THE LANCET
Global Health

Supplementary appendix 2

Appendix 2

Table S1: Data sources

Data Source	Reference and variables extracted
2013 National Health Survey (PNS)	National Health Survey 2013: Perceived health status, lifestyles and chronic diseases Brazil, major regions and federation units. Rio de Janeiro (RJ): Instituto Brasileiro de Geografia e Estatística; 2014. ftp://ftp.ibge.gov.br/PNS/2013/pns2013.pdf **Variables**: Share of households in vulnerable conditions; share of individuals with health risk factors
2019 Continuous National Household Sample Survey (PNADC, 4th Quarter)	Continuous National Household Sample Survey: IBGE Indicators, Fourth Quarter of 2019. Instituto Brasileiro de Geografia e Estatística; 2020. https://www.ibge.gov.br/estatisticas/sociais/trabalho/9171-pesquisa-nacional-por-amostra-de-domicilios-continua-mensal.html?=&t=microdados **Variables**: share of individuals aged ≥ 60 years and share of informal workers by state
Atlas of Human Development	Website: http://www.atlasbrasil.org.br/2013/en/home/ **Variables**: Human Development Index (HDI), HDI-E (Education), and HDI-I (Income) by municipality in 2010
National Register of Health Establishments (CNES)	Available in: http://cnes.datasus.gov.br **Variables**: Number of Total Beds and ICU Beds available in SUS by municipality in January 2020
2018 Medical Demography	Scheffer, M. et al. (2018) Demografia Médica no Brasil 2018 São Paulo,SP: FMUSP, CFM, Cremesp. https://portal.cfm.org.br/index.php?option=com_content&view=article&id=27509:2018-03-21-19-29-36&catid=3 **Variables**: Number of ICU Physicians in 2018
Brazilian Institute of Geography and Statistics (IBGE)	Available in: https://www.ibge.gov.br/estatisticas/sociais/populacao/9103-estimativas-de-populacao.html. **Variables**: Population Estimate in 2019 by municipality
Ministry of Social Development	Programa Bolsa Família. Available in: https://dados.gov.br/dataset/bolsa-familia-misocial. Accessed on: October, 10, 2020 **Variables**: Number of *Bolsa Família* beneficiaries on December 2019 by municipality
e-Gestor AB	Brazilian Ministry of Health. Website: https://egestorab.saude.gov.br/ Accessed on: June 28, 2020. **Variables**: Coverage Rates of *Estratégia Saúde na Família* (ESF) and *Agentes Comunitários de Saúde* (ACS) on December 2019
In Loco	Shared with authors in an anonymized and aggregated dataset. **Variables**: Physical Distancing by day, by state and municipality (Percent of individuals in sample who remained at home)
Brasil.io	Brasil.io website, collected from State Health Secretariats bulletins. Available in: https://brasil.io/home/ Accessed on June 30, 2020. **Variables**: Deaths from COVID-19 by day and municipality.
Policy Stringency Index	Available in: https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/IPIL8X. More recent data for October was not publicly available on the website at the time of the analysis and was obtained directly from authors. **Variables:** Policy Stringency Index
Brazilian Ministry of Health	New beds added. Available in: https://covid-insumos.saude.gov.br/paineis/insumos/painel_leitos.php (accessed on July 1, 2020) and https://viz.saude.gov.br/extensions/DEMAS_C19Insumos_LEITOS/DEMAS_C19Insumos_LEITOS.html (accessed on November 1, 2020) **Variables:** Number of New Beds added by state by June

Additional Details on the Construction of the Socioeconomic Vulnerability Index

We constructed a state-level index of socioeconomic vulnerability by extracting the principal component of four variables. The first, from 2013 PNS, is the percentage of households under vulnerable housing conditions at the state level. This includes households with (i) poor walls (uncoated masonry, uncoated rammed earth, and reclaimed wood/straw); or (ii) no sewage or septic tank; or (iii) no running water; or (iv) no waste collection. The second, from Q4-2019 PNADC, is the share of informal workers by state, comprising those who did not hold a formal labour contract and the self-employed. The last two variables were the income and education subcomponents of the Human Development Index (HDI), from UNDP and based on IBGE 2010 Population Census. The income and education subcomponents of HDI are available at the municipal level, thus we aggregate them to the state level in a weighted average by population.

Principal component analysis (PCA) is often used to create indices in many applications such as our SVI. Its essential goal is to reduce a complex set of many correlated variables into a set of fewer, uncorrelated components. Unlike analyses that rely on variables from different sources of data, countries and time periods, PCA is adequate in our case as we rely on a homogeneous set of IBGE survey variables to condensate the existing variation in four variables related to socioeconomic vulnerability across states into a simple index, for a single period of time. More specifically, we built the SVI by using the first component of a PCA based on the four state-level socioeconomic variables, as mentioned above. We report below the weights obtained in the principal component decomposition:

Variable	First Component
Household Vulnerability	-0.4521
Informality	-0.4710
Income HDI	0.5378
Education HDI	0.5334

We then renormalized the first component to create an index ranging from 0 to 1, being 0 the least vulnerable state and 1 the most vulnerable. The SVI was estimated by using the formula $SVI = [PC - ma\,x(PC)]/[min(PC) - ma\,x(PC)]$. An important limitation of the SVI relates to the fact that we used a limited set of socioeconomic variables to perform the PCA and that we used variables aggregated at the state level. This is justified by the fact that the most recent data from PNS and PNADC are representative at the state level, but not at the municipality or at a more disaggregated level. Yet, the pattern of correlation among the four variables used to compute the SVI was well-marked and the index adequately captured socioeconomic vulnerability across states in a straightforward way.

Figure S1: Rankings of socioeconomic, health system indicators, physical distancing, and governmental responses by state. State rankings (1st to 27th) for each indicator are in increasing order of vulnerability (1=less vulnerability and 27=more vulnerability). Higher vulnerability means, for instance, higher ranking in SVI, higher scarcity in hospital resources, and lower coverage of ACS and ESF. State acronyms are: AP (Amapá), RR (Roraima), AC (Acre), PA (Pará), AM (Amazonas), TO (Tocantins), RO (Rondônia), PI (Piauí), MA (Maranhão), CE (Ceará), BA (Bahia), AL (Alagoas), RN (Rio Grande do Norte), SE (Sergipe), PB (Paraíba), PE (Pernambuco), MT (Mato Grosso), DF (Distrito Federal), MS (Mato Grosso do Sul), GO (Goiás), RJ (Rio de Janeiro), SP (São Paulo), ES (espírito Santo), MG (Minas Gerais), SC (Santa Catarina), RS (Rio Grande do Sul), and PR (Paraná).
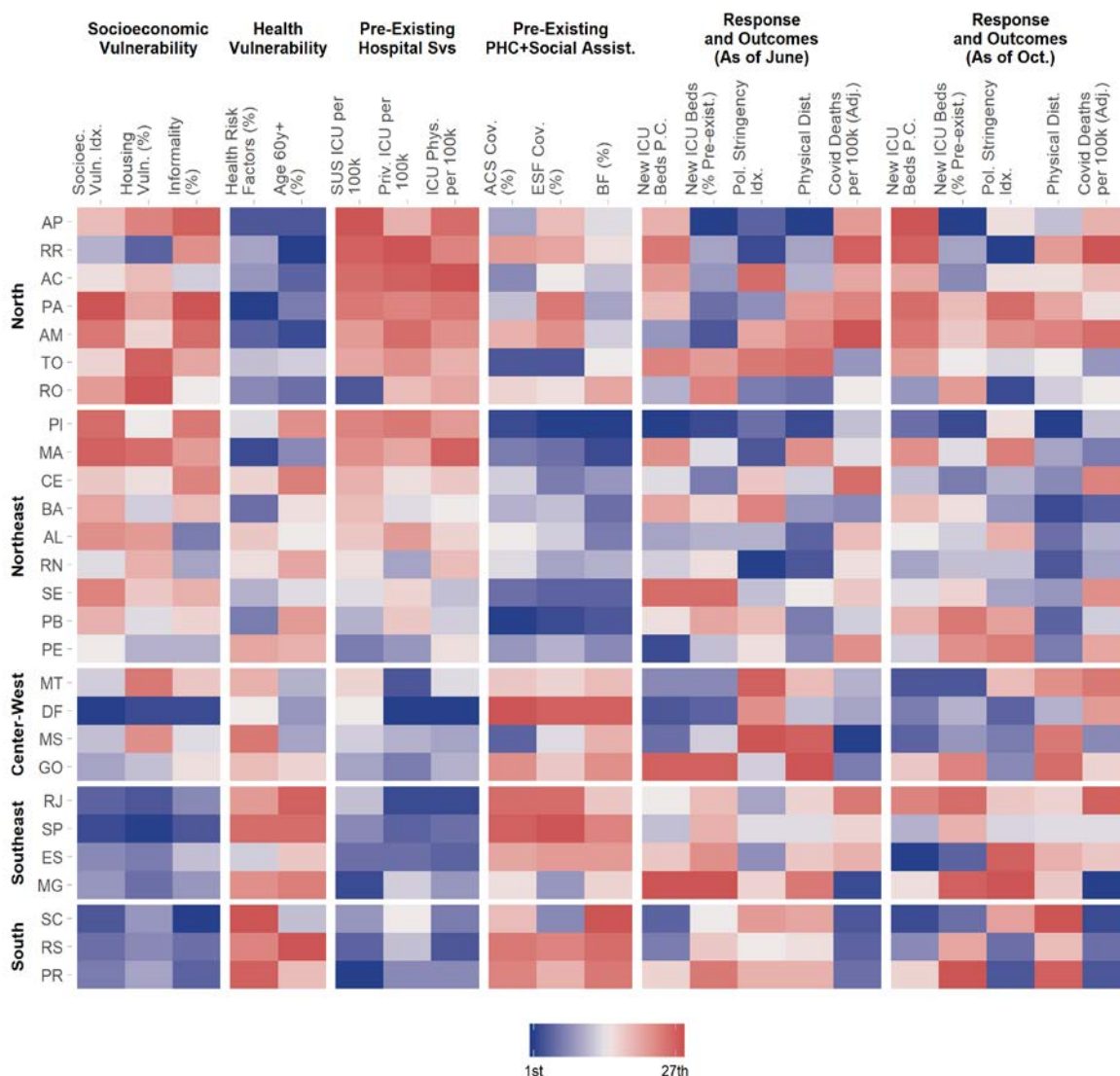
Figure S2. Differentials on outcome variables by socioeconomic vulnerability and month. (A) Death rates. (B) Physical distancing and policy stringency indicators. The plots report coefficients (and respective confidence intervals at 95%) of linear regressions which measure the difference in average outcomes between more vs less socioeconomically vulnerable municipalities, for each month (February is the omitted category). Regressions are adjusted for baseline characteristics (**Table S.2**).
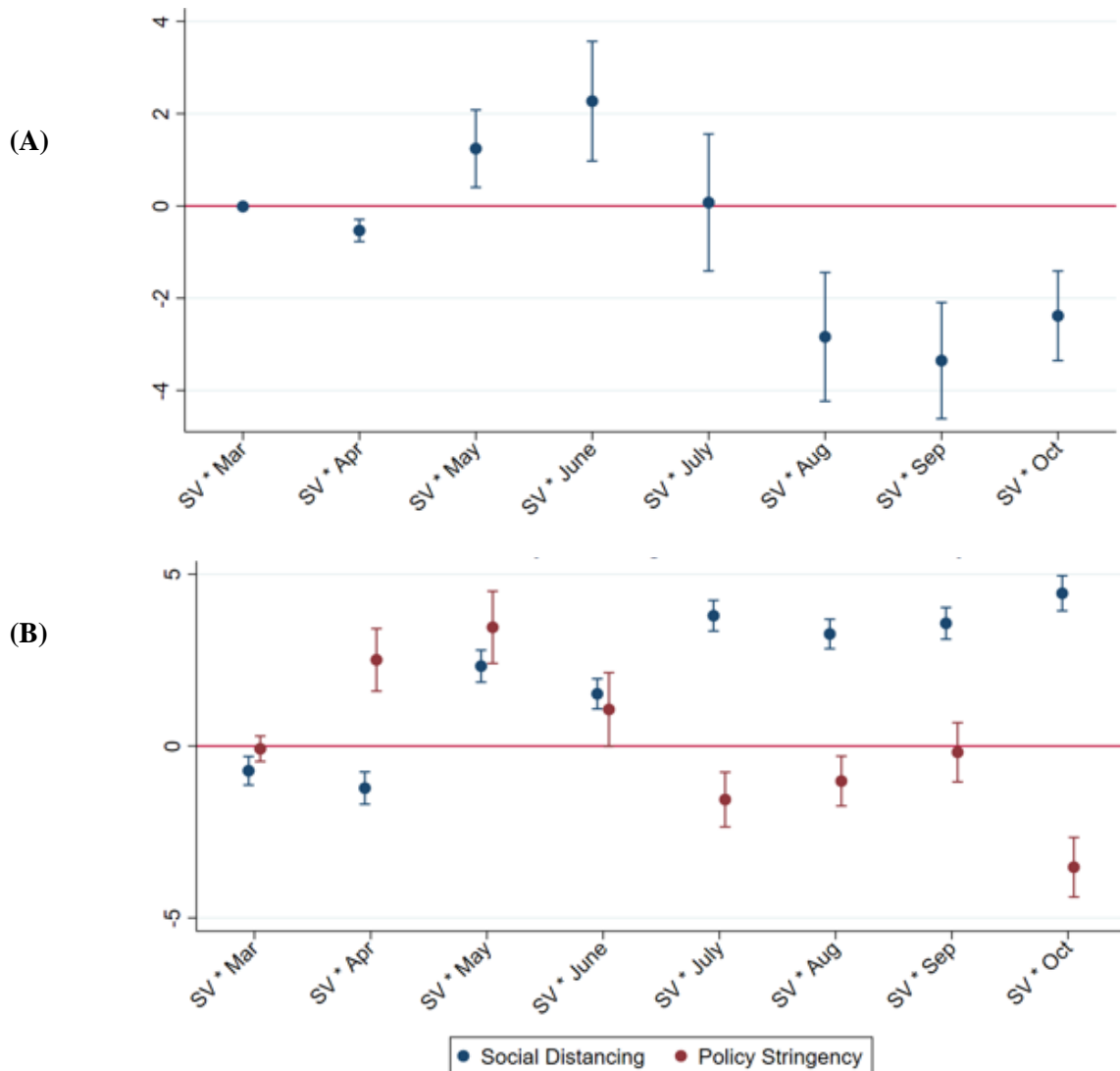
Table S2. Regression results: adjusted for baseline characteristics

	(1)	(2)	(3)
	Covid Death Rate	Physical Distancing (%)	Policy Stringency Index
Mar	0.013 (0.008)	8.445 (0.147)***	17.004 (0.139)***
Apr	0.835 (0.104)***	12.030 (0.150)***	42.487 (0.258)***
May	2.499 (0.223)***	10.060 (0.141)***	49.602 (0.290)***
Jun	5.254 (0.342)***	8.222 (0.131)***	51.296 (0.297)***
Jul	9.339 (0.463)***	8.318 (0.130)***	51.661 (0.212)***
Aug	10.981(0.483)***	7.193(0.126)***	48.072 (0.182)***
Sep	9.152 (0.436)***	5.856 (0.133)***	40.705 (0.297)***
Oct	6.560 (0.371)***	5.113 (0.141)***	38.634 (0.284)***
SV	1.317 (0.377)***	-2.619 (0.406)***	0.393 (0.418)
SV * Mar	-0.013 (0.008)	-0.717 (0.211)***	-0.080 (0.188)
SV * Apr	-0.533 (0.123)***	-1.222 (0.239)***	2.508 (0.464)***
SV * May	1.243 (0.428)***	2.326 (0.237)***	3.456 (0.535)***
SV * Jun	2.271 (0.661)***	1.521 (0.224)***	1.064 (0.546)*
SV * Jul	0.074 (0.756)	3.793 (0.227)***	-1.556 (0.405)***
SV * Aug	-2.838 (0.712)***	3.263 (0.219)***	-1.018 (0.369)***
SV * Sep	-3.352 (0.642)***	3.572 (0.235)***	-0.180 (0.439)
SV * Oct	-2.382 (0.495)***	4.445 (0.261)***	-3.524 (0.442)***
Inc. & Ed. HDI	22.170 (3.280)***	-13.672 (2.768)***	-1.175 (3.265)
Per Capita GDP	0.011 (0.008)	-0.001 (0.003)	-0.009 (0.005)*
Age 60+ yo (%)	-0.197 (0.030)***	-0.039 (0.028)	0.164 (0.032)***
Bolsa Familia Coverage (%)	0.178 (0.033)***	-0.065 (0.030)**	0.011 (0.041)
ACS Coverage (%)	-0.000 (0.008)	-0.011 (0.005)**	-0.014 (0.007)**
ESF Coverage (%)	-0.005 (0.007)	0.003 (0.005)	0.003 (0.007)
SUS ICU Beds per 100k	0.047 (0.024)*	-0.001 (0.012)	0.031 (0.020)
Private ICU Beds per 100k	0.034 (0.019)*	0.058 (0.016)***	-0.005 (0.019)
Observations	13,491	10,546	13,491
R-squared	0.150	0.452	0.833

Robust standard errors in parentheses, clustered at the municipality level.
Sign: *** $p<0.01$, ** $p<0.05$, * $p<0.1$