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Strengthening Health Systems To Face Pandemics: Subnational Policy Responses To COVID-19 In Latin America

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ABSTRACT Nonpharmaceutical interventions such as stay-at-home orders continue to be the main policy response to the COVID-19 pandemic in countries with limited or slow vaccine rollout. Often, nonpharmaceutical interventions are managed or implemented at the subnational level, yet little information exists on within-country variation in nonpharmaceutical intervention policies. We focused on Latin America, a COVID-19 epicenter, and collected and analyzed daily subnational data on public health measures in Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, and Peru to compare within- and across-country nonpharmaceutical interventions. We showed high heterogeneity in the adoption of these interventions at the subnational level in Brazil and Mexico; consistent national guidelines with subnational heterogeneity in Argentina and Colombia; and homogeneous policies guided by centralized national policies in Bolivia, Chile, and Peru. Our results point to the role of subnational policies and governments in responding to health crises. We found that subnational responses cannot replace coordinated national policy. Our findings imply that governments should focus on evidence-based national policies while coordinating with subnational governments to tailor local responses to changing local conditions.

Latin America is one of the regions most affected by the COVID-19 pandemic and has been an epicenter throughout. Although it is home to only 8 percent of the global population, it had accounted for more than 30 percent of accumulated COVID-19 deaths as of mid-May 2021.¹ The patterns, over time, of deaths and cases differ, yet no country in Latin America can attest to having implemented a national nonpharmaceutical intervention strategy that has been effective in containing the spread of COVID-19.^{1–4}

Nonpharmaceutical interventions are critical to containing the pandemic until vaccination reaches the majority of the population in Latin America and around the world.^{5–15} Vaccination will be a lengthy process, as rollout has often been slow and uneven despite the approval of several vaccines. Yet the timeliness, mix, and rigor of nonpharmaceutical interventions in Latin America have varied both across and within countries since the first COVID-19 case in the region was reported February 25, 2020, in São Paulo, Brazil.^{16,17}

By the end of March 2020 many countries had

implemented at least some national restrictions, yet the rigor and types of nonpharmaceutical interventions have waxed and waned during the pandemic.¹⁸ In Brazil and Mexico, which account for 55 percent of the region's population,¹⁹ federal governments delegated or "punted" responsibility for nonpharmaceutical interventions to state governments, leading to large-scale variation within each country with no central, evidence-based planning.²⁰ In other countries, national leaders relaxed policies at the subnational level in an attempt to balance health imperatives, economic outcomes, and limited compliance resulting from lockdown fatigue. Countries in the region struggled to gather adequate evidence to guide their subnational policy making. Only Uruguay—a country with high per capita deaths—and Chile focused on access to testing.²¹ However, access to diagnostic tests was often scarce in the region and unequally distributed between the rich and the poor.²² This inequity in access produced a patchwork of nonpharmaceutical interventions within and across countries, sometimes reactively and seldom proactively responding to geographic variation in risk based on evidence, given the limited testing and contact tracing available.

In this article we describe the adoption of nonpharmaceutical interventions at the state or departmental level for Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, and Peru, whose populations account for 80 percent of the population of Latin America, from the date of the first case in each country through February 2021,²² approximately a year after the first detected cases in the region. Our descriptive data suggest that countries with comprehensive national responses implemented containment policies throughout their territories.

Few studies have analyzed subnational variation in the use of nonpharmaceutical interventions in the COVID-19 response, even though variation exists in all countries and almost no data are available for low- and middle-income countries.^{6,10} Our analysis is based on a unique data set that records daily adoption of nonpharmaceutical interventions at the state or departmental level for the eight countries listed above since the first recorded case in each country. These data come from the Observatory for the Containment of COVID-19 in the Americas,²³ which provides data on the adoption of public policies at the national and subnational levels in Latin America.

Study Data And Methods

As part of the Observatory for the Containment of COVID-19 in the Americas,²³ we collected data

on nonpharmaceutical interventions related to physical distancing and containment of COVID-19 in each of the eight countries' subnational territories, beginning with the first reported case in each country. We focused on the state, department, or provincial level of government administration. The data presented in this article are from February 25, 2020, when the first COVID-19 case was confirmed in Latin America in São Paulo, Brazil, to the end of February 2021, spanning the first year of the pandemic in the region for half of the countries in the data set.

DATA We focused on the following nonpharmaceutical interventions: school closings, suspension of work, cancellation of public events, suspension of public transport, development of information campaigns, travel restrictions within the state, international travel controls, stay-at-home orders, restrictions on the size of gatherings, and the use of face masks. We selected these variables on the basis of a literature review at the beginning of the pandemic to identify measures influencing the level of COVID-19 cases and deaths.^{24–30} We also relied on the Oxford COVID-19 Government Response Tracker 5.0,³¹ which records data on countries' policy responses to the pandemic at the national level, as a guide to select the ten nonpharmaceutical intervention response variables. Other studies of nonpharmaceutical interventions to contain COVID-19 generally emphasize a subset of these variables.^{5–7,14,15,32,33} We adjusted each policy response variable to categorize state-level policy implementation.

We examined whether each policy was in effect each day from the day the first case was detected in the country. If a measure was in effect, we coded its application as partial or total to measure the policy's implementation intensity. Table 1 in the online appendix describes the ten policy variables and their possible values.³⁴ We assigned several discrete levels to the variables to achieve greater granularity in the analysis. Variables range from 0 to 1 in discrete levels; detailed variable descriptions, labels, and coding are in the first section of the appendix.³⁴

To gather the data, we first reviewed official government websites to capture laws, decrees, and news items specifying the implementation of each public policy variable. We then cross-referenced this material against publications in news outlets and journalists' coverage of laws, decrees, cases, and deaths. Finally, we gathered information from official state or departmental social media accounts, primarily Twitter and Facebook, when other official sources did not report data. We then carried out an internal, random coding review whereby two authors not involved in the original coding independently ver-

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ified daily subnational scores for specific policy variables to ensure validity and intercoder reliability. A detailed log of sources is in the appendix.³⁴

ANALYSIS We analyzed the ten nonpharmaceutical intervention variables individually and combined nine of them into a composite measure for each country. This article focuses on the composite measure. To analyze the nonpharmaceutical interventions as a block and allow for comparison both across and within countries of overall policy response to COVID-19, we built on the stringency index developed by the Oxford COVID-19 Government Response Tracker team to generate a measure of public policy adoption from all nonpharmaceutical intervention variables other than mask mandates.³¹

Our public policy adoption measure sums daily scores for each policy variable. The scores are expressed as an index, which we constructed to take time since implementation into account by multiplying the sum of policy scores by a ratio of the days since implementation to the days since a country's first case. The appendix contains a detailed discussion of the measure's construction.³⁴

For each country and policy implementation phase, we first estimated the mean public policy adoption score by weighting public policy adoption by the population of each state, province, or department. Then we documented and described subnational heterogeneity in the stringency of nonpharmaceutical interventions and compared the country responses against each other. We considered variation in nonpharmaceutical intervention policies using public policy adoption to measure the timeliness and intensity of implementing a standard set of policies.

We analyzed mask mandates separately because the use of face masks behaves differently from the other measures. Mask recommendations or requirements tended to be a reopening feature and are not designed to restrict movement. Instead, they modulate distancing and facilitate closer, safer contacts among the population. They were often implemented much later than the other indicators we collected, based on the World Health Organization's (WHO's) release of general guidance about the use of face coverings by the public on June 5, 2020.²⁴ Our measure is constructed similarly to the composite index: Scores reflect the stringency and timeliness of any mask use mandates, with higher scores indicating stricter, earlier adoption of the mandate.

LIMITATIONS This was a descriptive study of ten nonpharmaceutical intervention policies at the subnational level across eight countries. Our data suggest patterns for further investigation,

but we could not make causal claims or draw causal inferences from these data at this point. Although the eight countries in our data set cover 80 percent of the population in Latin America, there are important and diverse experiences in the countries that we could not incorporate.

Relatedly, the ten nonpharmaceutical interventions for which we collected data are not the only nonpharmaceutical interventions possible. In addition, the composite measures implicitly assume that the nonpharmaceutical interventions are additive and should be weighted equally. This is a simplifying assumption that could be interrogated critically in future research.

We did not consider the behavioral response to nonpharmaceutical interventions across the region. The effectiveness of nonpharmaceutical interventions for controlling SARS-CoV-2 transmission is contingent on compliance, which we know is not universal.^{35,36} However, we did not have cross-national, subnational data on compliance across nonpharmaceutical interventions to incorporate in our analysis.

The data on COVID-19 cases and deaths across the region were of uneven quality and often incomplete as a result of countries taking different approaches to testing, varying laboratory capabilities, varying case definitions, and often limited capacity to record and report information at the national and subnational levels. Country teams had differing access to data depending on a given country's data collection and availability and the size and access of the specific country team. As a result, we could not directly assess the effect of subnational policy responses on COVID-19 and its associated health outcomes across countries.

Study Results

We identified three broad phases of nonpharmaceutical intervention policy implementation across the countries: early response, meaning initial strategies including school closures, event restrictions, stay-at-home orders, and other large-scale interventions; lockdown, meaning the wholesale implementation of large-scale interventions, during which some countries also made adjustments to their initial strategies and mandated mask usage; and reopening, meaning the relaxation of national and state-level nonpharmaceutical intervention policies as testing and evidence became more widely available and a more localized, outbreak-driven response became the dominant approach to controlling the spread of the virus. We organize the results according to these phases.

We observed extensive variation in contain-

ment policies across and within countries in the early response and lockdown phases and then a slight convergence during the reopening phase. The timing and rigor of the adoption of the nine clustered policies at the subnational level in all eight countries are in exhibit 3A in the appendix.³⁴

EARLY RESPONSE Exhibit 1 presents policy responses to the COVID-19 pandemic since the first reported cases, plotted as daily index values. The dotted lines represent responses during the first phase, the dashed lines reflect the second phase, and the solid lines the third phase. Higher index values represent more strict policy responses.

Brazil and Mexico had the laxest early responses, with considerable variation across their states. Chile had an intermediate early response that had little subnational variation and was primarily driven by localized lockdowns, followed by Colombia and Argentina, which exhibited similarly strict responses but with significant subnational variation. Bolivia, Ecuador, and Peru stand out as the countries with the strictest early responses overall.

Exhibit 2 presents mask use mandates implemented since the first reported COVID-19 cases, similarly plotted as daily index values. We found that Colombia was the first country to act, insti-

tuting a mask mandate even before the WHO's recommendation, followed by Bolivia, Peru, Chile, Ecuador, Argentina, Mexico, and finally Brazil. Countries adopted this policy at different phases of their response and with differing rigor. Further, comparing exhibits 1 and 2 shows that the eight countries continued to promote masks while relaxing other containment policies.

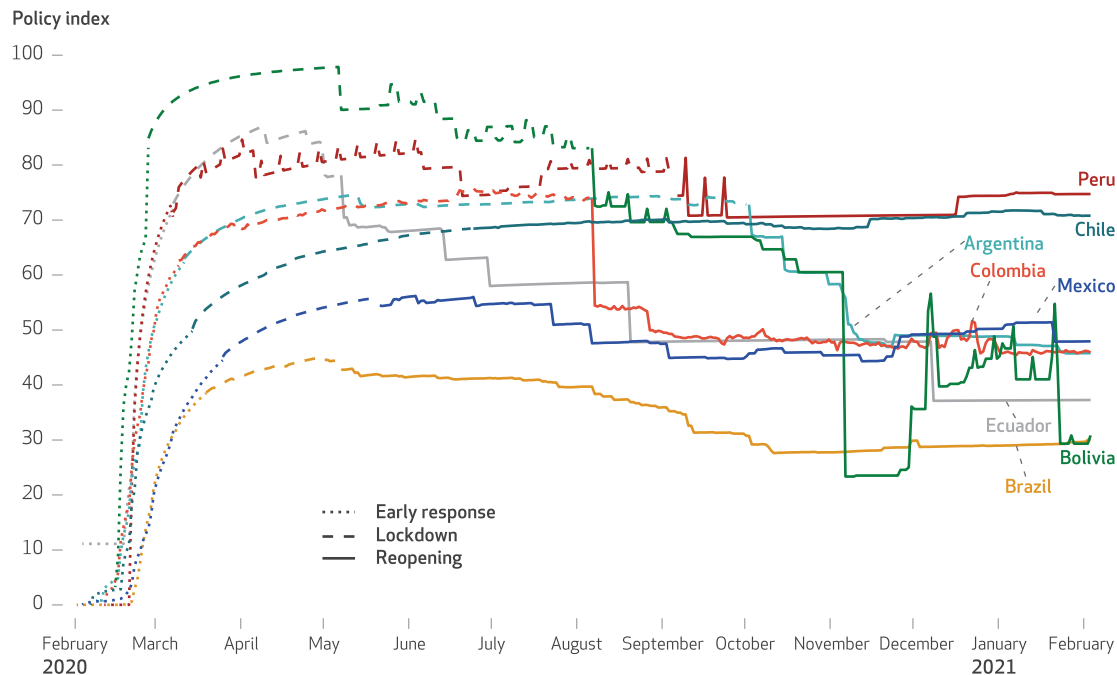
Exhibit 3 differentiates within countries and presents state-level variation in policy implementation in each country over time. Exhibit 3 is a box-and-whiskers plot that compares the nine clustered policy variable scores within and across countries for each pandemic phase (masks are excluded). Policy responses are color-coded for early response, lockdown, and reopening. The line within the box plot represents a country's median score during that phase. We chart the daily evolution of the average policy response for the nine clustered variables for states, provinces, or departments broken out by country in appendix exhibit 3a.³⁴

Bolivia, Ecuador, and Peru stand out as the countries with the least subnational variation in exhibit 3.

LOCKDOWN Most countries implemented stay-at-home orders during the lockdown phase (exhibits 1–3). The country with the lowest average

EXHIBIT 1

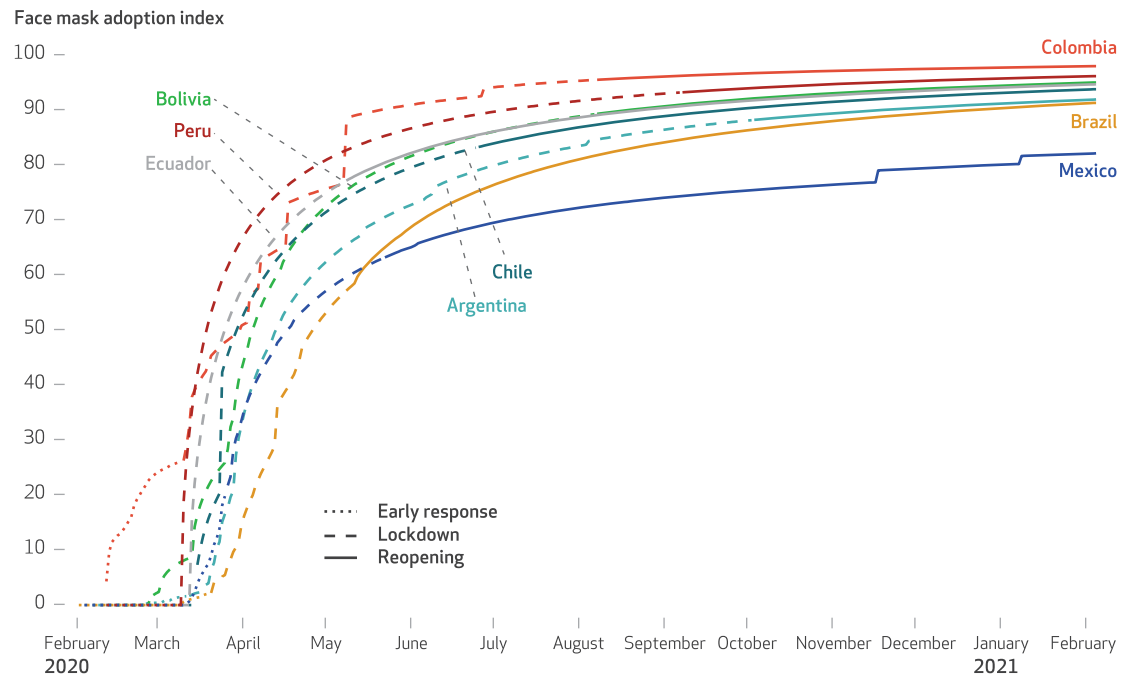
Public policy adoption of COVID-19 nonpharmaceutical interventions in 8 Latin American countries since the first reported case of COVID-19 in each country, February 2020–February 2021



SOURCE COVID-19 Observatory (see note 23 in text). **NOTES** The policy index is an aggregate measure of adoption of 9 nonpharmaceutical intervention variables other than mask mandates, which we analyzed separately. A higher score means adoption of more interventions, more stringent implementation, and earlier adoption. Additional detail is in the appendix (see note 34 in text).

EXHIBIT 2

Face mask adoption in 8 Latin American countries since the first reported case of COVID-19 in each country, February 2020–February 2021



SOURCE COVID-19 Observatory (see note 23 in text). **NOTES** The face mask adoption index is an individual measure of the timing and stringency of the adoption of mask use mandates. A higher score reflects the early adoption of more stringent mask mandates. Additional detail is in the appendix (see note 34 in text).

response is Brazil, again with considerable subnational variation, followed by Mexico, Chile, Argentina, Colombia, Peru, Ecuador, and Bolivia. Half of the countries under study exhibit significant subnational differences, although Brazil stands out as having the most heterogeneous response.

Brazil and Mexico had the least stringent non-pharmaceutical interventions across countries: They were the last to enter the lockdown phase, and their lockdowns were brief and limited compared with those of other countries. Conversely, Argentinians endured the longest lockdown in the world based on the pandemic to date.

REOPENING Brazil was the first of the eight countries to reopen, followed by Mexico and then Ecuador. Reopening did not begin in Bolivia or Colombia until September 2020, in Peru until October 2020, and in Argentina until November 2020. In the reopening phase (exhibits 1–3) subnational policies in Bolivia and Ecuador that had been very strict became more heterogeneous and relaxed significantly. In Peru, some relaxation of policies took place as well, although to a lesser extent. In Argentina, Brazil, and Mexico, the policy index scores in this phase were unexpectedly similar to those in the previous stricter phase. In Colombia, the reopening

entailed significant relaxation, which is visible in the drop in the average policy score. Chile began a five-step reopening plan July 19, 2020, gradually relaxing social distancing or imposing stricter restrictions at the municipal level.³⁷ As a result, the policy scores for Chile's subnational regions during the reopening phase are even higher than in the lockdown phase, but mobility restrictions were tailored to the epidemiological situation at the municipality level.

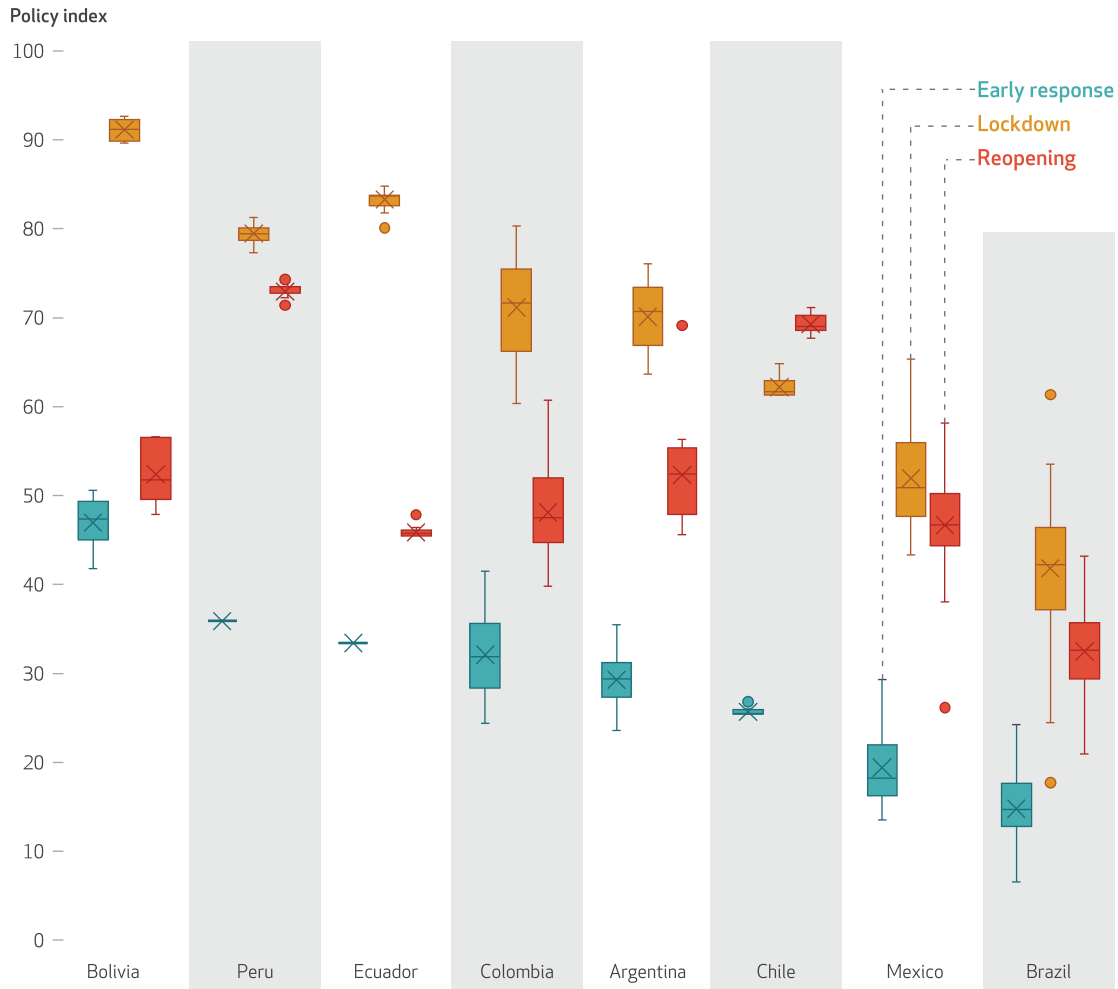
In Argentina, Bolivia, Chile, Colombia, Ecuador, and Peru, national governments established a strict countrywide framework of restrictions to contain COVID-19. Instead of independent and contrasting subnational responses, the national governments in these six countries set a high policy floor that subnational governments typically complied with, although we observed considerable variation within Argentina and Colombia.

Discussion

Our analysis aligns with other studies showing wide variation in nonpharmaceutical interventions to contain COVID-19, both across and within countries.^{9,11,14,15,33} Two groups emerge among the countries in this study across the early re-

EXHIBIT 3

Distribution of COVID-19 nonpharmaceutical intervention policy index scores across states for 8 Latin American countries, by country and phase, February 2020–February 2021



SOURCE COVID-19 Observatory (see note 23 in text). **NOTES** The policy index is an aggregate measure of adoption of 9 nonpharmaceutical intervention variables other than mask mandates, which we analyzed separately. A higher score means adoption of more interventions, more stringent implementation, and earlier adoption. The box-and-whisker plots show the interquartile range (the boundaries of the box), the mean (the X within the box), the median (the line within the box), the range of the data (the whiskers), and outlier points (the dots). Additional detail is in the appendix (see note 34 in text).

sponse, lockdown, and reopening phases of the pandemic to date: National governments in Argentina, Bolivia, Colombia, Ecuador, and Peru responded within days of their first cases with strict containment policies, superseding any objections from local governments. National governments in Brazil and Mexico lagged in policy implementation, which produced considerable variation at the subnational level and led to a lax aggregate response. Chile is between both groups, with a less strict response than the first group, based on Chile’s localized lockdowns at the municipal level.³³ However, Chile had an overarching national response that led to stricter measures than in the second group of countries.

Our analysis is descriptive but relates to the

broader literature on nonpharmaceutical interventions and health outcomes of the COVID-19 pandemic. Research on some nonpharmaceutical interventions we analyzed, such as mask mandates, is consistent in identifying a relationship between more stringent implementation and prevention of SARS-CoV-2 transmission.^{7,38–40} The caveat is that the efficacy of other nonpharmaceutical interventions, such as lockdowns, wanes over time as economic costs and fatigue mount while compliance falls.³³ Considerable scholarship proposes the nonpharmaceutical interventions we analyzed for combatting COVID-19.^{5,6,9,33} Yet there is great difficulty in estimating causal relationships among nonpharmaceutical interventions, cases,

and deaths from COVID-19. This is partly because of the extensive subnational variation in nonpharmaceutical interventions, cases, and deaths, coupled with the lack of data available at the subnational level. It is also partly because of the knowledge that officially adopting a policy does not necessarily mean policy compliance in practice. Given these difficulties, our descriptive study sets the stage for causal analysis by identifying this variation across and within countries.

Autonomy and responsibility within the health system could explain some of the observed variation across countries. Brazil, Chile, and Mexico have decentralized health systems in which state and local governments are responsible for a large portion of health spending and service delivery. Other countries, such as Ecuador, have more centralized systems in which subnational governments have less autonomy, fewer resources, and fewer responsibilities related to public health. However, some countries, such as Argentina, centralized a stringent nonpharmaceutical intervention response in an otherwise decentralized health system. Yet some Brazilian states and municipalities sued to retain decentralized rights to implement more stringent nonpharmaceutical interventions in the face of the national government's attempt to centralize a limited response.

The decentralization of health decision making prepandemic almost certainly influenced how a country implemented national policy.^{10,11,16} In addition, some countries and subnational units were more equipped to close borders to travelers and trade than others, which may have influenced the expansion of the pandemic. National-level lockdowns are particularly difficult to sustain in a region where more than half of the working-age population remains precariously employed in the informal sector and has limited access to social protection, external financing, or savings, making it difficult to comply with stay-at-home orders for extended periods. This reality almost certainly influenced policy-making decisions across Latin America.¹¹ Moreover, lockdowns are less effective in poor, densely populated communities, where household heads cannot work from home and residential crowding is a concern.^{35,41}

Our descriptive analysis suggests that the stringency of the early response may relate to the stringency of the lockdown phase: Countries in which subnational governments initially responded quickly and with more restrictions quickly moved to strict lockdowns, as in the cases of Argentina, Bolivia, Colombia, and Peru. In contrast, countries with limited early reactions, such as Brazil and Mexico, also had limited reactions in the second phase and never locked

down to the extent seen in other countries, despite attempts from some governors and mayors.

Countries that rolled out clear national policies appeared to display higher levels of policy stringency. Yet this stringency did not preclude subnational heterogeneity. National responses were strictly implemented in subnational units across Bolivia and Chile, resulting in near-zero subnational policy variation, except for localized lockdowns in Chile. However, in Argentina and Colombia, we observed the coexistence of a national policy framework with subnational heterogeneity at high levels of stringency.

Countries with either absent or late national response have lower policy index scores and more subnational variation. Along the same lines, countries with less stringent responses during the pandemic's early response and lockdown phases maintained a similar policy level in the reopening phase because these countries did not have many containment policies to relax in the first place. In contrast, countries with stricter responses in the first two phases relaxed significantly during reopening as they pared back stringent policies.

Finally, whether a country has a federal or unitary national government structure does not appear to explain the stringency of the response, its speed, or the extent of subnational variation in our descriptive analysis. Although Brazil's and Mexico's federal governments had lax responses, Argentina, a federal country, and Bolivia, a decentralized country, implemented strict policy responses that were guided by national mandates. In comparison, Colombia, a unitary country, demonstrated considerable subnational variation.

Policy Implications

Countries face stark social and economic costs imposed by large-scale nonpharmaceutical interventions to address COVID-19. At the same time, many countries have largely failed to control the spread of SARS-CoV-2.⁴² The potential trade-offs between slowing the spread of the disease and supporting livelihoods are especially important in low-income countries; rich countries have income support, but countries in Latin America often do not.

Our data are the first to cover daily, subnational policy responses to the COVID-19 pandemic for a cross-national sample and show that implementation of nonpharmaceutical interventions differed significantly within and across countries. Many Latin American governments quickly implemented nonpharmaceutical interventions as a critical first response to the COVID-19 pandemic. By the end of March 2020, most countries

had established a full suite of strong, nationally binding travel restrictions, school closures, entry bans, and mandatory lockdowns. But despite national responses, or the lack thereof, public health policies to contain COVID-19 in Latin American exhibit important cross-national and subnational variation.

Brazil and Mexico, the two largest countries in the region, implemented nonpharmaceutical interventions slowly and in a decentralized manner. Lacking a cohesive or evidence-based national policy, their leaders understated the risk of the virus and relied on or defaulted to state governments to design, organize, and implement nonpharmaceutical interventions. COVID-19 policy responses in Brazil and Mexico exhibit dramatic subnational heterogeneity—more so in Brazil, which is the only country in our sample without a coordinated national response. Citizens' public health experiences during the pandemic likely reflected subnational decision making and implementation capacity.

Bolivia, Ecuador, and Peru displayed coherent and comprehensive national responses that left little autonomy to subnational governments, leading to higher policy scores in our data with little subnational variation. In Argentina and Colombia, comprehensive national responses left more room for subnational governments to implement additional policies, leading to moderate subnational variation and high policy scores. Chile, in contrast, implemented a policy response that was nationally controlled but subnationally differentiated, including localized lockdowns.

National leaders in Bolivia, Colombia, and Ecuador set rigorous policy during the early

phases of the pandemic but responded to quarantine fatigue and shrinking economies by lifting most restrictions by late 2020. In general, most Latin American national and subnational governments relaxed containment policies beginning in August 2020. As cases and deaths rose, only a few countries effectively transitioned to policies that responded to outbreaks instead of resorting to large-scale lockdowns.

Conclusion

One important takeaway from this novel subnational data set is that subnational units cannot make up for a lax national response. In our data, subnational governments attempting to enact strict policies in countries without a comprehensive national response were unable to replicate the policy coverage of subnational governments in countries with a comprehensive response.

Our study highlights the importance of collecting subnational data instead of simply taking an aggregate measure or assuming that national policies are uniformly implemented. Subnational response patterns may be either tailored local measures or an indication of ineffective national planning and lack of coordination. Smaller countries may be more effective in comprehensive nonpharmaceutical intervention adoption and relaxation, but that may depend on their ability to close their borders to neighbors. Future pandemic responses require attention to local and subnational policy making. This, in turn, depends on forging coordinated, evidence-based national policy and connecting it to nonpharmaceutical interventions at the state and local levels. ■

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