Study protocol

Policy responses against the COVID-19 pandemic in Latin America: interrupted series analyses of local governments

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Roles and responsibilities

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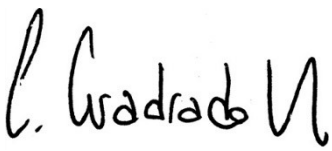

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Background

The COVID-19 pandemic is spreading rapidly worldwide. By January 22, 2021, there were more than 112 million confirmed SARS-COV-2 cases and nearly 2.5 million deaths attributable to COVID-19.[1] Latin America, the region with the highest income inequality,[2] remains as one of the worst-hit areas worldwide. Latin America accounts for 8.4% of the global population, but 20.3% of the total SARS-COV-2 cases and 30.2% of the COVID-19 deaths to date.[1] Several countries in the region are among the worst-hit worldwide. Brazil has had more than 11 million SARS-COV-2 cases and Mexico, Argentina and Colombia have exceeded the 2 million cases each. Similarly, the five most populated countries in the region (Brazil, Argentina, Mexico, Colombia and Peru) exceed 600,000 SARS-COV-2-related deaths.

The Chinese government reported the first cases of pneumonia of unknown origin on December 31, 2019,[3] followed by a rapid increase in the Hubei province in China during the first weeks of January 2020, expanding in continental China and neighboring countries. The World Health Organization declared COVID-19 a public health emergency of international concern on January 30, 2020[4] and a pandemic on March 11, 2020.[5] The pandemic reached Latin America later than other continents, and the first case of COVID-19 in the region was reported in Brazil on February 26,[6] followed by a case in Mexico on February 28, 2020 and subsequently spreading throughout the region during March 2020.

Policy responses to COVID-19 in Latin America have sought to reduce viral spread, increase the capacity of the health system response, mitigate negative consequences, and strengthen governance.[7] Effectiveness studies of social distancing policies in China,[8,9] India,[10] European countries[11,12], the United States[13] and worldwide [14] have shown that these appear to be effective to reduce viral transmission.

Despite the heavy burden of the COVID-19 in Latin American countries, there have been few studies examining the effectiveness of COVID-19 policies.[15-17] Likewise, few studies have explored variation at the local level in the effectiveness of COVID-19 policies.[10,13,16] Inequalities in policy effectiveness can arise due to within-country differences at the local level due to their

geographical, sociodemographic, mobility patterns, and governance differences. In Latin America, high levels of poverty, urban density, household crowding, lack of safety nets, unemployment and precarious work cluster geographically and coexist with structural inequities in governance and built environments, thus creating barriers for effective compliance with preventive recommendations and for the implementation of well-functioning contact tracing and isolation mechanisms. Understanding the effectiveness of policies at the local level and exploring potential explanations for effect heterogeneity is essential to reduce the burden of the ongoing COVID-19 pandemic and inform the preparedness for future pandemics.

In this study, we aim, first, to estimate the effectiveness of nonpharmaceutical interventions on SARS-COV2 transmission and COVID-19 mortality in Latin America; second, to examine the effect heterogeneity of transmission and mortality at the local level. Third, assuming we find evidence of moderate to substantial heterogeneity at the local level, we aim to explore potential explanations for this heterogeneity. We will use an interrupted time series method to estimate their effects in each local government, and random effects meta-analysis and meta-regression to obtain pooled effects, heterogeneity estimates and potential explanations.

Methods

Design and setting

The study is a natural experiment where we exploit the variation in the temporal and spatial implementation of policy interventions, aimed to reduce the spread and mortality of COVID-19 in Latin America. The unit of analysis are local governments, i.e. third-tier administrative levels such as municipalities, districts or cantons.

We will include all countries fulfilling the following eligibility criteria: (1) Spanish or Portuguese speaking countries in Latin America, and (2) availability of open data at the subnational level for either of the outcomes. Appendix I presents the eligible countries, the exclusion criteria and the sources of data for each excluded country. To date, eligible countries are Argentina, Brazil, Chile, Colombia, Costa Rica, Guatemala, Mexico, Paraguay, and Peru. These countries represent 80.9%

of the population in Latin America, and the vast majority of SARS-CoV-2 cases and COVID-19 deaths.

Interventions

We will examine the impact of several interventions to tackle the COVID-19 pandemic. These interventions include (i) policies aimed at reducing viral transmission, (ii) policies aimed at increasing the capacity of the health system's response, and (iii) policies aimed at mitigating the negative consequences of the epidemic and potential adverse effects of interventions. We will use the PoliMap taxonomy to categorise the examined policies.[18] Table 1 describes the policy interventions in each policy domain included in the study.

Table 1. Policy interventions included in the study

Domain	**Policy interventions**
Viral spread (for both outcomes)	Total lockdown Partial lockdown (geographical, step-wise/graduated response) Curfew School closure Closure of shopping malls, gyms, churches, parks Remote work Restrictions to national/subnational mobility Prohibition of mass gatherings
Health systems response (for COVID-19 deaths outcome)	Interventions to increase testing capacity Interventions to increase the number of ICU/critical beds
Mitigation strategies (for both outcomes)	Direct social assistance (in-kind/cash) Cash transfer Withdrawal of pension funds

Comparator

In an interrupted time series analysis, the comparator is a counterfactual outcome defined as the projection of the pre-intervention trend to simulate what would have happened if the policy had not occurred (see Statistical Analysis Plan for definitions).

Outcomes

We will assess three primary outcomes. The first outcome will be the 7-day moving average of daily confirmed cases of COVID-19/SARS-CoV-2. The second outcome is the time-varying reproductive number between the current and previous period.[19] The third outcome is the 7-day moving average of the daily number of deaths by COVID-19 in Latin American subnational regions. For the statistical modelling, these averages will be rounded to the nearest integer. We will consider a 7-day lag as the primary lag. Details on sensitivity analyses can be found in the Statistical Analysis Plan.

We define the outcomes following the official national sources definitions, as each country applies its criteria to define the occurrences and the deaths caused by COVID-19. It is important to note that those criteria are not always clearly stated, but all subnational units are under the same measure at each time.

Data sources

We will obtain COVID-19 cases and deaths data, as well as the covariates, on official government sources, such as the Ministry of Health and Ministry of Science and Technology (see Supplementary Appendix Table S2). The intervention information will come from legal documents, official statements, and quantitative accounts from trustable sources.

Covariates

The first model at the local level does not include covariates (see below). The second model (i.e. the meta-analysis), we will examine the change in heterogeneity after adjusting for several covariates at the local level. Local level covariates include projected population size in 2020, demographic density, age-structure of the population, household density and socioeconomic status. We will use data from official sources of information, primarily the latest national population census in each included country.

Statistical analysis

The Statistical Analysis Plan provides details on the modelling assumptions. We will use an interrupted time series design, where each local government acts as its own control.[20,21] The main

strength of this design is its capacity to distinguish the effect of the intervention from secular change.[22] We will use a Poisson regression to model the count data (for both outcomes) and accounting for overdispersion and secular trends.[23] A full discussion on potential biases and violations of assumptions can be found in the Statistical Analysis Plan.

In a second stage, we will use random effects meta analysis to pool the effect estimates for each intervention or combination of interventions. This analysis informs whether any implemented intervention was effective to reduce COVID-19 cases and deaths and the degree of heterogeneity between the effects at the local level. If we observe high levels of heterogeneity (defined as higher than 50%), we will also use standard meta-regression techniques to assess whether local level determinants (see *Covariates*) can explain the observed heterogeneity.

We will build the models and test the analytical strategy using publicly available data on COVID-19 cases and deaths from Finland and Sweden from January 1 to March 31.

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Supplementary Appendix

Table S1. Countries included in the study and data sources.

Country	Official source	Data source
Argentina	Dirección Nacional de Epidemiología y Análisis de Situación de Salud	http://datos.salud.gob.ar/dataset/covid-19-casos-registrados-en-la-republica-argentina/archivo/fd657d02-a33a-498b-a91b-2ef1a68b8d16
Brazil	Open DataSUS	https://opendatasus.saude.gov.br/dataset/casos-nacionais
Chile	Departamento de Estadísticas e Información de Salud	https://deis.minsal.cl/#datosabiertos
Colombia	Instituto Nacional de Salud	https://www.datos.gov.co/Salud-y-Protecci-n-Social/Casos-positivos-de-COVID-19-en-Colombia/gt2j-8ykr
Guatemala	Ministerio de Salud Pública y Asistencia Social	https://tablerocovid.mspas.gob.gt/
Costa Rica	Observatorio Geográfico en Salud - Ministerio de Salud	http://geovision.uned.ac.cr/oges/#descargas
Mexico	Subdirector de Notificación y Registros Epidemiológicos	https://datos.gob.mx/busca/dataset/informacion-referente-a-casos-covid-19-en-mexico
Paraguay	Ministerio de Salud Pública y Bienestar Social	https://public.tableau.com/profile/mspbs#!/vizhome/COVID19PY-Registros/Descargardatos
Peru	Ministerio de Salud	https://www.datosabiertos.gob.pe/group/datos-abiertos-de-covid-19

Table S2. Countries excluded from the study.

Eligible Country	Reason for exclusion	Source
Bolivia	There is weekly data available at the municipal level, but we did not find daily data.	https://datos.gob.bo/dataset/casos-covid-19-acumulado-por-municipios
Cuba	Information is available in daily reports, but we did not find open data to download.	https://salud.msp.gob.cu/
Ecuador	Daily subnational data is available in charts, but it is not open to download.	https://www.coronavirusecuador.com/data
El Salvador	Daily subnational data is available in charts, but it is not open to download.	https://covid19.gob.sv/
French Guiana	The official language is not Spanish or Portuguese.	-
Guiana	The official language is not Spanish or Portuguese.	-
Haiti	The official language is not Spanish or Portuguese	-
Honduras	Information is available in reports, but we could not find data to download.	http://www.salud.gob.hn/site/index.php/covid19
Nicaragua	We did not find an official source of information.	
Panama	There is a map and some charts with information, but data is not open to download.	http://minsa.gob.pa/covid-19
Republica Dominicana	Information is available in reports, but we did not find open data to download.	https://www.msp.gob.do/web/?page_id=6948
Suriname	The official language is not Spanish or Portuguese.	-
Uruguay	There is information on cumulative cases and deaths available, but not daily subnational data on new events.	https://catalogodatos.gub.uy/dataset/sinae01-covid19
Venezuela	There is daily data available, but it is not disaggregated at the subnational level.	https://covid19.patria.org.ve/api-covid-19-venezuela/

Table S3. Covariates used in the study and availability at the local level.

	Local level availability				
	Population size	Population density	Age structure	Household density	Socioeconomic status
Argentina	Yes	Yes	Yes	Yes	Yes
Brazil	Yes	Yes	Yes	Yes	Yes
Chile	Yes	Yes	Yes	Yes	Yes
Colombia	Yes	Yes	Yes	Yes	Yes
Costa Rica	Yes	Yes	Yes	Yes	Yes
Guatemala	Yes	Yes	Yes	Yes	Yes
Mexico	Yes	Yes	Yes	Yes	Yes
Paraguay	Yes	Yes	Yes	Yes	Yes
Peru	Yes	Yes	Yes	Yes	Yes