, and noting a growing set of recommendations to reduce social contacts, all of which happened before mrNPIs.

TK: the study did not take into account differences in timing of measures (where in the epidemic situation). They claim to analyze case growth data on a subnational level, but this is not clear from the results.

TK: Update includes only 2 papers more, without different conclusions.

- Important differences arise across jurisdictions in infection levels, death rates, policy implementation, and compliance with policies. These differences have major implications for COVID control
- The relatively limited impact of testing (H2) and contact tracing (H3) could arise from the lifting of policies others than those reported in the Oxford database around the same time that H2 and H3 policies were implemented

TK: No confidence intervals or sensitivity analyses.

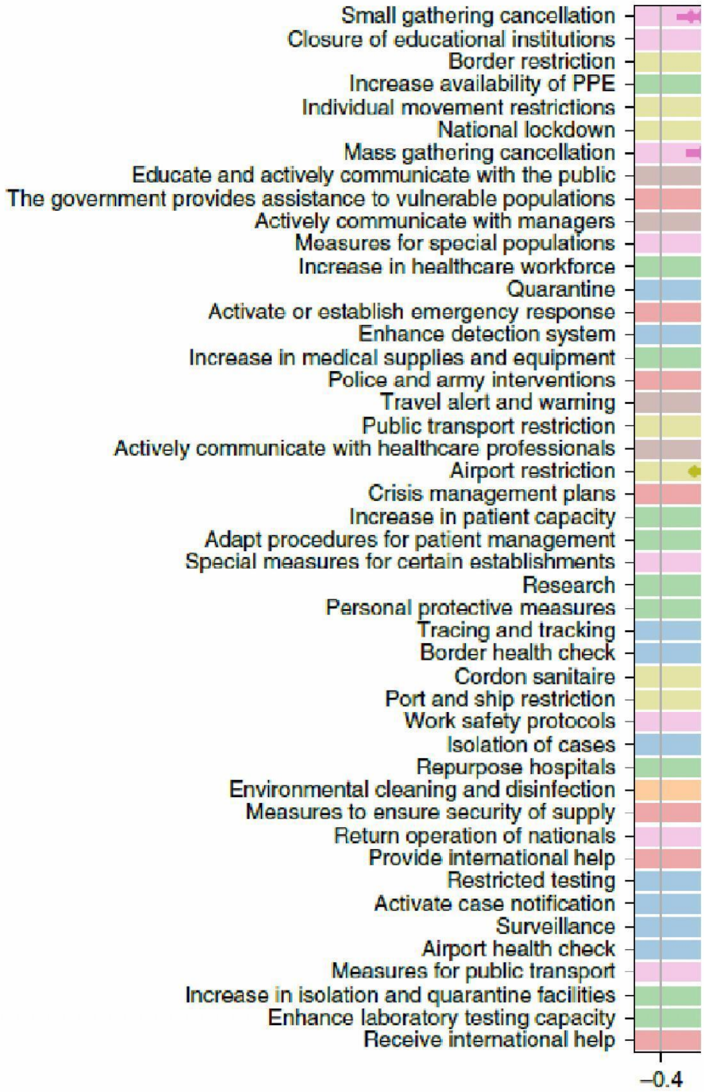


Figure 1. Change in Rt (ΔRt) for 46 NPIs at L2, as quantified by CC ana
95% confidence intervals of ΔRt for the most effective interv
corresponding Z-scores of measure effectiveness as determin
ranked according to the number of methods agreeing on the
[Haug et al., 2020]

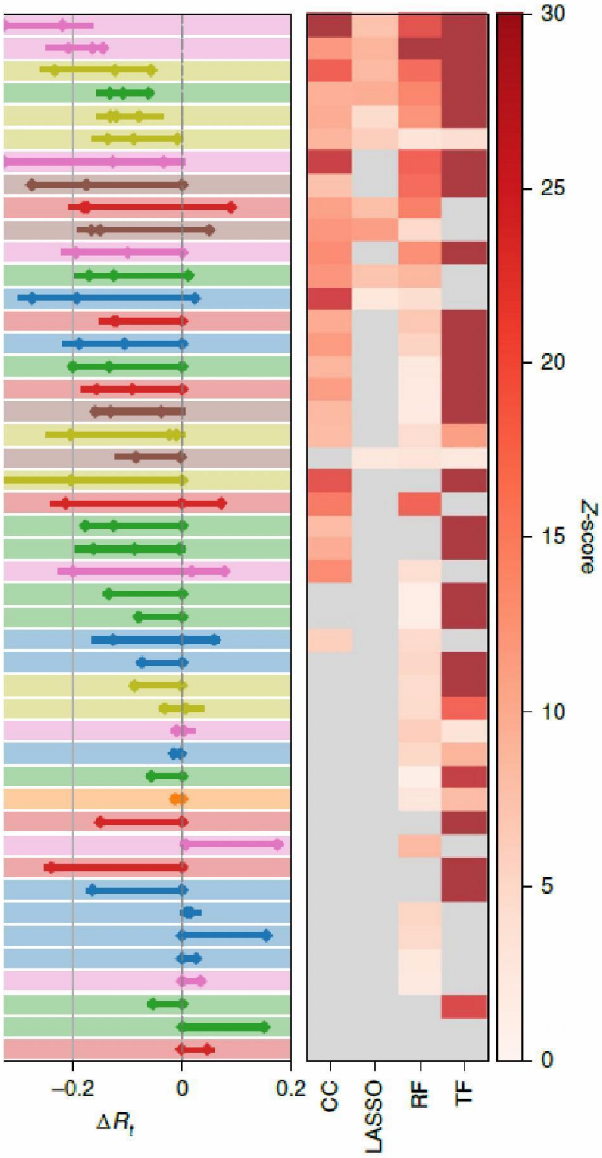


Table 1 | Comparison of effectivene

L2 category
Small gathering cancellation
Closure of educational institutions
Border restriction
Increased availability of PPE
Individual movement restrictions
National lockdown
Mass gathering cancellation
Educate and actively communicate with
The government provides assistance to populations
Actively communicate with managers
Measures for special populations
Increase healthcare workforce
Quarantine
Activate or establish emergency respon
Enhance detection system
Increase in medical supplies and equipr
Police and army interventions
Travel alert and warning
Public transport restriction
Actively communicate with healthcare

Out of the 46 NPI categories, all four methods show observed reduction in R_t for the various methods and fluctuates within the 95% confidence interval.

lysis, LASSO and TF regression. The left-hand panel shows the combined entions across all included territories. The heatmap in the right-hand panel shows the ed by the four different methods. Grey indicates no significantly positive effect. NPIs are ir impacts, from top (significant in all methods) to bottom (ineffective in all analyses).

ess rankings on L2

	Score (%)	Consensus	ΔR_t^{CC}	ΔR_t^{LASSO}	Importance (RF)	ΔR_t^{TF}
	83	4	−0.35 (2)	−0.22 (5)	0.020 (2)	−0.327 (3)
	73	4	−0.16 (2)	−0.21 (4)	0.028 (2)	−0.146 (2)
	56	4	−0.23 (2)	−0.12 (2)	0.017 (2)	−0.057 (2)
	51	4	−0.11 (2)	−0.13 (2)	0.012 (1)	−0.062 (2)
	42	4	−0.13 (2)	−0.08 (3)	0.017 (2)	−0.121 (2)
	25	4	−0.14 (3)	−0.09 (2)	0.0020 (9)	−0.008 (3)
	53	3	−0.33 (2)	0	0.012 (1)	−0.127 (2)
ı the public	48	3	−0.18 (4)	0	0.018 (2)	−0.276 (2)
vulnerable	41	3	−0.17 (3)	−0.18 (4)	0.009 (1)	0.090 (3)
	40	3	−0.15 (2)	−0.20 (4)	0.004 (2)	−0.050 (2)
	37	3	−0.19 (2)	0	0.008 (1)	−0.100 (2)
	35	3	−0.17 (20)	−0.13 (3)	0.030 (8)	0.011 (2)
	30	3	−0.28 (2)	−0.2 (1)	0.0023 (9)	0.023 (2)
ıse	29	3	−0.13 (2)	0	0.0037 (9)	−0.121 (2)
	25	3	−0.19 (3)	0	0.0032 (9)	−0.106 (2)
ment	25	3	−0.13 (3)	−0.004 (3)	0.003 (2)	−0.200 (3)
	23	3	−0.16 (2)	0	0.003 (2)	−0.091 (2)
	20	3	−0.13 (3)	0.0 (1)	0.002 (1)	−0.159 (3)
	13	3	00.20 (4)	−0.01 (7)	0.004 (1)	−0.023 (3)
professionals	11	3	0	−0.08 (4)	0.003 (1)	−0.003 (2)

significant results for six NPIs (consensus 4) while three methods agree on 14 further NPIs (consensus 3). We report the average normalized score, the
l NPI importance for RF. Numbers in parentheses denote half of the amount by which the last digit of the corresponding number outside the parentheses

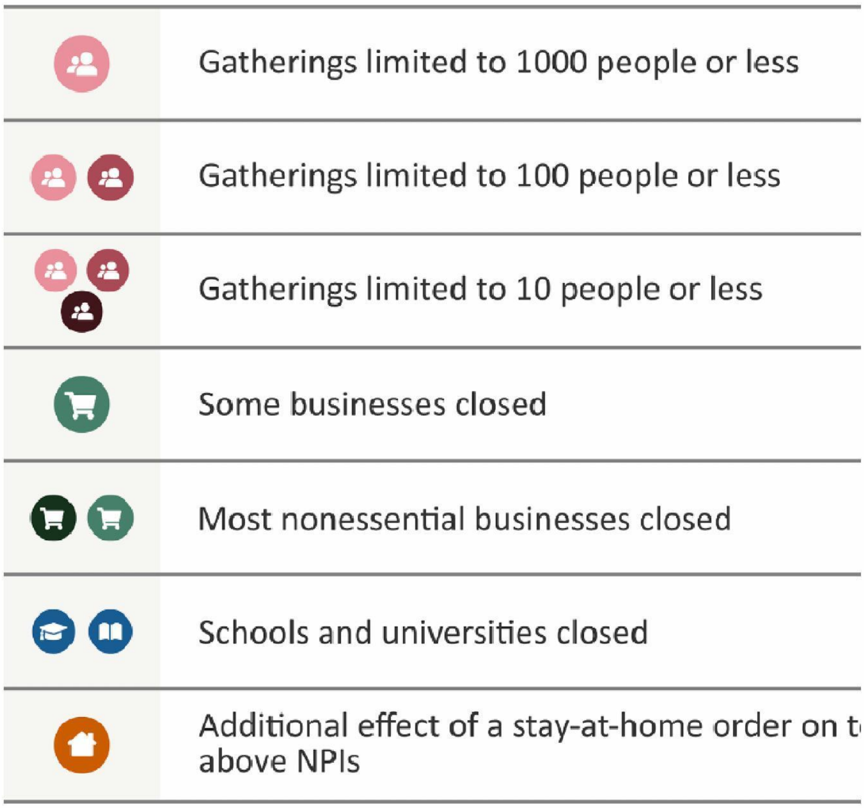
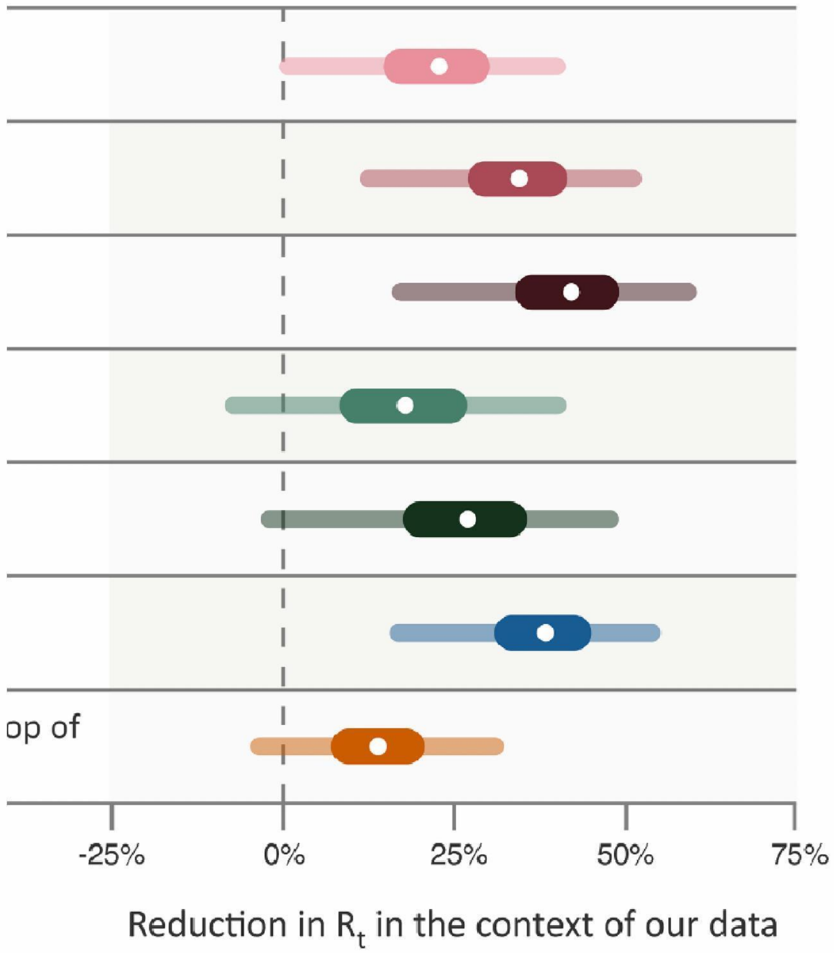
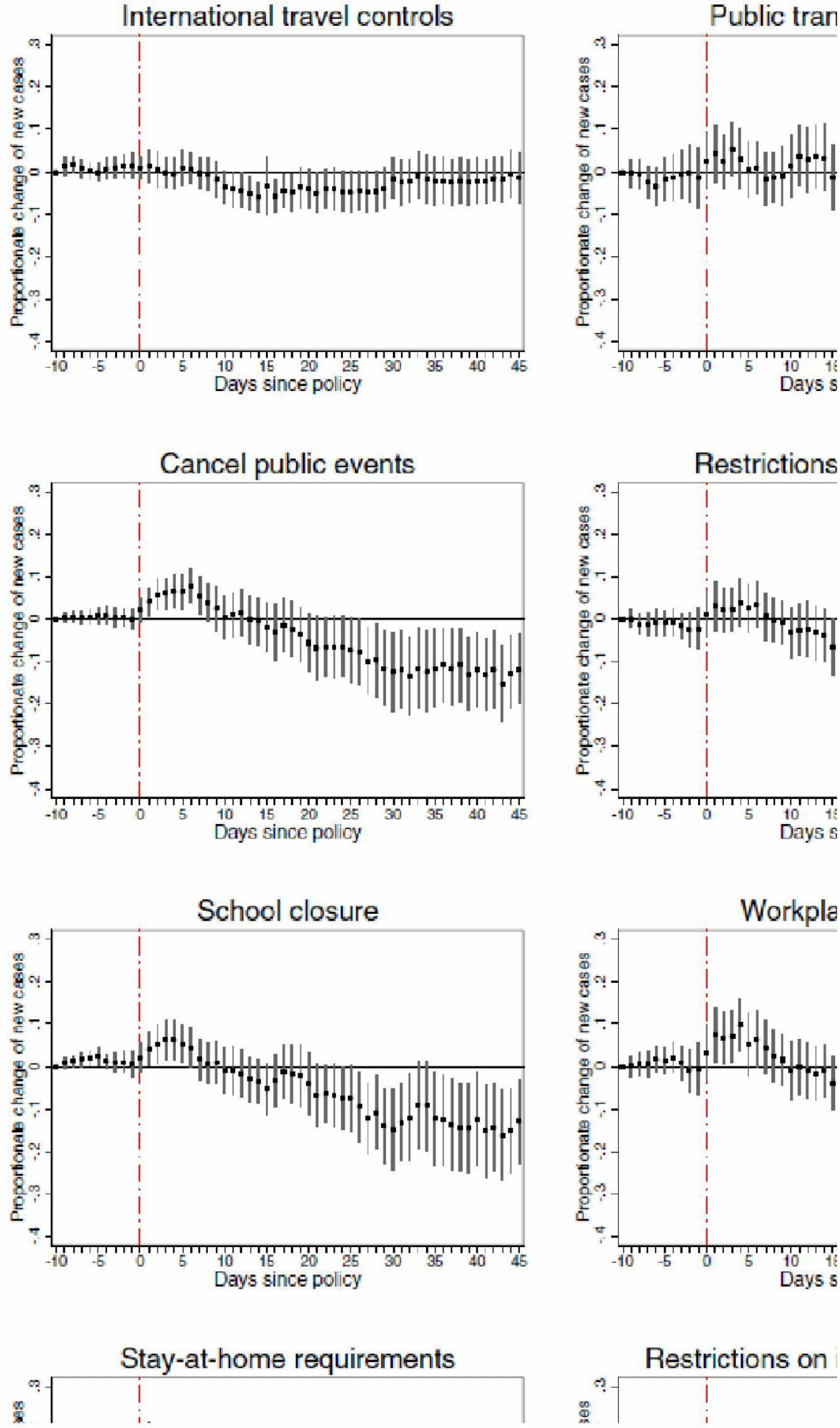


Figure 2. NPI effectiveness under default model settings [Brauner et al., 2020]


op of
-25%
0%
25%
50%
75%
Reduction in R_t in the context of our data


International travel controls
Public tran
Proportionate change of new cases
Days since policy
Days s
Cancel public events
Restrictions
School closure
Workpla
Stay-at-home requirements
Restrictions on

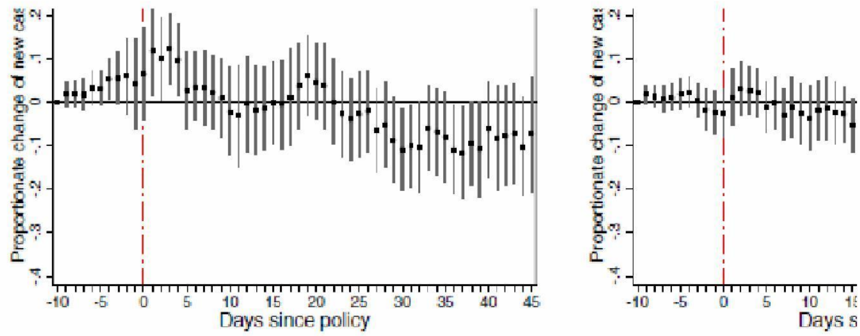


Figure 3. Effects of lockdown policies on COVID-19 confirmed new cases (3-day moving avera

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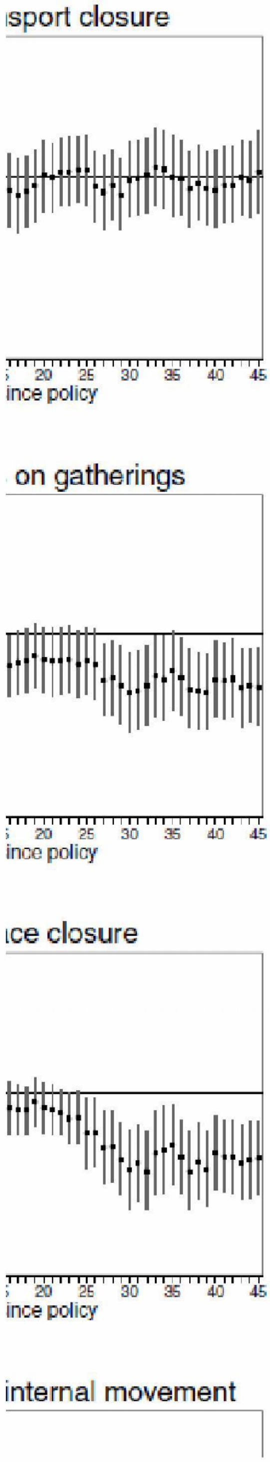
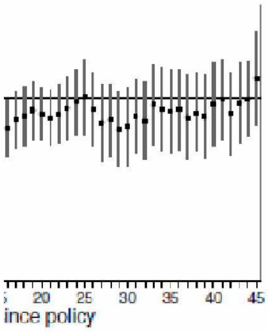

sport closure
20 25 30 35 40 45
ince policy
on gatherings
20 25 30 35 40 45
ince policy
ce closure
20 25 30 35 40 45
ince policy
internal movement



ge, in logs) with controls for concurrent policies [Askitas et al., 2021]

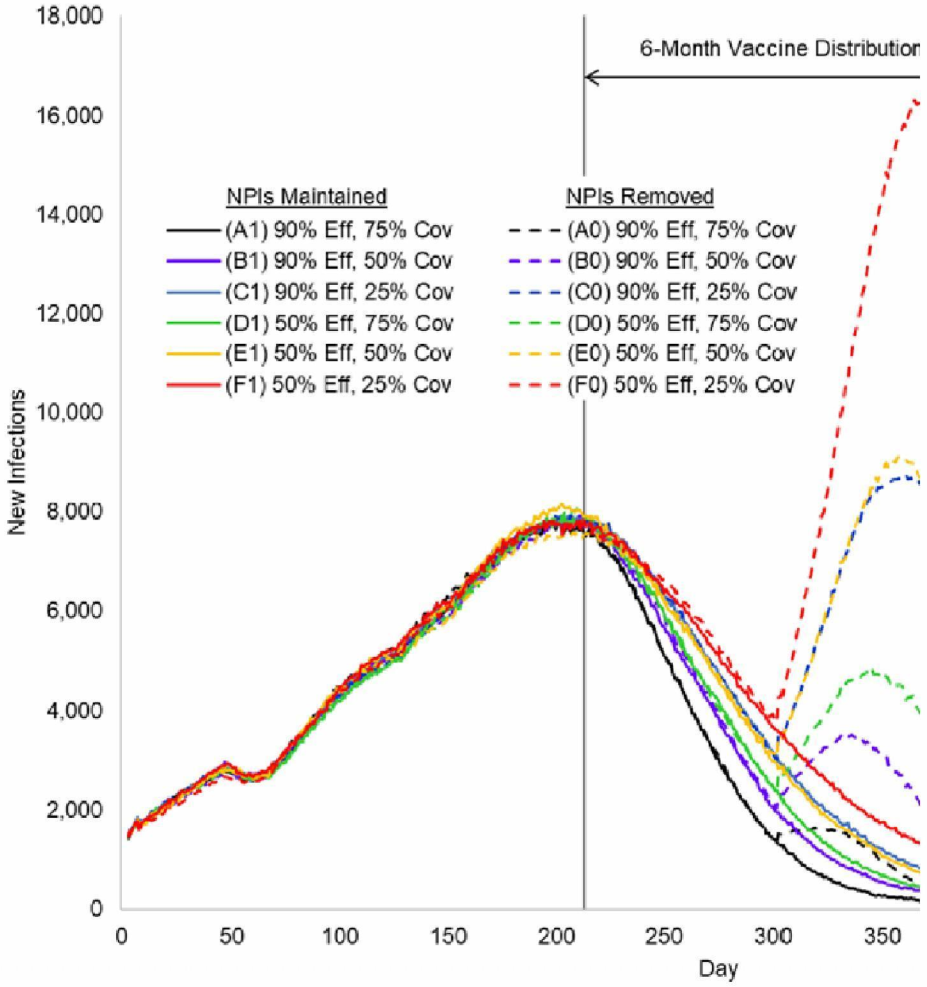
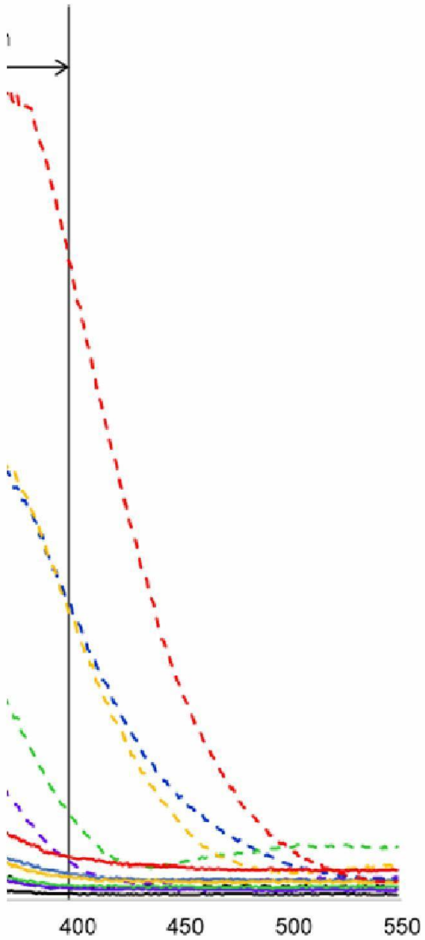


Figure 4. Daily New Infections by Vaccination and Non-Pharmaceutical Intervention Scenarios over the



18-Month Simulation (Patel et al. 2020)

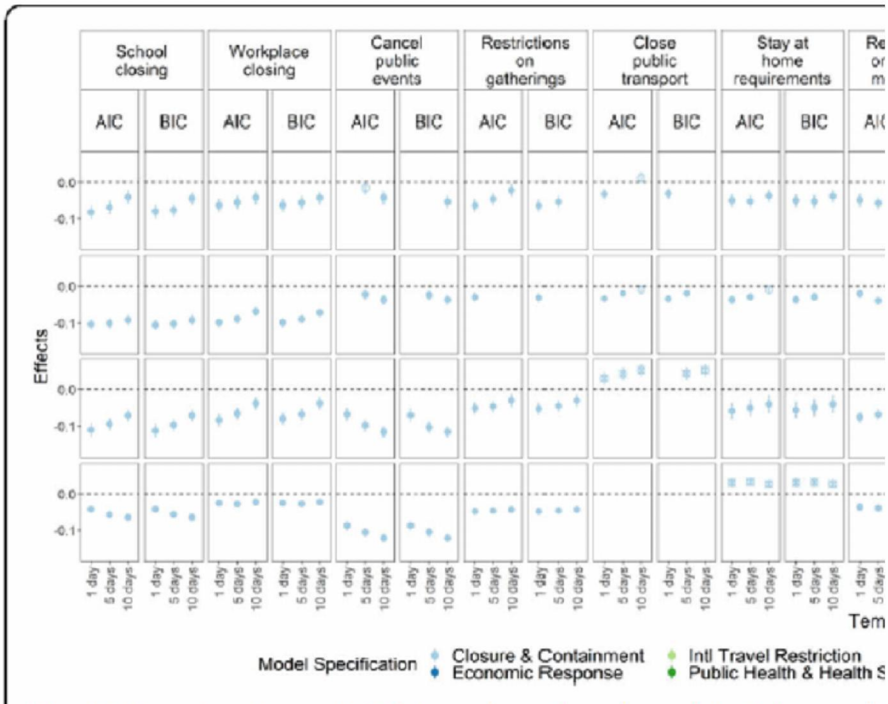
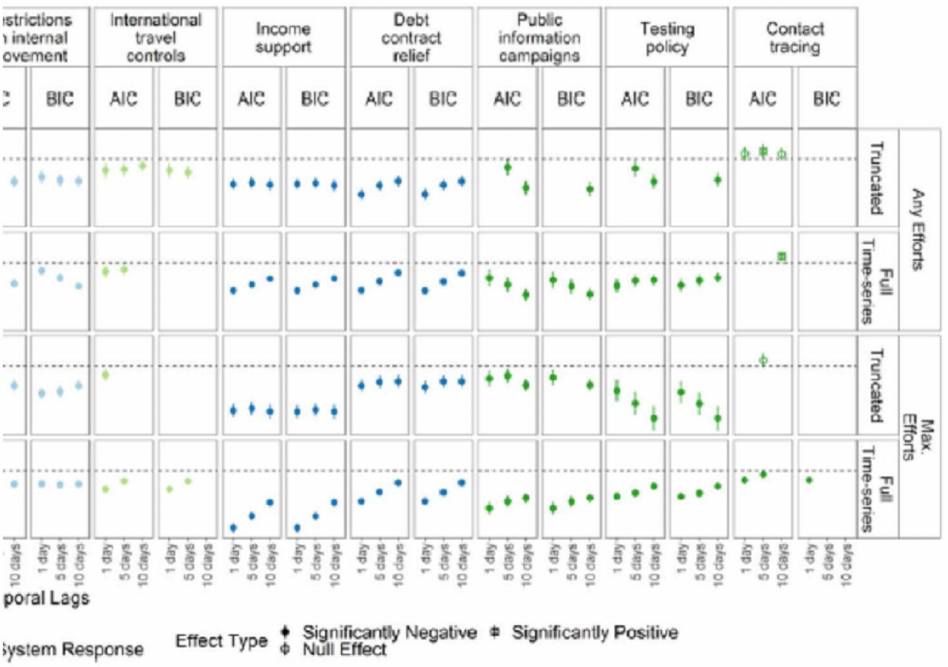


Fig. 5 Effect sizes for each NPI from the selected models. Points and



lines indicate mean and 95% confidence intervals.

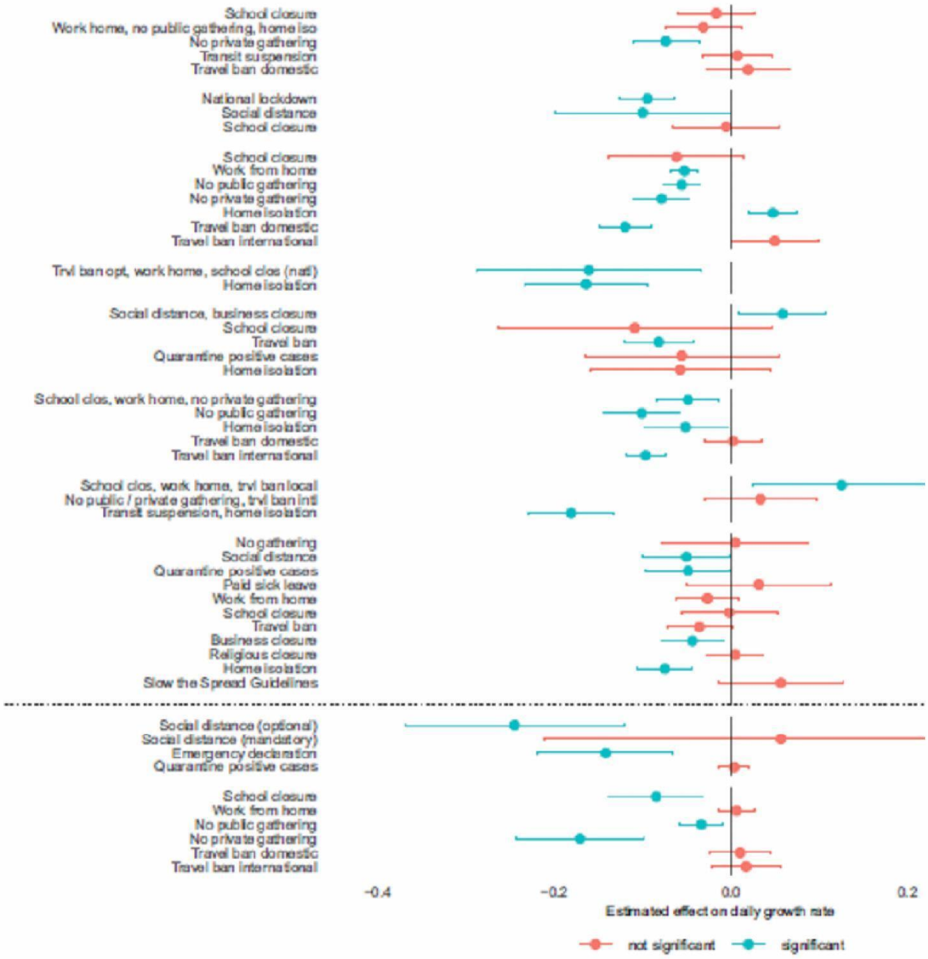
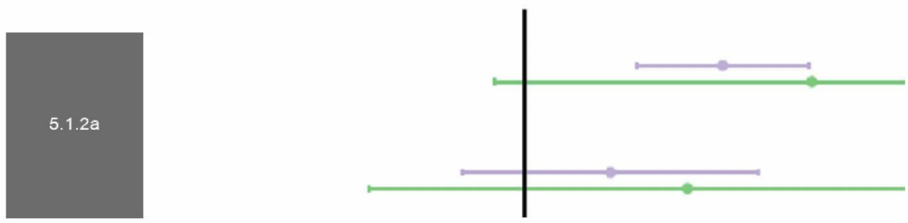


FIGURE 2 Effects of individual NPIs in all study countries. The variation in the tim
identify the effects of individual NPIs on the daily growth rate of cases. Where multiple N
day) across all subnational units (eg school closure, work from home and no private gath
individually and is shown combined



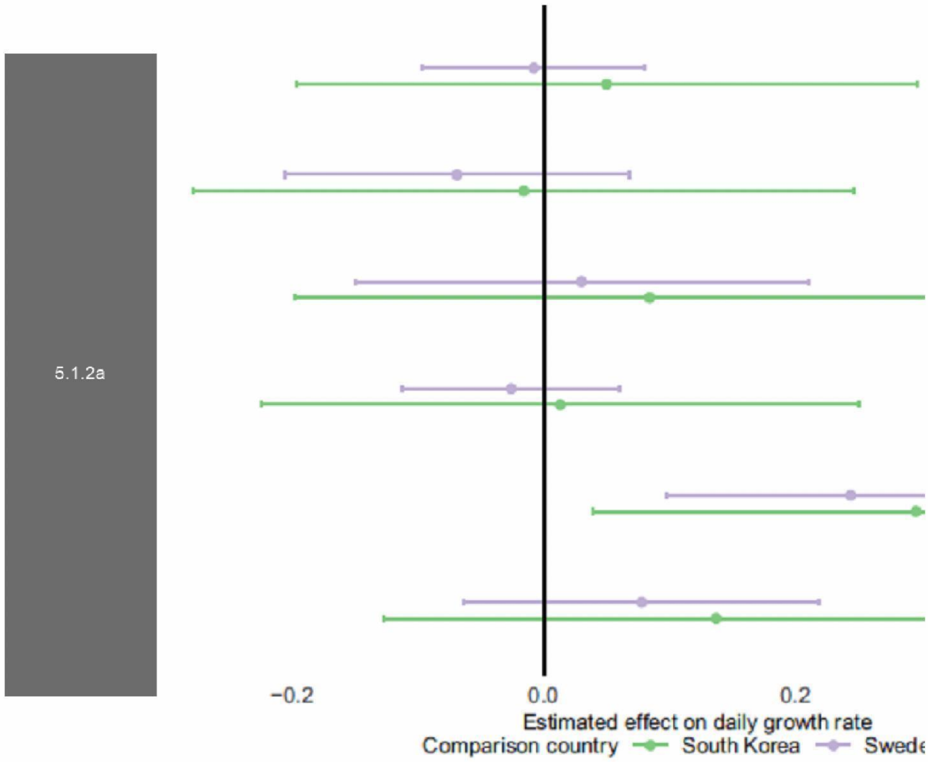
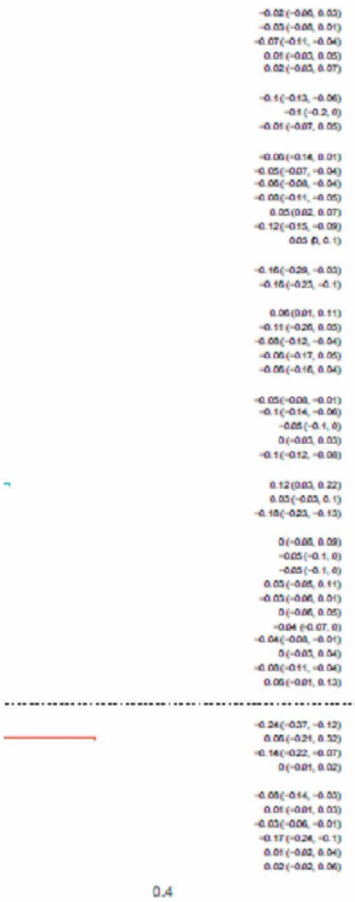


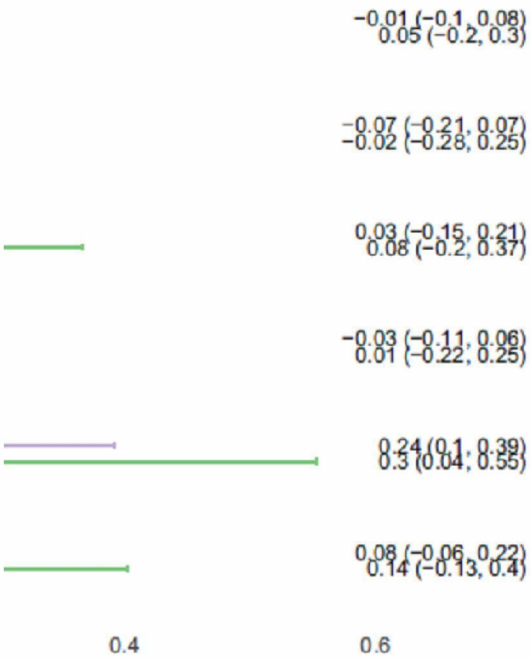
FIGURE 4 Effect of mrNPIs on daily growth rates after accounting for the effects of lrN
comparison is there evidence of reduction in case growth rates from mrNPIs, in any country. T
of mrNPIs resulting in *increased* daily growth in cases) in 12 out of 16 comparisons



[redacted]

[redacted]

ning and location of NPI implementation allows us to
NPIs were implemented simultaneously (in the same
erings in [redacted], their overall effect cannot be identified

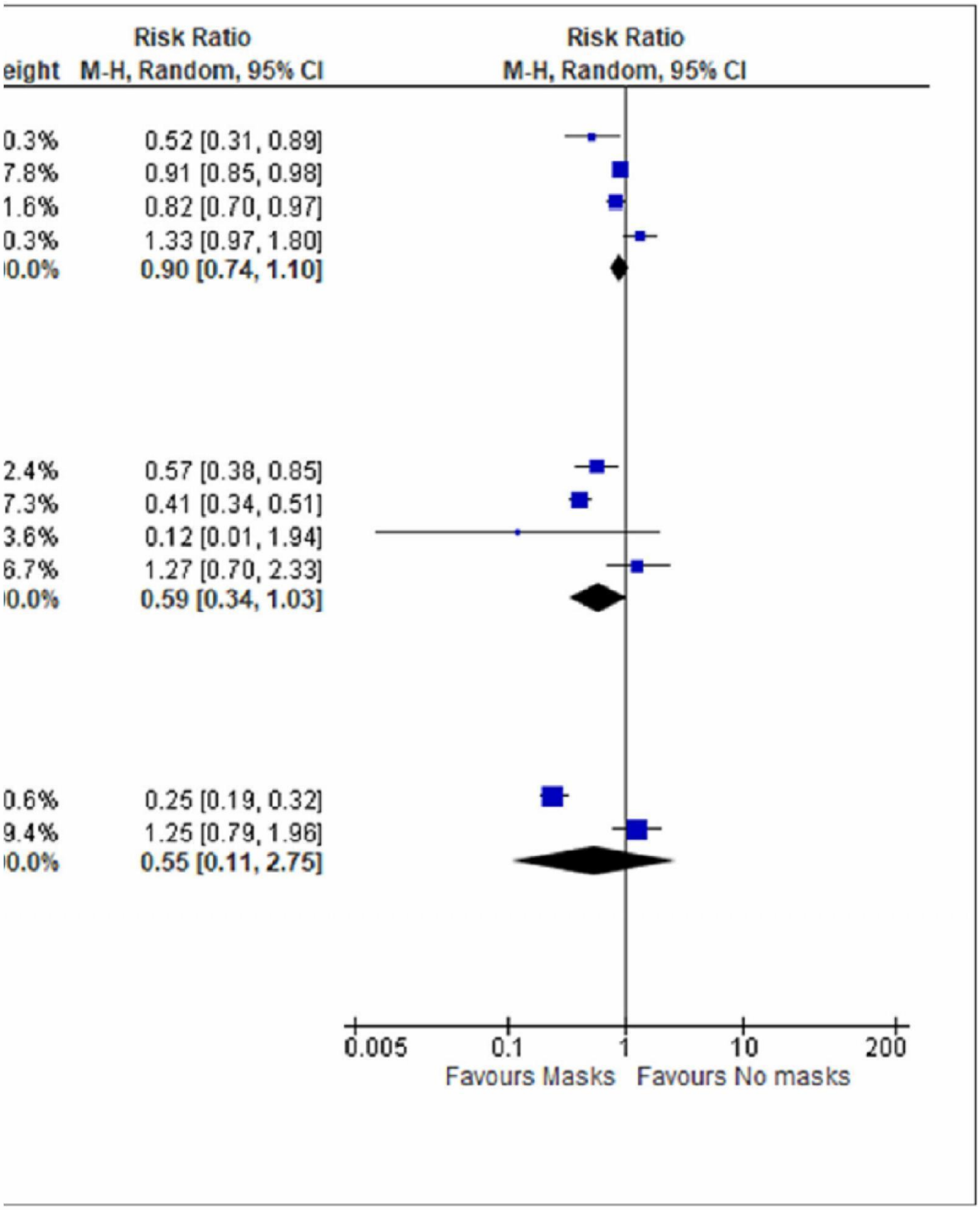


en

PIs in 5.1.2a and 5.1.2a Under no
The point estimates are positive (point in the direction

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	W
1.3.1 cross sectional studies					
Kim 2012 (school)	14	466	239	4164	1
Uchida 2017(school)	1069	5474	1080	5050	3
Al-Jasser 2013 (mass gathering)	98	216	361	656	3
Deris 2010 (mass gathering)	121	282	34	105	2
Subtotal (95% CI)		**6438**		**9975**	**10**
Total events	1302		1714		
Heterogeneity: $Tau^2 = 0.03$; $Chi^2 = 11.34$, df = 3 (P = 0.01); $I^2 = 74\%$					
Test for overall effect: Z = 1.04 (P = 0.30)					
1.3.2 case-control studies					
Wu 2004 (community)	25	146	69	229	3
Lau 2004 (community)	92	479	238	511	3
Zhang 2013 (aircraft)	0	12	9	29	[illegible]
Emamian 2013 (mass gathering)	21	57	11	38	2
Subtotal (95% CI)		**694**		**807**	**10**
Total events	138		327		
Heterogeneity: $Tau^2 = 0.20$; $Chi^2 = 13.77$, df = 3 (P = 0.003); $I^2 = 78\%$					
Test for overall effect: Z = 1.87 (P = 0.06)					
1.3.3 prospective studies					
Choudhry 2006 (mass gathering)	51	340	292	477	5
Balaban 2012 (mass gathering)	37	89	18	54	4
Subtotal (95% CI)		**429**		**531**	**10**
Total events	88		310		
Heterogeneity: $Tau^2 = 1.32$; $Chi^2 = 38.41$, df = 1 (P < 0.00001); $I^2 = 97\%$					
Test for overall effect: Z = 0.73 (P = 0.46)					
Test for subgroup differences: $Chi^2 = 2.28$, df = 2 (P = 0.32), $I^2 = 12.2\%$					

FIGURE 3 | Forest plot of respiratory infection rate in observational studies.


Risk Ratio
eight M-H, Random, 95% CI
Risk Ratio
M-H, Random, 95% CI
0.3% 0.52 [0.31, 0.89]
7.8% 0.91 [0.85, 0.98]
1.6% 0.82 [0.70, 0.97]
0.3% 1.33 [0.97, 1.80]
0.0% 0.90 [0.74, 1.10]
2.4% 0.57 [0.38, 0.85]
7.3% 0.41 [0.34, 0.51]
3.6% 0.12 [0.01, 1.94]
6.7% 1.27 [0.70, 2.33]
0.0% 0.59 [0.34, 1.03]
0.6% 0.25 [0.19, 0.32]
9.4% 1.25 [0.79, 1.96]
0.0% 0.55 [0.11, 2.75]
0.005
0.1
1
10
200
Favours Masks
Favours No masks

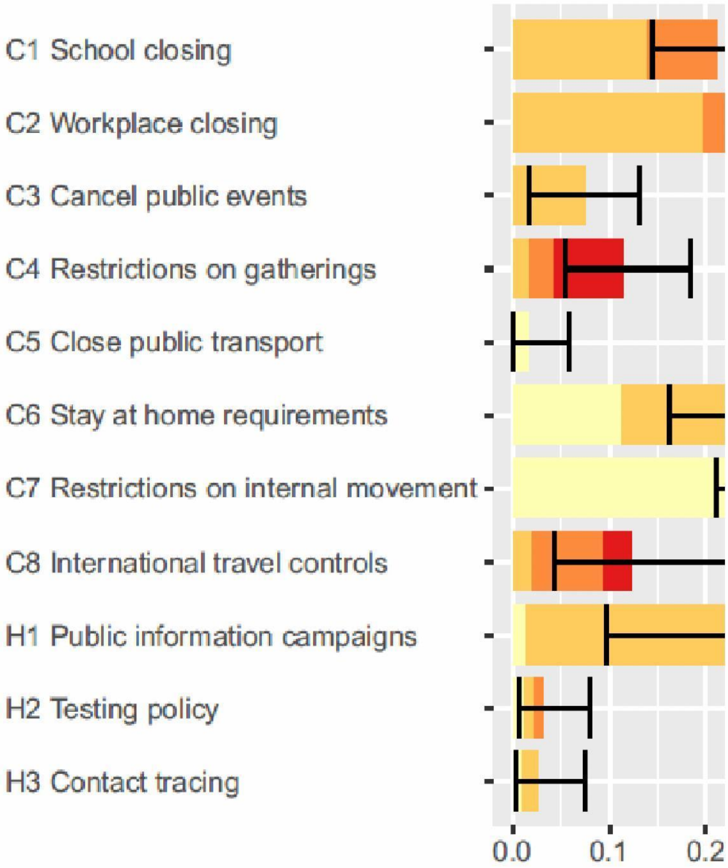
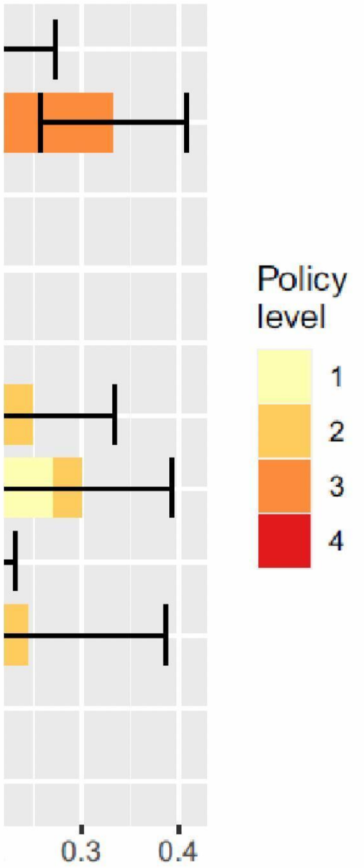


Figure 10. Marginal effect sizes of policy measures on reducing weekly growth rate level; Lines = 95% intervals for maximum policy level [Wibbens et al, 202



s. Bars = median estimate by policy
0]

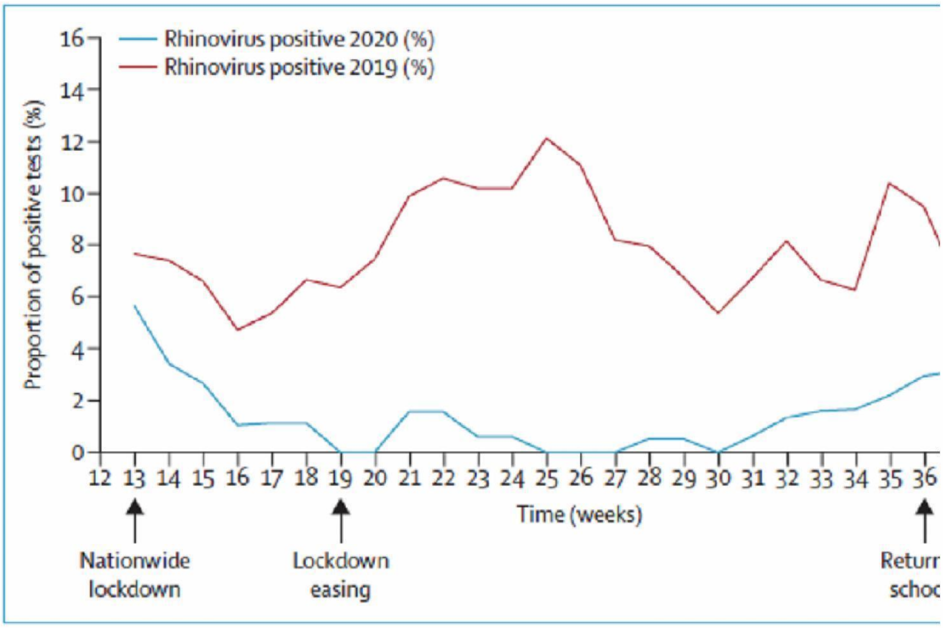


Figure: Proportion of tests positive for human rhinovirus
Data points are 2-week rolling average.


37 38 39 40
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