Voting in a global pandemic: Assessing dueling influences of Covid-19 on turnout

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Abstract

Objective: We investigate the impact of a global health crisis on political behavior. Specifically, we assess the impact of Covid-19 incidence rates, and the impact of temporal and spatial proximity to the crisis, on voter turnout in the 2020 Brazilian municipal elections.

Methods: We use Ordinary Least Squares and Spatial Durbin Error models to evaluate sub-national variation in municipal-level Covid-19 incidence and voter turnout. We include controls for political, economic, health, and state context.

Results: Ceteris paribus, increasing deaths in the month leading up to the election from 0.01 to 1 per 1000 people is associated with a 5 percentage point decrease in turnout; higher cases and deaths earlier in the pandemic are generally associated with higher turnout. Covid-19 incidence rates in nearby municipalities affect local turnout in the same directions.

Conclusion: Higher Covid-19 incidence near the time of the election decreases voter turnout, while incidence farther from the election increases voter turnout.

Globalization and climate change have increased the frequency and extent of extreme weather, financial and economic crises, and disease outbreaks (Baer and Singer, 2016). These multidimensional crises simultaneously encompass society, politics, and the environment (Gills, 2010), often with profound repercussions for democracy. They can also act as “stress tests,” revealing the capacity and willingness of elected officials to respond and the political psychology and behavior of voters. The Covid-19 pandemic—a health and economic crisis—has had profound effects on the material and physical security of citizens, on psychological factors such as anxiety and risk perceptions (Dryhurst et al., 2020), and on public opinion and trust in science and political institutions (Bol et al., 2020; Schraff, 2020; Agley, 2020). The myriad impacts of the pandemic are likely to affect voter turnout and democratic accountability (de Koeijer and Parkinson, 2020; Achen and Bartels, 2017).

The dynamics and motivations of political behavior during a crisis are complex. Changes in the perceived costs and benefits of voting can either increase or decrease turnout (Aldrich, 1993), and vote shares can shift as voters punish (Cole, Healy and Werker, 2012) or reward incumbents (Cole, Healy and Werker, 2012; Bechtel and Hainmueller, 2011). While an election offers an opportunity to hold elected officials...
accountable, voting in person during a pandemic also entails health risks. Still, individuals who were negatively impacted by the pandemic may be incentivized to vote as a way of expressing their dissatisfaction. During the pandemic, turnout rates decreased in most countries but also increased in others (IDEA, 2021); however, cross-national analyses obscure sub-national variation in Covid-19 incidence and turnout rates, which may decrease in some areas but increase in others.

What might explain the dueling impacts of the pandemic on turnout? Early in the pandemic, the precise nature of many of the risks associated with Covid-19 was unknown, creating epistemic uncertainty. Threats characterized by this sort of uncertainty often lead people to respond based on affective and qualitative dimensions of risk, rather than rational calculation (Slovic, Fischhoff and Lichtenstein, 1981b, 1981c; Fox-Glassman and Weber, 2016). In particular, the perceived temporal, social and geographical distance of a threat may be an important moderator of concern (Trope and Liberman, 2010; Spence, Poortinga and Pidgeon, 2012). The more proximal a threat is perceived to be, the larger it looms in the mind of a decision-maker. As such, the relationship between Covid-19 and turnout may depend on the temporal and spatial proximity of Covid-19 burden.

The Covid-19 crisis may affect the costs and benefits of voting in dueling ways, depending on distance in time to the election (temporal proximity). We theorize that higher Covid-19 incidence around the election date will decrease voter turnout, since health risks will loom large in the minds of voters, emphasizing the increased costs of voting. However, higher incidence farther from the election will increase voter turnout, since it increases personal interest in politics and political outcomes and thus the perceived benefit of voting, while at the same time posing no immediate risk to voters. We expect that Covid-19 incidence rates in nearby geographic areas also affect voter turnout through perceived spillovers in risk and social networks (spatial proximity).

We study these phenomena in Brazil—a major emerging democracy with substantial sub-national variation along many dimensions, including the spread, severity and response to Covid-19 (Castro et al., 2021). Brazil had a limited federal response to the pandemic, and as of February 2021, had the second highest death count in the world (JHU, 2021). Municipal elections on November 15, 2020 coincided with the aftermath of Brazil’s first peak of Covid-19 and before the onset of the second peak. Voting is mandatory in Brazil, and there is no option to vote by mail. As such, the elections occurred against a backdrop of material and physical hardship for many voters and differential health risks, which depend on a host of sociodemographic and contextual factors. On average, voter turnout in municipal elections decreased significantly from 2016 to 2020 (Tarouco, 2021), with some speculating that this was due to Covid-19 and broader disinterest in political participation (Senado Notícias, 2020). Nevertheless, there was still within-election, between-municipality variation in turnout rates in 2020; our research design leverages this variation (see Figure 3). Using data from 5,539 Brazilian municipalities, we test our hypotheses with an ordinary least squares analysis of voter turnout rates in the first round municipal election regressed on contemporaneous and temporally lagged Covid-19 incidence per 1000 inhabitants. We use the coefficients on lagged Covid-19 incidence to test hypotheses about temporal proximity and a Spatial Durbin Error Model to account for spatial correlation and test hypotheses about spatial proximity. All specifications include the lagged 2016 turnout rate; political, health, economic, education, and demographic controls; and state fixed effects.

Using cumulative Covid-19 incidence data since the start of the pandemic, it initially appeared that the pandemic had no effect on turnout. However, these results obscured the dueling forces of increased risk perceptions and the desire to hold officials accountable, and the important role of temporal and spatial variation on these influences. We find that higher Covid-19 incidence closer in time to the election decreases voter turnout, and we find preliminary evidence that higher incidence earlier in the pandemic increases voter turnout; higher incidence rates in nearby municipalities affect voter turnout in the same directions. This research has broader implications for understanding the competing influences that crises, especially those with temporal and spatial dynamics, have on political behavior.

1 See Table S5 in the Supporting Information available on OSF at https://osf.io/fy4hn/.
CRISES AND TURNOUT

Crises represent moments of heightened engagement between constituencies and politicians. They are often largely exogenous, at least in their timing, and can reveal the capacity and willingness of elected officials to respond effectively to events. They usually entail frequent and highly visible communications by elected officials as well as material responses to stabilize and mitigate the impacts of the crisis. Additionally, crises and crisis relief can have profound impacts on constituencies and can shape their political behavior. As such, they offer a window into the dynamics of democratic governance and voter behavior. For example, the aftermath of severe weather events provides a test of political leadership and public responses to politicians’ actions, revealing the incentives and behaviors of both politicians and voters (Oliver and Reeves, 2015). Much of the literature on the politics of crises has thus focused on the dynamics of political and bureaucratic responses, blame and accountability through retrospective voting, and voter turnout (Gasper and Reeves, 2011; Sylves, 2019).

In this article, we focus on the impact of crises on voter turnout – a key measure of political engagement in democracies and a prerequisite for democratic accountability. Crises affect voter turnout by shifting objective and perceived costs and benefits of voting. Natural disasters may increase the logistical costs of voting (Gomez, Hansford and Krause, 2007), though extreme impacts may actually mobilize voters (Sinclair, Hall and Alvarez, 2011). Economic recessions can activate adversely affected voters, leading to electoral punishment of incumbents, but economic distress and hardship can also suppress voter turnout (Hall, Yoder and Karandikar, 2021). Chen (2013) finds that payments in the aftermath of a disaster mobilize voters who support the incumbent but demobilize opposition voters. Crises may thus galvanize voters by increasing the perceived benefits or urgency of having one’s voice heard or enacting influence on the political system. However, and perhaps more salient, they can also increase the objective and perceived material, health or social costs of voting, as their impacts intersect socioeconomic and demographic risk factors.

Scholarship on voter turnout focuses on both the broader context in which an individual votes as well as the political psychology of an individual’s decision to vote. A review of the literature and a recent meta-analysis of research on voter turnout highlight the impacts of three main categories of variables: socioeconomic, political, and institutional. Scholars find that turnout is, on average, higher in constituencies with compulsory voting, concurrent elections, lower registration requirements, smaller populations, more stable population levels, closer elections, and higher campaign expenditures, among other factors (Blais, 2006; Cancela and Geys, 2016). At the individual-level, rational-choice approaches dating back to Downs (1957) model individual voting decisions as rational assessments of the objective costs and benefits of voting (relative to abstention). In general, voting is seen as a low-cost, low-benefit action; it is a decision that is made at the margin, so that small changes in relative perceived costs and benefits can alter turnout decisions (Aldrich, 1993).

The Covid-19 pandemic – a health and economic crisis – affected voters’ material and physical security as well as psychological factors such as anxiety and risk perceptions (Dryhurst et al., 2020). The pandemic, and related government responses such as lockdowns and other social distancing measures, have also shaped public opinion, political support, and trust (Bol et al., 2020). Emerging evidence from national and cross-national surveys suggests diverging effects on trust in science and political institutions, depending on political orientation and religious beliefs (Agley, 2020; Flinders, 2021; Esaiasson et al., 2021; Fetzer et al., 2020). The impacts of the pandemic prompted some governments to enact rapid responses (Gentilini et al., 2020), while others rejected the threat of the pandemic and the need for social distancing measures.

In a recent cross-national analysis of voter turnout during the Covid-19 pandemic, the Institute for Democracy and Electoral Assistance (IDEA) found that the majority of countries or territories experienced a decline in voter turnout, although some experienced an increase (IDEA, 2021). Santana, Rama

2 However, analysis of the effect of natural disasters on voter turnout is also sensitive to spatial autocorrelation (Cooperman, 2017; Betz, Cook and Hollenbach, 2020).
3 Togo, CAR, Burundi, Niger, Switzerland, South Korea, Poland, Liechtenstein, United States, Belize, Italy, Guernsey, Montenegro, Slovakia, Sri Lanka, Russia, Ghana, New Zealand, Israel, Mongolia, Singapore, Georgia, and Seychelles experienced an increase in turnout in 2020 relative to average turnout.
and Bértoa (2020) find that countries with more severe Covid-19 incidence had lower voter turnout relative to their previous comparable election.

The many impacts of the pandemic likely shifted the perceived costs and benefits associated with turnout, especially in-person (Finkel, Lawrence and Mertha, 2020; Achen and Bartels, 2017). Scholarship from political science and psychology point to multiple mechanisms by which a crisis like Covid-19 might shift the perceived costs and benefits of voting, leading alternatively to lower or higher turnout.

Covid-19 and costs of voter turnout

The costs of voting generally center around the time or distance required to vote in-person (Brady and McNulty, 2011; Dyck and Gimpel, 2005), difficulty in filling out the ballot, complicated processes or regulations for registering to vote or turning in the ballot, or the need to obtain information about candidates, especially in multiparty systems (Harder and Krosnick, 2008; Santana and Aguilar, 2021). A crisis could increase or decrease costs depending on how electoral boards alter their procedures. For example, the government could close down voting locations due to the crisis, decreasing accessibility and increasing the cost of voting for many (Morris and Miller, 2020). Alternately, the government could introduce new procedures such as expanded voting by mail, which might decrease the costs (McGuire et al., 2020). Our study takes place in Brazil, where voting procedures did not change due to the crisis; we therefore focus on Covid-19’s impact on individual-level factors.

The Covid-19 pandemic is distinct from other crises, such as natural disasters, in that it has introduced a new cost: personal health risk due to in-person voting. With a communicable disease, perceived costs also depend on the spread and impacts of the virus in neighboring counties or municipalities. The likelihood of adverse health effects depends on local incidence rates, case fatality rates, social distancing policies in the broader municipality and at polling stations, capacity and access to adequate healthcare, community behavior, and an individual’s own behaviors and preexisting risk factors (e.g., health conditions or financial security) (Jin et al., 2021). Higher case or death rates in one’s municipality or neighboring municipalities would increase the perceived cost of voting; alternatively, voters in areas with more stringent social distancing or lockdown policies may perceive lower health costs of voting (Giommoni and Loumeau, 2020).

The numerous factors affecting health risks are difficult for individuals to estimate, resulting in epistemic uncertainty about risks.

While rational-choice theories model individual voting decisions as cost-benefit calculations, there is also ample evidence from psychology that decision-makers facing epistemic uncertainty rely on risk perceptions rather than objective probabilities (Slovic, Fischhoff and Lichtenstein, 1981b). Even when probabilities and magnitudes are known, individuals often respond using heuristics, especially in the context of threats (Slovic et al., 2005). Decision making about hazards is often based on the perceived costs and benefits, which are shaped by affective, qualitative, perceptual and context-dependent factors, as well as past experience, and can deviate from objective risk measures (Finucane et al., 2000; Slovic, Fischhoff and Lichtenstein, 1981b, 1981a).

Evidence from many domains suggests that people only take precautions when they are sufficiently alarmed about a hazard (Weber, 2016; Peters and Slovic, 2000). Negative affect motivates us to remove ourselves from dangerous situations or to alter our environments to reduce feelings of being at risk (Weber, 2016). Research on “risk as feelings” has shown that affective responses are especially important for

4 There were changes to the campaign procedures and timing of elections, which we elaborate below.

5 In-person voting could also lead to increased Covid-19 case rates (Bertoli, Guichard and Marchetta, 2020; Flanders, Flanders and Goodman, 2020). Brazil did not hold any elections during the pandemic prior to the first round of municipal elections in November 2020. We only evaluate data from the first round of elections in this study.
hazards with financial or health impacts (Loewenstein et al., 2001; Holtgrave and Weber, 1993). Indeed, people who perceive greater risks of Covid-19 were more likely to engage in protective behaviors (de Bruin and Bennett, 2020).

Furthermore, the perceived temporal, social and geographical proximity or distance of a hazard can increase its perceived risk, reported concern and the impetus or willingness of an individual to take mitigative actions (Trope and Liberman, 2010; Liberman, Trope and Stephan, 2007; Carmi and Kimhi, 2015; Spence, Poortinga and Pidgeon, 2012). The more proximal a threat is perceived to be on any of these dimensions, the larger it looms in the mind of a decision-maker. These findings are particularly relevant in the case of Covid-19, which varied in intensity over time and space in the lead up to the Brazilian municipal elections, as it spread through social, economic and transportation networks (Laroze, Neumayer and Plümper, 2021; Kuchler, Russel and Stroebel, 2021; Castro et al., 2021). Related work finds that recent personal experience, and the severity or strength of that experience, strongly influences the evaluation of whether a situation is risky (Weber, 2016).

**Covid-19 and benefits of voter turnout**

The benefits of voting generally center around personal interest in politics, a sense of duty, or a preference about the outcome of an election (Blais and Achen, 2019; Söderlund, Wass and Blais, 2011; Blais, 2006). An election offers an infrequent opportunity to hold elected officials accountable. Personal experience with a crisis, or dissatisfaction with mitigation or relief efforts, may increase the perceived benefit of voting and thus increase turnout if it motivates people to reward or punish certain candidates or parties (Oliver and Reeves, 2015; Cole, Healy and Werker, 2012; Achen and Bartels, 2017). Crises may increase partisan polarization, which could also motivate people to reward or punish candidates or parties (Muñoz and Meguid, 2021). While negative economic impacts can mobilize voters (Burden and Wichowsky, 2014), economic distress or personal economic hardship (e.g., foreclosures during the Great Recession) can actually suppress voter turnout (Hall, Yoder and Karandikar, 2021; McCartney, 2021). Politicians and party leaders are also strategic in how they frame the impacts of the crisis and government response in order to mobilize or polarize voters (Ashworth and De Mesquita, 2014; Kreps and Kriner, 2020). Recent evidence suggests that these strategic dynamics have taken place during the Covid-19 pandemic (Green et al., 2020).

A crisis could decrease the perceived benefit of voting if voters are less engaged or involved in the campaign, which could occur if the government alters the campaign period or procedures due to the crisis. A public health crisis could further reduce voters’ engagement with candidates during the campaign period, especially in areas with higher incidence rates or among voters with higher perceived or actual vulnerability to the virus. As described above, the effect of a public health crisis on voter engagement is mediated by the voter’s perceived personal benefits and risks to voting.

Electoral competition and incumbency could also play a role. Many scholars point to the role of electoral competition, particularly the closeness of an election, in increasing the potential benefit of voting. In close elections, the voter feels that her vote is more likely to be pivotal, and political parties launch stronger mobilization and campaign efforts (Söderlund, Wass and Blais, 2011). A “rally ‘round the flag” effect during a crisis could increase affective ties between voters and the incumbent (Merolla and Zechmeister, 2013), and changes to campaign procedures that reduced face-to-face interaction could advantage incumbents (Avelino, 2020; Tarouco, 2021). In addition, incumbents running for re-election may be more engaged in responding to the crisis and able to take advantage of relaxed oversight or procurement policies during emergencies (Cooperman, 2021). Incumbents could also delay implementing unpopular policies or

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6 Other factors that may affect the perceived benefit from voting, due to their effects on voters’ interest or engagement in politics, include the number of parties, type of electoral system, or fragmentation of the party system (Cancela and Geys, 2016). These are less likely to change in the short term due to a crisis.

7 The incumbent’s performance in responding to the crisis, or their anticipated performance, could also affect the incumbent’s decision to run for re-election. Most research on the relationship between turnout and incumbent re-election focuses on turnout as the independent variable; for example,
releasing information about incidence rates until after the election.\textsuperscript{8} These incumbency advantages could decrease electoral competition and lower the perceived benefit of voting in elections with incumbents. Alternatively, the crisis could increase the value to voters of punishing incumbents for poor performance; the presence of an incumbent in the race could thus increase the perceived benefit of voting.

\section*{CASE}

We evaluate the effect of the Covid-19 global public health crisis on voter turnout in Brazil during the municipal elections that took place across the country in November 2020. Brazil is a major emerging democracy with primary administrative units at the federal, state (26 states and one federal district), and municipal (5570 municipalities) levels. Municipalities are similar to counties in the U.S. context, and each municipality has a mayor and a city council. The large number of municipalities and sub-national variation in public policy, economic development, geography, demographics, healthcare, and culture make Brazil an interesting and important place to study political behavior in the context of a crisis like Covid-19.

\subsection*{Electoral institutions and municipal politics in Brazil}

Municipal elections for the mayor and city councilors take place every four years.\textsuperscript{9} Municipal elections are staggered by two years from state and federal elections, which also occur every four years. Municipal elections took place on Sunday, November 15, 2020 (first round) in 5568 municipalities and Sunday, November 29, 2020 (second round) in 57 municipalities.\textsuperscript{10}

Brazil has mandatory in-person voting for literate citizens aged 18 to 70 years old. Voting is optional for those who are illiterate, aged 16 or 17 years old, or over 70 years old. Given the compulsory nature of voting, voters have an option to submit a blank ballot (\textit{branco}) or a spoiled ballot (\textit{nulo}) to express dissatisfaction with the candidates or process.\textsuperscript{11}

Brazil does not have an absentee or mail-in ballot option. Voters unable to vote on election day due to travel or illness must justify their abstention by requesting an exemption within 60 days after the election via an online site (\textit{Sistema Justifica}), via a smartphone app (\textit{e-Título}) released by the federal election board (\textit{Tribunal Superior Eleitoral - TSE}), in person at the electoral office in their zone, or by mail to the electoral office in their zone (TSE, 2021; Fabro, 2020). While the app suffered some delays on election day due to high volume, the TSE reported over 400,000 voters used the app to justify their absence (Carvalho, 2020).

Voters who abstain without justification must pay a fine that varies by electoral zone (R$ 1.05 and R$ 3.51, or less than $1 USD), though voters can also request a waiver if they can prove they do not have sufficient resources to pay the fine (Otoboni, 2020). Those who do not pay it are prevented from accessing many state services; for example, they cannot participate in civil service exams or public bidding processes, work in the government, get a passport, enroll in a public university, or get loans from state banks (Cepaluni and Hidalgo, 2016).

\begin{thebibliography}
\bibitem{Hansford2010} Hansford and Gomez, 2010. In many contexts, rates of incumbent candidacy (by individual or party) are high; however, this is not true at the municipal level in Brazil due to term limits combined with weak party identification (De Magalhaes, 2015). An interesting area of future research would investigate whether the timing of a crisis affects incumbents’ decisions to run for re-election and whether the presence of an incumbent increases or decreases turnout.
\bibitem{We thank an anonymous reviewer for this point.} We thank an anonymous reviewer for this point. We use data on Covid-19 incidence downloaded on December 18, 2020, and our results are robust to using the data available on the election day itself; see Table S4, Supporting Information.
\bibitem{Mayors are eligible for two consecutive terms and are directly elected through plurality rule (fewer than 200,000 eligible voters) or majority rule with runoffs (more than 200,000 eligible voters).} Mayors are eligible for two consecutive terms and are directly elected through plurality rule (fewer than 200,000 eligible voters) or majority rule with runoffs (more than 200,000 eligible voters).
\bibitem{The elections were originally scheduled for October 4 and October 25 but were postponed due to Covid-19 to November 15 and 29.} The elections were originally scheduled for October 4 and October 25 but were postponed due to Covid-19 to November 15 and 29.
\bibitem{There is debate about whether spoiled votes occur because voters make mistakes, which could be more likely among those with lower levels of formal education, or because voters intentionally nullify them as an act of protest (Borba and Ribeiro, 2018).} There is debate about whether spoiled votes occur because voters make mistakes, which could be more likely among those with lower levels of formal education, or because voters intentionally nullify them as an act of protest (Borba and Ribeiro, 2018).
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While voting is mandatory, there is still significant variation in turnout across Brazil’s 5,570 municipalities. In 2016, the mean municipal voter turnout rate was 85.7 percent, with a minimum of 65.2 percent and a maximum of 98.5 percent. Small changes in voter turnout can make a substantive difference given the competitiveness of local elections. In the 2016 election, 16 percent of mayoral elections were won by a vote difference equal to or smaller than 3 percentage points, and 24 percent of all city councilors in the country were elected with a vote share equal to or smaller than 3 percent of ballots that were cast in their municipalities.\(^{12}\)

Scholars of voter turnout in Brazil argue that the primary driver of variation in voter turnout is the cost of transportation to reach the polls (Borba and Ribeiro, 2018, p. 43). Another driver of variation is the cost of justifying an abstention. Low costs for justifying by phone could decrease turnout, but high costs for justifying in-person could increase turnout if the polls are closer than the election board. Justifying abstention remains most challenging for those in rural areas or with low incomes, who are less likely to be able to afford the time or cost of transportation to the electoral office or are less likely to have access to a smartphone with sufficient network coverage.\(^{13}\)

Voter turnout could also relate to party politics and political polarization. Brazil has one of the most fragmented party systems in the world at both the federal and municipal levels (Borges, 2018). Outside the few large parties and state capitals, party label does not provide much information to nonpartisan voters at the municipal level; while partisans do have attachments to specific parties, especially at the state or national level, the large number of parties makes it likely that their party will not have a candidate at the local level (Samuels and Zucco, 2018, p. 138). Mayors often switch parties between elections, further weakening the role of party labels at the municipal level (Feierherd, 2020). While voters do tend to reward (or punish) candidates based on actions taken by politicians of the same party in other levels of government, this finding only holds within the few parties with strong party labels (Feierherd, 2020; Ventura, 2020). Except in the largest state capitals, mayoral elections are primarily local affairs with a focus on local issues. Voters gather information from TV, radio, newspapers, the Internet, and social networks when evaluating candidates and making decisions about voting (Smith, 2018; Boas and Hidalgo, 2011).

The current president, Jair Bolsonaro, was elected in 2018 in a highly polarized environment (Hunter and Power, 2019; Samuels and Zucco, 2018). Bolsonaro joined the Partido Social Liberal (PSL) in January 2018 and was elected in November 2018 as a member of that party, but he left the party in November 2019 and was unaffiliated during 2020. Mayoral candidates may have local reputations for being aligned with or against Bolsonaro, and incumbent mayors may have undertaken policies that were aligned with or against the federal government. However, the high number of parties, weak party labels, and Bolsonaro’s lack of a party make it challenging to predict how voters would reward or punish mayoral candidates based on candidates’ party affiliations. Nevertheless, Bolsonaro’s statements discrediting the electoral process may have led his supporters to abstain at higher rates in 2020 (Dias, 2020; Alessi and Benites, 2020).

### Covid-19 in Brazil

Several recent cross-national assessments of absolute and per capita cases, deaths, and testing measures have ranked Brazil among the worst countries out of those assessed. With a total death count of 230,000 as of February 7, 2021, Brazil was the second highest country in the world according to the Johns Hopkins Coronavirus Research Center (JHU, 2021).

Covid-19 reached Latin America later than other continents. The first recorded case in Brazil was not identified until February 25, 2020 in São Paulo. Despite the slow arrival of Covid-19, the case rate in

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\(^{12}\) City councilors are elected through open-list proportional representation, so a higher vote share does not guarantee a seat unless it reaches the district threshold: total valid votes divided by the number of seats in the district (municipality). Nevertheless, voter turnout is important, and small changes can be pivotal, in both mayor and city council races.

\(^{13}\) In 2018, Pew Research Center estimated that 60 percent of Brazilians had access to a smartphone (Taylor and Silver, 2019). In 2019, 3G networks were available in 5413 municipalities (99.6 percent of population) and 4G networks were available in 4,503 municipalities (95.8 percent of the population) (Bnamericas, 2019).
Brazil quickly escalated. By March 21, the virus spread to every state, and transmission rates were the highest in the world by May 2020. The first peak occurred in mid-August. The Ministry of Health, a body under federal executive power, initially restricted testing to individuals facing severe health conditions and openly rejected WHO recommendations (Paraguassu and Brito, 2020; Reuters, 2020b; Porterfield, 2020). The federal government focused instead on the economic impacts of the lockdown and passed a series of fiscal measures aimed at the economy (IMF, 2021). In April, Bolsonaro fired his Minister of Health, Luiz Henrique Mandetta, following disagreements about social distancing measures; the next Minister of Health resigned from office in mid-May. Bolsonaro appointed an Army General with no medical experience as the interim Minister (Barberia and Gómez, 2020). In June 2020, Brazil surpassed Britain to have the second highest death count in the world, second only to the U.S. (Reuters, 2020a).

The first wave of Covid-19 cases occurred between June and September 2020, with a second wave starting in November 2020 (Figure 1). There was extensive heterogeneity in the trajectory of the Covid-19 epidemic across Brazil. For example, the estimated number of days until 0.1 percent of a state’s population was infected since the first recorded case in Brazil ranged from 20 days in São Paulo to 60 days in Goiás, underscoring the importance of sub-national analyses in understanding the influence of Covid-19 burden on voter turnout (Mellan et al., 2020).

While average case rates were fairly low in November relative to the earlier peak, there was significant sub-national variation in case and death rates before the election. Figure 2 shows case rates aggregated within states in the month leading up to the election (October 16-November 15), with some as low as 0.15 cases per 1000 inhabitants in the state of Mato Grosso or as high as 10.36 cases per 1000 inhabitants in the state of Roraima.

In terms of its health system, Brazil was relatively well-equipped to manage a major disease outbreak and has recent experience in managing outbreaks. Brazil has a relatively robust and extensive national healthcare system (Sistema Único de Saúde – SUS), a key determinant of a country’s ability to manage the pandemic. It has more ICU beds per capita than Italy, France or Spain. However, only half of these beds are in public hospitals, and resources are poorly distributed across Brazilian municipalities, some of which have no ICU beds at all. Hospitals in many areas, including areas that are rural, low-income or have indigenous populations, were quickly at capacity. Federal data lacked coherence with other sources and were systematically delayed, preventing coordinated and effective responses by health authorities (Lotta, 2020).
President Bolsonaro actively rejected the crisis’s severity and need for social distancing measures or government responses, relegating much of the responsibility to state and municipal governments. He adopted a strong anti-science, populist rhetoric toward the pandemic (Donadelli, 2020), encouraged large gatherings, and refused to wear a mask. He publicly promoted unproven remedies, cast doubts on vaccination campaigns, and referred to scientific recommendations as “hysteria” and to Covid-19 as a “little flu” (Sandy and Milhorance, 2020).

President Bolsonaro’s actions were exacerbated by the living conditions that some Brazilians face. Thirteen million Brazilians live in slums (favelas), often in homes with more than three people per room and with limited access to clean water, making social distancing and hygiene recommendations difficult to follow and variable across locations (Lancet, 2020). Organizations published manifestos calling for coherent solutions by the federal government, which were accompanied by public protests and multiple impeachment requests (Sandy and Milhorance, 2020). By some estimates, 76 percent of Bolsonaro supporters were in favor of social distancing, and support for Bolsonaro decreased (Rosati, 2020; Datafolha, 2020).

Brazil has a relatively decentralized structure, with state governors able to enact social distancing measures in the absence of federal action (Sandy and Milhorance, 2020). There is also sub-national variation along many dimensions, including demographics, state finances, and healthcare. The multilevel health system has significant variation between and within states (Alves, 2015; Alves and Gibson, 2019), and states with fewer health-care resources tended to have higher mortality rates (Tavares and Betti, 2021). Despite this variability, all state governors implemented social distancing policies, including school or business closures, albeit at different times and with varying levels of stringency and public adherence (Barberia et al., 2020; de Souza Santos et al., 2021; Hale et al., 2020; Castro et al., 2021). These spurred local disagreements about the distribution of resources and were jeopardized by the absence of effective monitoring and control at the federal level (Pereira, Oliveira and Sampaio, 2020).

The politicization of Covid-19 led to an alliance between ministers in the federal government, congressional leaders, and a majority of governors, who decided not to comply with federal regulations and guidelines (Sandy and Milhorance, 2020). Brazil’s Federal Supreme Court consistently upheld physical distancing measures by states (STF, 2020), which Bolsonaro regularly opposed and undermined. Furthermore, states invested resources to rapidly expand emergency bed capacity in intensive care units and worked to transfer patients to areas with fewer cases and even to the private health-care system – these and other measures kept the universal public health-care system functioning in the absence of coordinated and substantive federal efforts (Cruz, 2020; Barberia and Gómez, 2020). While many Brazilians largely followed social distancing measures imposed at local levels, Bolsonaro’s messaging contradicted those efforts (Andreoni, 2020).
The municipal elections thus occurred in a context where both the costs and benefits of turning out to vote may have shifted. Perceived costs and benefits are likely shaped by political messaging, especially by co-partisan messengers, and may thus fall along political lines (Samuels and Zucco Jr., 2018). Bolsonaro’s politicization and rejection of Covid-19 may have led his supporters to perceive fewer health risks; scholars found evidence that Bolsonaro’s communications reduced social distancing behavior and increased case and death rates in areas where he had more supporters (Ajzenman, Cavalcanti and Da Mata, 2020; Cabral, Pongeluppe and Ito, 2021; Leone, 2021; Fernandes et al., 2020). However, it is unclear how negative personal experience with the virus—a key determinant of the severity of risk perceptions—would affect participation in a polarized environment. Furthermore, the balance of these costs and benefits may in turn intersect systematically with individual characteristics (e.g., age), potentially shifting political representation and influence.

The Covid-19 pandemic led to changes in the timing of the election and restrictions on face-to-face campaign procedures, but there were no changes to the number or location of polling stations nor to the method of voting or the duration of the campaign period. All changes were decided by the federal election board (TSE) and consistent across states. Scholars theorize that the limitations on face-to-face interaction during campaigns, combined with the previously imposed shorter campaign period, advantaged incumbents and disadvantaged challengers (Avelino, 2020). The federal election board (TSE) outlined a number of preventative measures, including provision of hand sanitizer, use of face masks by voters, use of face masks and shields by election workers, and a recommendation to prioritize older or high-risk voters during the 7–10 a.m. voting period (TSE, 2020b).

HYPOTHESES

Brazil is an interesting case to study the relationship between Covid-19 incidence and voter turnout. Brazil’s mandatory voting policies make it a harder case for observing change in turnout over time. It had relatively few institutional and procedural changes due to the pandemic and substantial spatial variation in the timing and severity of Covid-19 cases and deaths relative to the election date. We expect that the primary impact of the Covid-19 crisis on elections in Brazil is through its effect on the perceived costs or benefits of voting. We develop diverging hypotheses based on how perceived costs and benefits might change depending on the timing of Covid-19 incidence rates relative to the election.

We expect that there will be decreased turnout in areas for which high Covid-19 incidence rates co-occur with the lead-up to the election (October 16–November 15). Covid-19 introduced new and substantial individual costs to in-person voting—the risk of contagion. This cost will be more severe in municipalities with higher incidence rates around the election. The roll-out of the smartphone app increased voters’ ability to justify their abstention in light of the public health risks of in-person voting, so voters with higher perceived risk could easily justify their abstention.

An additional mechanism is that the changes to the campaign procedures could lead to depressed turnout, especially in areas with high Covid-19 incidence. Since challengers were unable to mount strong campaigns, races may have been less competitive and would-be opposition voters may have been slightly less inclined to turnout to vote; in municipalities without an incumbent running for re-election, voters may have been less inclined to vote since they had less information about the candidates and less excitement due to the subdued campaign period. While this could depress turnout overall, it would not be correlated with Covid-19 incidence unless campaigns were even more subdued in areas with high incidence.

14 The campaign period was shortened to 45 days beginning in 2016 (TSE, 2020a).
15 The only exception was the city of Macapá that faced an energy crisis in November 2020, which required postponing the election in this municipality. For this reason, we opted to drop Macapá from our analyses.
16 The crisis did not affect transportation costs to the polls, though it may have increased the personal risk to an individual of using certain modes of transportation, especially for those relying on public buses.
However, we expect the opposite relationship when evaluating Covid-19 incidence rates at a longer time scale; we focus our predictions on the period from the start of the pandemic to 3 months before the election (March 1–August 15).\textsuperscript{17} In areas with higher incidence early in the pandemic, voters may have stronger motivation to reward or sanction local politicians for their Covid-19 policy response. We predict that high Covid-19 incidence rates further from the election will increase the perceived benefit of voting. To account for the possibility that early and late peaks are anti-correlated, or for other temporal dynamics in the spread of Covid-19 across municipalities that might confound this analysis, we control for additional temporal bins in the model. This allows us to test whether voters in places with higher early Covid-19 incidence are more likely to be mobilized to vote given similar personal risks in the lead up to and at the time of the election.

Our targeted focus on early and late incidence are in part motivated by the observation of recency and primacy effects (Postman and Phillips, 1965; Glanzer and Cunitz, 1966)—the tendency to recall both recent and early events better than what comes in between—and the contemporaneous risk posed by high incidence rates close to the election date. In addition to distinct temporal trajectories, the contagion dynamics of Covid-19 have spatial consequences that lead to sub-national heterogeneity in incidence rates (Castro et al., 2021; Mellan et al., 2020; Hafner, 2020). All else equal, an area is more likely to become infected if its neighbors have higher infection rates, suggesting that neighboring incidence rates also increase personal health risks (Hafner, 2020). In Brazil, economic, media, and social networks span municipal boundaries (Pedrosa and Albuquerque, 2020; Aguiar, 2016), and the spread of Covid-19 followed social, economic, and transportation networks (Laroze, Neumayer and Plümper, 2021; Kuchler, Russel and Stroebel, 2021; Aguiar, 2020).

We anticipate that case and death rates may have similar, though slightly different, impacts on perceived risk and thus voter turnout.\textsuperscript{18} Higher case rates may signify higher personal risk to in-person voting, since the disease is circulating more widely in the population. In general, deaths from Covid-19 are slightly delayed in time from initial case reporting (Soliman, Alyafei and Elalaily, 2020),\textsuperscript{19} and higher death rates may amplify the perceived threat of Covid-19 to voters. Deaths in nearby municipalities, which are likely to be highly salient and reported in local media sources and through informal social networks, may also increase the perceived risks or costs associated with voting. The personal impact of deaths among close friends and family or in one’s social surroundings may have a greater impact than cases on an individual’s determination to hold elected officials accountable, which would increase the perceived benefit of voting. As per our hypotheses, we expect to see that these twin pressures on turnout depend on the temporal distance from the election day.

In summary, we present the following hypotheses:

1. Higher Covid-19 incidence rates in the month before the election (October 16–November 15) are associated with lower voter turnout.
2. Higher Covid-19 incidence rates earlier in the pandemic, and further from the time of the election (March 1–August 15), are associated with higher voter turnout.
3. Higher Covid-19 incidence rates in nearby geographic areas are associated with voter turnout in a given municipality; the direction follows that of hypotheses 1 and 2.

\textsuperscript{17} We do not have any directional hypothesis for two months prior to the election. The two to three month period preceding the election could have diverging impacts depending on individuals’ experience and memory of those time periods and how they relate to the more immediate threats around the time of the election. As such, we focus our predictions on the role of earlier (March 1–August 15) and later (October 16–November 15) cases and deaths relative to the timing of the election.

\textsuperscript{18} Case and death rates are correlated (see Table S3 in Supporting Information). The correlation between early cases and deaths is equal to 0.78. In the third month before the election, the correlation is 0.82, and it is 0.73 and 0.71 in the second and first months before the election, respectively.

\textsuperscript{19} However, death clusters sometimes preceded case clusters in Brazil, especially early in the pandemic, which Castro et al. (2021) attribute to poor performance in testing, surveillance, and reporting. The lack or inconsistency of testing in many countries, including Brazil, as well as the prevalence of asymptomatic cases, have made deaths a particularly important metric for assessing disease progress during the Covid-19 pandemic (Subbaraman, 2020).
TABLE 1  Descriptive statistics

| Variable                             | N    | Mean | St. Dev. | Min  | Max  |
|--------------------------------------|------|------|----------|------|------|
| Turnout Rate (2020)                  | 5539 | 0.8  | 0.1      | 0.6  | 1.0  |
| Turnout Rate (2016)                  | 5539 | 0.9  | 0.1      | 0.7  | 1.0  |
| Early Deaths¹                        | 5539 | 0.3  | 1.2      | 0.0  | 50.5 |
| Deaths 3rd Mo. before the Elec.¹     | 5539 | 0.1  | 0.3      | 0.0  | 9.6  |
| Deaths 2nd Mo. before the Elec.¹     | 5539 | 0.1  | 0.4      | 0.0  | 15.3 |
| Deaths 1st up to the Elec.¹          | 5539 | 0.1  | 0.2      | 0.0  | 8.3  |
| Early Cases¹                         | 5539 | 15.8 | 37.1     | 0.0  | 869.5|
| Cases 3rd Mo. before the Elec.¹      | 5539 | 6.0  | 12.6     | 0.0  | 288.5|
| Cases 2nd Mo. before the Elec.¹      | 5539 | 4.4  | 12.8     | 0.0  | 417.7|
| Cases 1st Mo. up to the Elec.¹       | 5539 | 3.7  | 11.0     | 0.0  | 425.1|
| Log. Comp. Case Fatality Rate¹       | 5539 | 0.001| 0.3      | −0.3 | 0.8  |
| Incumbent                            | 5539 | 0.6  | 0.5      | 0    | 1    |
| Bolsonaro Vote Share (2018)          | 5539 | 0.4  | 0.2      | 0.02 | 0.8  |
| Internet Access                      | 5539 | 73.3 | 22.8     | 0.0  | 100.0|
| Elderly Population (%)               | 5539 | 0.2  | 0.05     | 0.02 | 0.4  |
| College Degree (%)                   | 5539 | 0.1  | 0.03     | 0.003| 0.3  |
| Rural Population (%)                 | 5539 | 0.5  | 0.3      | 0.0  | 1.0  |
| Female Population (%)                | 5539 | 0.5  | 0.02     | 0.1  | 0.6  |
| Municipal GDP per capita             | 5539 | 23,459.1 | 23,955.8 | 4788.2 | 583,171.8 |
| Dist. from a Large City (minutes)    | 5539 | 176.1 | 577.2    | 0    | 8,737|
| Available Ventilators                | 5539 | 0.01 | 0.03     | 0    | 1    |
| Population Density                   | 5539 | 121.1 | 633.6    | 0.04 | 14,403.2 |

¹ Variables per 1000 inhabitants.

METHOD

To test the impact of Covid-19 on voter turnout, we collected turnout rates in the first round of municipal elections in Brazil on November 15, 2020.²⁰ The TSE released data for elections in 5568 municipalities,²¹ from which we computed our outcome—turnout rate—as the ratio of all votes that were cast (including blank or spoiled ballots) divided by the number of registered voters in each municipality.

The main explanatory variables measure the cumulative number of either Covid-19 cases or deaths per 1000 inhabitants.²² Table 1 presents descriptive statistics of all variables included in our analyses. We log-transformed the Covid-19 case and death variables to account for their highly skewed distribution.²³ To test hypotheses about temporal proximity/distance, we operationalized cumulative Covid-19 deaths and

²⁰ We do not evaluate second round elections because there are far fewer observations (only 57 municipalities) and the Covid-19 incidence rates shortly before the second round elections could be correlated with turnout rates in the first round elections.

²¹ We downloaded the data from www.tse.jus.br on December 23. There is no municipal election in Brasília, the Federal District, and the first round in Macapá was postponed to December 6th due to an energy crisis.

²² Data downloaded from brasil.io on January 2nd, 2021. Brasil.io collects daily data on Covid-19 incidence from states’ health bureau. We run robustness checks using Covid-19 data that was officially available on November 14, which under-reported recent cases and deaths.

²³ This is additionally supported by early efforts in psychology, which used psychophysics experiments to understand the relationship between external signals/information and sensation (e.g., loudness or duration). This early work gave rise to Weber-Fechner’s law, which states that over a large dynamic range external stimuli are scaled into a logarithmic internal representation of sensation. More recent work has shown that the logarithmic compression of information holds for the processing of numbers (Dehaene, 2003).
cases in four time windows within each municipality: the month leading up to the election, two months prior to the election, three months prior to the election, and then from the fourth month prior to the election to the start of the pandemic (March 1).24

We predict that Covid-19 cases and deaths have a negative effect on turnout when they happen closer to the election day and a positive effect on turnout when they happen at the start of the pandemic.25 Therefore, the coefficient of Covid-19 incidence in the month prior to the election should be negative; the coefficient of Covid-19 incidence during early stages of the pandemic up to the 4th month before the election should be positive.26

Our model specification includes political, health, and economic controls. The lagged outcome—the turnout rate in the 2016 election—aims to control for unobserved factors of a municipality that may influence voter turnout. Bolsonaro is a polarizing president who has denied the pandemic and encouraged people to ignore social distancing policies. He argued that he played a major role against the corrupt establishment in Brazilian politics and electoral fraud. Since Bolsonaro was not affiliated with a political party in the 2020 election, his supporters may not have had a strong preference for candidates running in local races. Thus, Bolsonaro’s messages could influence both the spread of the disease (Ajzenman, Cavalcanti and Da Mata, 2020; Cabral, Pongeluppe and Ito, 2021; Leone, 2021; Fernandes et al., 2020) and electoral abstention. For this reason, we include in our models the vote share that Bolsonaro received in the 2018 presidential election as a proxy for his support in the municipality. In addition, all models have a dummy variable that indicates whether the incumbent mayor ran for reelection in 2020.27

Because voters could justify their absence via a smartphone app, our models include a measurement of the percentage of the municipal area with Internet service available for smartphones—either 3G or 4G. We further control for the share of elderly in the population (the percentage of people above 60 years old),28 education (the percentage of people with a college degree),29 the share of the rural population,30 and the share of women living in the municipality.31 Additionally, our models include municipal GDP per capita,32 the share of available ventilators per 1000 inhabitants,33 the population density,34 and a

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24 First, we summed all cases (or deaths) from the beginning of the pandemic in Brazil until three months before the election day: March 1–August 15. Second, we summed the number of cases (or deaths) reported in the 3rd month before the election: August 16–September 15. Third, we summed the number of cases (or deaths) reported in the 2nd month before the election in each municipality: September 16–October 15. Finally, we summed up cases (or deaths) in the 1st month up to the election: October 16–November 15. Although our main explanatory variable varies across both time and space, our data set does not have the structure of panel data. The outcome—turnout in local elections—is measured for each unit with an interval of four years when the municipal elections take place. Hence, the time component of our outcome—every four years—does not match the temporal dimension of our explanatory data—measured by days, weeks, or months in 2020. For this reason, we cannot implement a typical time-series cross-sectional analysis.

25 Our theory describes individual-level variation in perceived costs and benefits of voting. However, the only available data on voter turnout are at the municipal level. The primary advantages of our model are the ability to identify the relationship between municipal-level spatial/temporal variation in Covid-19 incidence and voter turnout. The primary disadvantage is that, by aggregating the data at the municipal level, we cannot identify individual relationship between costs/benefits and psychological mechanisms. We note this in the conclusion as an avenue for future research.

26 Our hypotheses focus on these temporal extremes of earlier and later in the pandemic; we do not have specific directional hypotheses about the middle stages.

27 We thank an anonymous reviewer for this suggestion.

28 Data downloaded on December 22, 2020, from datasus.gov.br.

29 Data on education was downloaded from www.ibge.gov.br on December 19, 2020.

30 Data on rural population downloaded from www.ibge.gov.br on December 20, 2020.

31 Data downloaded on December 22, 2020, from datasus.gov.br.

32 Municipal GDP per capita is available on www.ibge.gov.br. Data downloaded on December 20, 2020. Ideally, we would like to account for unemployment as well. However, given that municipal data on unemployment is unavailable, we control for socio-demographic factors such as rural population, education, and population density. These factors, along with state fixed effects, are likely correlated with economic activities that drive local unemployment.

33 Data downloaded on December 22, 2020, from datasus.gov.br.

34 The population density was generated by combining the estimated population in 2020 and the area—in squared kilometers—of each municipality, both downloaded from www.ibge.gov.br on December 20, 2020.
measure of remoteness, which measures the distance in minutes of each municipality from the closest large city.\footnote{The distance from a large city is likely associated with both the Covid-19 spread and turnout rate. To control for this confound, we use the variable “remoteness” (remota\'d\'o) from www.ibge.gov.br, which measures the distance of each municipality from the closest large city classified as such by the Brazilian Institute of Geography and Statistics (IBGE).}

Municipal performance in responding to the pandemic could influence voting choice and, as such, impact turnout. Voters are likely aware of the performance in neighboring municipalities and may make decisions based on that comparison. The case fatality rate is one proxy for measuring the overall performance on a key health outcome.\footnote{Case fatality rates in turn depend on numerous factors including local lockdown policy decisions, behaviors, disease variant/mutation, and risk factors. We therefore use the case fatality rate in our calculation of a spatial comparative measure and include control variables of available ventilators, GDP per capita, share of elderly in the population, social distancing policies, and other factors in our analyses and robustness checks.} We therefore create a measure of comparative performance that captures the difference between the maximum case fatality rate in a municipality and the maximum case fatality rate in neighboring municipalities, weighted by distance from these municipalities.\footnote{We thank an anonymous reviewer for this suggestion. We calculate the measure as follows. (1) We generate the case fatality rate in municipality $i$ at time $t$ by dividing the cumulative number of known deaths at time $t$ by the cumulative confirmed cases at $t – 9$, as suggested by (Soliman, Ahyari, and Elalaily, 2020). They argue that a case fatality rate should be based on number of deaths relative to number of cases 9 days prior, which avoids the issue that at time $t$, in the midst of an ongoing pandemic, the outcome of the disease is “unknown for a nonlegible proportion of patients” (Ghani et al., 2005). (2) To reduce the influence of having a large number of COVID-19 deaths and cases belatedly reported on a single day, for each time $t$ we calculate the 7-day average of the case fatality rate up to time $t$. (3) For each municipality, we store the maximum value of the 7-day average case fatality rate during the period March 9–November 14, 2020. (4) We calculate a comparative measure by taking the difference between the maximum 7-day average case fatality rate in a municipality and the spatially lagged maximum 7-day average case fatality rate using a row-standardized, inverse distance weighting matrix. (5) We transform the measure by taking the natural log to account for skew in the variable’s distribution. Hence, the higher the value of the performance measure, the worse the maximum case fatality rate in a municipality relative to its neighbors.} The higher the value of this measure, the worse the maximum case fatality rate in a municipality relative to its neighbors.

Finally, we include state fixed effects to control for social distancing policy measures that states have adopted as well as other state-level factors that are not observed.\footnote{Data are not available for social distancing policies, or adherence to social distancing policies, at the municipal level. Our findings are generally robust to model specifications that replace state fixed effects with an index of social distancing policy stringency adopted by states (Table S7, Supporting Information).}\footnote{All highly skewed variables were log-transformed. Our final data set comprises 5,539 municipalities.} We therefore create a measure of comparative performance that captures the difference between the maximum case fatality rate in a municipality and the maximum case fatality rate in neighboring municipalities, weighted by distance from these municipalities.\footnote{The distance from a large city is likely associated with both the Covid-19 spread and turnout rate. To control for this confound, we use the variable “remoteness” (remota\'d\'o) from www.ibge.gov.br, which measures the distance of each municipality from the closest large city classified as such by the Brazilian Institute of Geography and Statistics (IBGE).}

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Finally, we include state fixed effects to control for social distancing policy measures that states have adopted as well as other state-level factors that are not observed.\footnote{Data are not available for social distancing policies, or adherence to social distancing policies, at the municipal level. Our findings are generally robust to model specifications that replace state fixed effects with an index of social distancing policy stringency adopted by states (Table S7, Supporting Information).}\footnote{All highly skewed variables were log-transformed. Our final data set comprises 5,539 municipalities.} We therefore create a measure of comparative performance that captures the difference between the maximum case fatality rate in a municipality and the maximum case fatality rate in neighboring municipalities, weighted by distance from these municipalities.\footnote{The distance from a large city is likely associated with both the Covid-19 spread and turnout rate. To control for this confound, we use the variable “remoteness” (remota\'d\'o) from www.ibge.gov.br, which measures the distance of each municipality from the closest large city classified as such by the Brazilian Institute of Geography and Statistics (IBGE).}

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Finally, we include state fixed effects to control for social distancing policy measures that states have adopted as well as other state-level factors that are not observed.\footnote{Data are not available for social distancing policies, or adherence to social distancing policies, at the municipal level. Our findings are generally robust to model specifications that replace state fixed effects with an index of social distancing policy stringency adopted by states (Table S7, Supporting Information).}\footnote{All highly skewed variables were log-transformed. Our final data set comprises 5,539 municipalities.} We therefore create a measure of comparative performance that captures the difference between the maximum case fatality rate in a municipality and the maximum case fatality rate in neighboring municipalities, weighted by distance from these municipalities.\footnote{We thank an anonymous reviewer for this suggestion. We calculate the measure as follows. (1) We generate the case fatality rate in municipality $i$ at time $t$ by dividing the cumulative number of known deaths at time $t$ by the cumulative confirmed cases at $t – 9$, as suggested by (Soliman, Ahyari, and Elalally, 2020). They argue that a case fatality rate should be based on number of deaths relative to number of cases 9 days prior, which avoids the issue that at time $t$, in the midst of an ongoing pandemic, the outcome of the disease is “unknown for a nonlegible proportion of patients” (Ghani et al., 2005). (2) To reduce the influence of having a large number of COVID-19 deaths and cases belatedly reported on a single day, for each time $t$ we calculate the 7-day average of the case fatality rate up to time $t$. (3) For each municipality, we store the maximum value of the 7-day average case fatality rate during the period March 9–November 14, 2020. (4) We calculate a comparative measure by taking the difference between the maximum 7-day average case fatality rate in a municipality and the spatially lagged maximum 7-day average case fatality rate using a row-standardized, inverse distance weighting matrix. (5) We transform the measure by taking the natural log to account for skew in the variable’s distribution. Hence, the higher the value of the performance measure, the worse the case fatality rate in a municipality relative to its neighbors. We have also estimated models with the case fatality rate on election day, without the spatial difference. See Table S8, Supporting Information, which includes a categorical measure for quartiles of the case fatality rate on election day.
for the possibility of dependence in the residuals. Thus, our model specifications can be represented by the following equation:

\[
y = \beta X + WZ\theta + u
\]

\[
u = \lambda Wu + \varepsilon
\]

where \(X\) is a matrix of nonspatial variables listed in Table 1, \(W\) is a raw-normalized, inverse distance, connectivity matrix, \(Z\) represents a matrix of variables for which we estimate spatial effects, and \(\theta\) is the vector of spatial coefficients. In our model specifications, \(Z\) includes our measure of Covid-19 incidence (either cases or deaths). Therefore, spatially lagged cases and deaths in our model capture how the turnout of a given municipality \(i\) is affected by Covid-19 incidence rates in its neighbors. We also estimate the spatial effect of municipal GDP per capita, since wealth tends to be correlated in space, and wealthy people who live in another city near the municipality where they vote might be more likely to drive to this nearby municipality to vote. Finally, \(\lambda\) is the parameter that measures the spatial dependence in the residuals.\(^{42}\)

**RESULTS**

Table 2 presents the results of our main OLS and SDEM specifications. Models 1 and 2 account for the impacts of the pandemic using four temporal bins of Covid-19 deaths. Models 3 and 4 use the cumulative

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\(^{41}\)The Supporting Information demonstrates that our findings are generally robust to alternative specifications for the connectivity matrix, see Table S9. We estimated SDEM equations with an alternative \(W\) that limits the spatial influence between units that are 500 km apart from each other.

\(^{42}\)All models we estimated presented high values of \(\lambda\), always close to 0.9.
TABLE 2  OLS and spatial Durbin error models (SDEM)

| Dependent variable: Turnout Rate (2020) | OLS (1) | SDEM (2) | OLS (3) | SDEM (4) |
|----------------------------------------|--------|--------|--------|--------|
| Log Early Deaths                       | 0.004* (0.002) | 0.002 (0.002) |        |        |
| Log Deaths 3rd Month Pre-Elec.         | 0.003 (0.004)  | 0.003 (0.004) |        |        |
| Log Deaths 2nd Month Pre-Elec.         | −0.003 (0.004) | −0.003 (0.004) |        |        |
| Log Deaths 1st Month up to Elec.       | −0.013*** (0.005) | −0.011** (0.005) |        |        |
| Log Early Cases                        | 0.001** (0.001) | 0.001 (0.001)  |        |        |
| Log Cases 3rd Month Pre-Elec.          | 0.001 (0.001)  | 0.002* (0.001) |        |        |
| Log Cases 2nd Month Pre-Elec.          | −0.001 (0.001) | −0.001 (0.001) |        |        |
| Log Cases 1st Month up to Elec.        | −0.003*** (0.001) | −0.002** (0.001) |        |        |
| Log Comp. Case Fatality Rate           | −0.004** (0.002) | −0.004** (0.002) | −0.003* (0.002) | −0.003* (0.002) |
| Bolsonaro Share Votes (2018)           | −0.031*** (0.005) | −0.036*** (0.005) | −0.031*** (0.005) | −0.036*** (0.005) |
| Lagged Turnout Rate (2016)              | 0.579*** (0.010) | 0.562*** (0.010) | 0.579*** (0.010) | 0.564*** (0.010) |
| Internet Access                        | 0.0003*** (0.00003) | 0.0003*** (0.00003) | 0.0003*** (0.00003) | 0.0002*** (0.00003) |
| Incumbent                               | −0.002* (0.001) | −0.002* (0.001) | −0.002* (0.001) | −0.002* (0.001) |
| College Degree (%)                     | −0.295*** (0.020) | −0.295*** (0.020) | −0.288*** (0.020) | −0.293*** (0.020) |
| Elder Population (%)                   | 0.099*** (0.015) | 0.078*** (0.015) | 0.101*** (0.015) | 0.078*** (0.015) |
| Rural Population (%)                   | 0.033*** (0.002) | 0.034*** (0.002) | 0.033*** (0.002) | 0.033*** (0.002) |
| Female Population (%)                  | −0.125*** (0.027) | −0.089*** (0.026) | −0.128*** (0.027) | −0.092*** (0.026) |
| Log GDP Per Capita                     | 0.004*** (0.001) | 0.002** (0.001)  | 0.004*** (0.001) | 0.002** (0.001)  |
| Log Dist. Large City (min.)            | 0.002** (0.001) | 0.002** (0.001) | 0.002** (0.001) | 0.001** (0.001) |
| Log Ventilators Per Capita             | −0.009 (0.014)  | −0.005 (0.013)  | −0.008 (0.014)  | −0.005 (0.013)  |
| Log Population Density                 | −0.004*** (0.001) | −0.004*** (0.001) | −0.004*** (0.001) | −0.003*** (0.001) |
| Spatial Lagged Early Deaths            | 0.093** (0.040) |        |        |        |
| Spatial Lagged Deaths (3rd Month)      | 0.169 (0.159)  |        |        |        |
| Spatial Lagged Deaths (2nd Month)      | 0.076 (0.169)  |        |        |        |
| Spatial Lagged Deaths (1st Month)      | −0.511** (0.216) |        |        |        |
| Spatial Lagged Early Cases             |        |        | 0.015 (0.011) |        |
| Spatial Lagged Cases (3rd Month)       |        |        | 0.020 (0.025) |        |
| Spatial Lagged Cases (2nd Month)       |        |        | −0.037 (0.024) |        |
| Spatial Lagged Cases (1st Month)       |        |        | −0.015 (0.022) |        |
| Spatial Lagged GDP Per Capita          | 0.047*** (0.009) |        | 0.053*** (0.009) |        |
| Constant                               | 0.338*** (0.018) | −0.148 (0.097) | 0.337*** (0.018) | −0.190* (0.101) |
| States Fixed Effects                   | Yes    | Yes    | Yes    | Yes    |
| Observations                           | 5,539  | 5,539  | 5,539  | 5,539  |
| R²                                     | 0.741  | 0.742  |        |        |
| Adjusted R²                            | 0.739  | 0.740  |        |        |
| Log Likelihood                         | 11,511.200 | 11,514.880 |        |        |
| σ²                                     | 0.001  | 0.001  |        |        |
| Akaike Inf. Crit.                      | −22,922.410 | −22,929.760 |        |        |

(Continues)
number of cases within the same four temporal bins. In the following subsections, we discuss the effects of temporal and spatial proximity of the crisis on voter turnout.

**Temporal proximity**

The first eight rows in Table 2 report the coefficients on our temporal measures of Covid-19 incidence. Regardless of the measure to capture the impact of the pandemic (cases or deaths), greater Covid-19 incidence closer to election day has a negative impact on turnout. The direct effect of Covid-19 in the month leading up to the election is negative and statistically significant across all the four models, as well as additional robustness tests and alternative specifications included in the Supporting Information. Cases and deaths two or three months before the election are not negatively associated with voter turnout.

These findings are consistent with our first hypothesis that Covid-19 incidence near the time of the election has a larger negative effect on turnout. Voters likely choose to abstain because they are more afraid of getting infected as they observe more Covid-19 incidence close to the election. Higher rates of reported deaths are a more alarming occurrence than higher rates of reported cases. Hence, the substantive effect of deaths in the month leading up to the election is larger than that of cases during the same period.

Moreover, we observe some support – albeit not as robust as the negative effect of recent Covid-19 incidence rates – for our second hypothesis that the effect of early Covid-19 incidence increases voter turnout. The effects of early deaths on voter turnout is statistically significant in Model 1 at $p < 0.1$. After controlling for spatially lagged Covid-19 incidence (Model 2), the effect of early deaths is not statistically significant, but spatially lagged early deaths are positive and significant ($p < 0.05$), pointing to preliminary evidence for our second hypothesis.

Early incidence may increase turnout for at least two reasons. First, voters may use the election to signal their (dis)satisfaction with politicians’ performance during the pandemic. Second, municipalities with a higher incidence of early cases and deaths may have implemented more severe social distancing measures. Finally, primacy effects may increase the salience of early Covid-19 incidence (Postman and

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43 The reason early deaths and cases lack significance in spatial models (Models 2 and 4 in Table 2) might be due to either omitted variables bias—for example, spatial effects that inflated the results of direct early cases and deaths—or multicollinearity, given that local and spatially lagged incident rates are correlated. The correlation between local and spatial early deaths is 0.33, whereas it is equal to 0.49 between local and spatial early cases.

44 See the footnote above about why early deaths are not significant in spatial models.

45 Indeed, when we remove state fixed effects and include a control variable for state-level social distancing policies, we find in Table S7, Supporting Information that more stringent social distancing policies temporally close to (“1st Month”) and far from (“Early”) the election are correlated with
Figure 4 Direct effects of cases and deaths (1st month leading up to election) on turnout. Note: Panel (a) plots the marginal effect of deaths in the month leading up to the election from Model 2 in Table 2. Panel (b) shows the marginal effect of cases in the month leading up to the election from Model 4 in Table 2.

Phillips, 1965; Glanzer and Cunitz, 1966). In sum, a naive model that aggregates incidence throughout the pandemic would find no effect of Covid-19 on voter turnout because the opposite effects of early and recent incidence cancel out. 46

The magnitude of the coefficients are substantive. Holding all other covariates constant, if the cumulative number of cases in the month leading up to the election moves from 0.01 per 1000 inhabitants to the third quartile of the data—3.9 cases per 1000 people—the turnout rate in the municipality would decrease by more than 1 percentage point. 47 The effect of deaths is larger. Ceteris paribus, increasing deaths in the month leading up to the election from 0.01 to 1 per 1000 people would decrease turnout rate by more than 5 percentage points. 48 As mentioned earlier, even a 1 percentage point change in turnout rates would be pivotal for many city council seats and in tight mayoral races. In 2016, 20 percent of mayoral elections were decided by a margin of less than 4 percentage points, and more than 40 percent of all elected city councilors got less than 4 percent of valid votes in their municipalities.

Figure 4 plots marginal effects across different values of cumulative deaths (Panel A) and cumulative cases (Panel B) in the month leading up to the election. The Figure shows the effect of moving from 0.01 deaths or cases per 1000 people to one of the values across the x-axis. As we can observe in Panel A, ceteris paribus, moving from almost no Covid-19 deaths to a higher number of fatalities, such as 4 per 1000 people, is associated with a drop in the turnout rate of 6.5 percentage points. A large increase in Covid-19 cases, such as from almost no cases to 200 cases per 1000 people, is associated with a drop in the turnout rate of about 2 percentage points.

Our findings are robust to estimations that use the data that was officially available to voters on the election day. 49 These data tend to under-report the number of Covid-19 incidences because not all cases and deaths that occurred a few weeks before the election were reported by election day. The spatial territories of media networks vary significantly, with many local or sub-state networks (Aguiar, 2016, 2017), significantly higher turnout, which is consistent with findings by Giommoni and Loumeau (2020). However, the 2nd month and 3rd month policy measures are correlated with decreased turnout. We note that the absence of state-level fixed effects renders these results difficult to interpret as there are likely many important omitted factors that could be driving these differences.

46 See Table S3, Supporting Information.
47 This effect is calculated by the multiplication between the coefficient of cases in Model 4 in Table 2 (−0.002) and the natural log transformation of a hypothetical change in Covid-19 cases—ln(3.9/0.01).
48 This effect is calculated by the multiplication between the coefficient of cases in Model 2 in Table 2 (−0.011) and the natural log transformation of a hypothetical change in Covid-19 deaths—ln(1/0.01).
49 See Table S4, Supporting Information. The data available on the election day reported Covid-19 cases and deaths until November 14, 2020, the day before the election.
and residents get information about Covid-19 from television, radio, the Internet, and communication through social networks (Zanetti and Reis, 2020). Despite not being included in official sources, residents are likely to learn about the increase of Covid-19 incidence in their localities through these formal and informal sources, particularly in smaller municipalities.

**Spatial proximity**

Table 2 also reports the coefficient of spatially lagged Covid-19 variables (Models 2 and 4). We observe the same temporal trends discussed above: the spatial coefficient of early deaths is positive and statistically significant, and the spatial coefficient of deaths during the month leading up to the election is negative and statistically significant (Model 2). The other two temporal bins—two and three months before the election—are not statistically significant. We observe the same tendency in Model 4, which uses cases to measure the pandemic in neighboring municipalities. The coefficient for spatially lagged early cases is positive, whereas the coefficient for spatially lagged cases in the month leading up to the election is negative. However, these effects are not statistically significant. It is reasonable to suppose that voters get more information about—and pay more attention to—the Covid-19 fatalities happening in other municipalities than the case rates.

More importantly, spatial coefficients of Covid-19 deaths (Model 2) demonstrate that there is a significant spatial relationship between Covid-19 incidence and turnout. That is, the cumulative number of Covid-19 deaths in municipality \( i \) negatively affected voter turnout in nearby municipality \( j \). To interpret these spatial effects, we must calculate the spatial effect of change in deaths by: \( W \ast \hat{\theta}_{deaths} \ast \Delta_{deaths} \), where \( \Delta \) represents the change in the cumulative number of deaths in a given municipality \( i \). Thus, the spatial effect depends on the weight \( w_{ij} \) that the connectivity matrix \( W \) assigns to the dyad of municipalities \( i \) and \( j \) based on the distance between them.\(^{50}\)

To visualize the spatial effect, we follow Whitten, Williams and Wimpy’s (2021) suggestion to use a map to simulate how a shock in the explanatory variable in a given city \( i \) affects the outcome in neighboring municipalities \( j/s \). Our simulation increases the number of deaths per 1000 inhabitants in the month leading up to the election in the city of Bauru in the state of São Paulo from 0.01 to 2. Next, we use the connectivity matrix to simulate how this shock in deaths in Bauru would influence the turnout rate of other cities in the state of São Paulo. Panel (a) in Figure 5 shows the direct effect of increasing deaths in Bauru: this large shock would reduce the turnout rate in Bauru by almost 6 percentage points. Because it is a nonspatial impact, no other city is affected in Panel A.

In Panel B, we plot spatial effects, demonstrating how other municipalities in São Paulo would be affected. Notice that the spatial effect is stronger in nearby municipalities around the city of Bauru, where the shock would decrease the turnout rate by more than 1 percentage point. The spatial effect dissipates quickly as we move away from the epicenter of the shock. As expected, the spatial effect is significantly

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\(^{50}\) Our basic spatial specification for the connectivity matrix is the inverse distance between two municipalities.
smaller than the direct effect observed in Panel A of Figure 5. These findings corroborate our third hypothesis, which predicted that Covid-19 incidence in nearby municipalities would have a negative effect on local turnout, and that the strength of this effect would scale with distance of the municipality.

CONCLUSION

Brazil’s first round municipal elections on November 15, 2020 coincided with the aftermath of the protracted and severe first peak of Covid-19 and before the onset of the second peak. These were important elections because they (1) offered a means for voters to hold local elected officials accountable for the impacts of the pandemic and perceived efficacy in handling the crisis, including relief and lockdown measures, (2) occurred against a backdrop of material and physical hardship for many, and (3) took place in contexts with different levels of risks or threats to individual well-being from participating in public events. They were also the first elections since President Bolsonaro was elected in 2018. The municipal elections thus took place in a context that likely shifted the perceived costs and benefits of turning out to vote.

We use recently developed spatial analysis tools that account for the possibility of spatial correlation in the residuals to understand both the temporal and spatial dynamics of the effect of the crisis on political participation. We analyze Covid-19 cases and deaths contemporaneous with and at increasing temporal distance from the election, and at increasing spatial distance from a given municipality. We find that higher Covid-19 case or death rates in the month before the election depress voter turnout, and higher Covid-19 death rates in nearby municipalities in the month before the election also depress voter turnout. However, we find preliminary evidence that higher Covid-19 case and death rates earlier in the pandemic are associated with higher voter turnout; and that higher Covid-19 death rates in nearby municipalities early in the pandemic are also associated with higher turnout.

The findings contribute to our understanding of the political implications of risk perceptions and protective action in the face of relatively unknown or novel hazards. In a context of epistemic uncertainty about a hazard, people often make decisions based on affective and qualitative dimensions of risk (Slovic, Fischhoff and Lichtenstein, 1981b; Slovic et al., 2005; Weber, 2016). Furthermore, perceived risk of a hazard is heightened, and even overestimated, when it is directly experienced and when the psychological distance of the hazard is reduced (Trope and Liberman, 2010; Liberman, Trope and Stephan, 2007; Weber, 2016). As Covid-19 incidence rates increase in spatial and temporal proximity to an election, and the hazard becomes less hypothetical, the decision of whether or not to vote is likely to occur in a context of elevated risk perceptions. Thus our findings provide additional evidence for this important psychological theory by showing that both perceived and objective risks of elevated Covid-19 incidence increase with spatial and temporal proximity.

This research has broader implications for understanding how crises shift political behavior. We show that the impacts of a crisis on turnout can be better understood if they are disaggregated—economic or health crises generally unfold over weeks, months or years, and the impact of similar events at different points in time may have different implications for voter turnout. When incidence rates are higher early in the pandemic, voters likely remember this experience but no longer perceive immediate risk; they are mobilized to act on their experience and perceive higher benefits of voting. When high incidence rates occur later in the pandemic, voters perceive higher health risks and costs of voting.

Furthermore, we highlight specific ways that perceived costs and benefits of democratic participation may shift in the context of a highly communicable disease. While previous studies have shown direct impacts of crises on turnout, we also show that when a hazard has spatial dependency, turnout in one location is affected by events unfolding in neighboring areas. These findings suggest that dueling temporal pressures on costs and benefits of voting, as well as spatial amplification of these pressures, may be present during the same crisis, with implications for sub-national variation in political behavior.

Importantly, the Covid-19 pandemic shows that shifts in risks and benefits are unevenly distributed. The virus is deadlier for older individuals, and for those with preexisting health conditions, which can in turn depend on socioeconomic, environmental and institutional conditions. Furthermore, the ability to
limit personal interactions and to access reliable healthcare and other resources vary along other preexist-
ing vulnerability dimensions, such as income and race. Covid-19 has also been politicized by the current administration in Brazil, with sub-national variation in responses and resources. All of these factors likely mean that the shifts in perceived costs and benefits of voting will also be unevenly distributed across these dimensions, potentially affecting who turns out to vote and which voices and perspectives are represented in demands for democratic accountability.

Future research can further develop our understanding of how the political landscape is being reshaped by the pandemic by (1) analyzing turnout by cohort, and (2) considering the effects of Covid-19 on other electoral outcomes such as the decision for incumbents to run for re-election and vote share for different types of mayoral candidates. In future work, we hope to be able to identify the mechanisms underlying political behavior more precisely using individual-level surveys or social distancing data. We encourage researchers to evaluate the political predictors and consequences of variation in municipal-level social distancing policies and adherence to those policies over time if systematic panel data become available.

In the present study, we highlight that the influence of a health crisis on voter turnout varies in space and time. By considering different temporal windows of Covid-19 impacts as well as geographical variation and correlation of impacts, we find evidence of dueling forces shaping voter turnout at the municipal level, offering a more nuanced picture of how slowly unfolding crises impact the democratic process.

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