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Disaggregating disparities: A case study of heterogenous COVID-19 disparities across waves, geographies, social vulnerability, and political lean in Louisiana

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ABSTRACT

While the first wave of COVID-19 primarily impacted urban areas, subsequent waves were more widespread. Most analysis of Covid-19 rates examine state or metropolitan areas, ignoring potential heterogeneity within states and metro areas, over time, and between populations with differing contextual and compositional features. In this study, we compare spatial and temporal trends in Covid-19 cases and deaths in Louisiana, USA, over time and across populations and geographies (New Orleans, other urban areas, suburban, rural) and parish-level political lean. We employ publicly available longitudinal census tract and parish-level Covid-19 data reported from February 27th, 2020 to October 27th, 2021. We find that incidence and mortality rates were initially highest in New Orleans and Democratic areas and higher in other geographies and more conservative areas during subsequent waves. We also find wide relative disparities during the first wave, where increased social vulnerability was associated with increased positivity and incidence across geographies and political contexts. However, relative disparities diverged by geography and political lean and outcome across the remaining waves. This work draws attention to the differential rates of Covid-19 cases and deaths by geography, time, and population throughout the pandemic, and importance of political and geographic boundaries for rates of Covid-19.

1. Introduction

The first months of Covid-19, and subsequent media coverage and academic publications, focused on urban areas as Covid-19 hot spots (Oster et al., 2020). In April 2020, Covid-19 rates were highest in cities such as New York City, New Orleans, and Seattle, but subsequent spread has moved beyond cities (Oster et al., 2020; Frey, 2020). However, by the summer and fall of 2020, suburban areas experienced similar infection and deaths rates compared to urban areas (Zhang and Schwartz, 2020). By the third wave in the fall of 2020, cases had also risen in rural areas across the US, so much so that, in aggregate, rural areas had some of the highest rates in the country. US geographic regions have also become increasingly politically polarized (Kaplan et al., 2020) and, similar to geography, cases and mortality showed differential political patterns over time; cases first impacted liberal leaning cities, moved to politically mixed areas in the summer of 2020, and increasingly impacted more conservative areas by the fall of 2020 (Kaashoek et al., 2021).

Despite the heterogeneous impacts of Covid-19 throughout the course of the pandemic, with limited exceptions (Tieskens et al., 2021; Ioannou et al., 2020; Kim et al., 2021), most analysis of U.S. Covid-19 disparities have focused on a single wave (Figueroa et al., 2020) or cumulative rates (Reitsma et al., 2021; Acosta et al., 2021), statewide comparisons (Siegel et al., 2021), comparisons within specific cities (Bilal et al., 2021; Do and Frank, 2021) or across cities/counties (Figueroa et al., 2021; Stokes et al., 2021), or at a national level(Bassett, 2020; Rossen et al., 2021), and have rarely considered temporal, geographic, and contextual (political and sociodemographic) determinants simultaneously. Moreover, few studies have considered political lean as a contextual determinant of COVID-19 outcomes (Kaashoek et al., 2021; Krieger et al., 2021; Gao and Radford, 2021; Bernet, 2021). In a commentary published in the *American Journal of Epidemiology,* Schnake-Mahl & Bilal advocated for disaggregation of Covid-19 metrics across time, place, and people (population subgroups),

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arguing that lack of disaggregation misses important contextual and compositional features critical for understanding and addressing disparities in Covid-19 (Schnake-Mahl and Bilal, 2021). One limitation of most Covid-19 analyses is the lack of geographically detailed data at the census tract level. Exclusive reliance on county-level data misses important heterogeneities in the impact of Covid-19 within counties, and those jurisdictions that provide sub-county data generally use zip codes, which are easier to collect during a public health emergency. However, zip codes (and their area-level correlate, zip code tabulation areas), are also relatively large and heterogeneous units (Grubesic and Matisziw, 2006).

We conduct descriptive spatial and temporal analysis of trends in Covid-19 positivity, cases, and deaths using census tract level data. Louisiana is a state with some of the highest cumulative case rates, one of few states that experienced high rates of Covid-19 in all four Covid-19 waves and provides geographically detailed (census tract) longitudinal data on cases and tests. Other studies have looked at neighborhood contextual factors in Louisiana, finding higher risk of Covid-19 in more deprived and vulnerable neighborhoods (Biggs et al., 2021; Madhav et al., 2020; Oates et al., 2021). However, these studies have used cumulative counts and have not looked at geographies separately or examined the intersection of vulnerability and political lean. We first explore differential trends in positivity, incidence, and mortality disaggregated by geography and time in Louisiana, as well as by parish-level political context and time. Second, we describe changing disparity trends over time by context and composition, by measuring the association between social vulnerability and positivity and incidence, by geographic area and by parish political context.

2. Study data and methods

We used weekly census-tract (proxy for neighborhood) tests, positive tests, and confirmed case data made publicly available by the Louisiana Department of Health (LDH), and reported from February 27th 2020 to October 27th 2021 (Louisiana Department of Health. 2020). Confirmed cases represent individual persons with positive results for Covid-19, while multiple positive tests may be reported for an individual due to repeat testing. We also used daily parish-level (equivalent to county) mortality data, from the same period, from the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (Dong et al., 2020) because longitudinal mortality data was not available from the LDH. The Johns Hopkins data aggregates mortality data from the LDH and includes both confirmed and probable deaths (See LDH website for confirmed and probable death definition (Louisiana Department of Health. 2020)). Cases and tests were assigned to a census tract or parish based on the residence of the individual tested, though census tracts with less than 800 people were not assigned cases to protect privacy; approximately 85% of tests were matched to tracts. We also obtained census tract population from the 2015–2019 American Community Survey (ACS) for rate calculations.

We linked census tract and parish data to the United States Department of Agriculture 2010 Rural-Urban Commuting Area (RUCA) codes and Rural-Urban Continuum Codes (RUCC), respectively (USDA, 2020; USDA, 2013). RUCA codes classify census tracts and RUCC classify counties; both are based on indicators of population density and urbanization, and RUCC uses adjacency to a metro area. We regrouped the codes into four geographies: New Orleans (NOLA) proper (Orleans parish/city), other urban, suburban, and rural areas (see Appendix Tables 1–2 for details). We designated NOLA separately because it is the most populous city in the state and has maintained differentially strict re-opening policies compared to other parishes (City of New Orleans, 2020). We also regrouped weeks into five periods: 1) first wave, encompassing onset to June 31st; 2) second wave, July 1st through October 31st 2020; 3) third wave, November 1st 2020 through March 31st 2021; 4) vaccine rollout, April 1st 2021 through June 30th 2021, and 5) fourth wave, July 1st through October 27th 2021, coinciding with the Delta wave emergence in Louisiana. We chose April 1st, 2021 as the beginning of vaccination rollout as eligibility was opened to all adults in the state on March 29th, 2021.

We also linked our data to the Centers for Disease Control Social Vulnerability Index (SVI), a summary index of 15 census variables measuring populations most at risk during public health emergencies (Flanagan et al., 2011). Inclusion of the SVI allows us to measure contextual and compositional neighborhood attributes that may drive disparities in Covid-19 outcomes. To further investigate if specific aspects of social vulnerability drove Covid-19 patterns, we included four additional contextual and compositional variables: median household income (MHI), percent overcrowded housing (percent of household with $>$ 1 person-per-room), percent service workers, and percent less than high school education, all derived from the 2015–2019 ACS. To proxy political context, we linked parish data to 2020 presidential election results, obtained from the MIT Election Data + Science Lab (Nosrati et al., 2018). Political lean has been an important determinant of Covid-19 policies and behaviors (Williams and Ferreira, 2021; Samore et al., 2021), and may modify Covid-19 disparities. We categorized parishes with 60 or more percent of votes for the Democratic or Republican presidential nominees as Democratic or Republican, and all other parishes as Mixed. Census tract level voting data is not available for Louisiana (Presidential precint data for the, 2020) as early and provisional votes were not assigned to census tracts so we use parishes as the level at which we measure local political context, for analyses using this data.

To compute outcomes by geography or political context group, we summed the number of tests, positive tests, cases, deaths, and population by tract or parish and then summed the tract/parish outcomes and population counts by geography or political group, to compute the following monthly outcomes by geography or political group: incidence (sum confirmed cases/sum census tract populations), positivity ratios (sum positive tests/sum total tests), and death rates (sum total deaths/sum parish population). We also calculated the Relative Index of Inequality (RII), a relative disparity measure (Moreno-Betancur et al., 2015), to summarize the magnitude of social vulnerability disparities by geography and political context over time. Following the regression-based approach by Moreno-Betancur Moreno-Betancur et al., 2015), the RII allows us to summarize the linear association between social vulnerability and Covid-19 outcomes, across the entire social vulnerability scale. We employed a negative binomial model of number of positive tests or cases, using total tests or population as the offsets, with an independent variable for the continuous SVI ranging from 0 to 1 (higher more vulnerable). The exponentiated coefficient represents the RII, and 95% confidence intervals were calculated using robust standard errors. RIIs>1 were interpreted as disparities (higher rates in the most versus the least vulnerable areas), with values further above 1 interpreted as wider disparities, while RIIs below 1 were interpreted as inverted disparities (lower rates in the most versus the least vulnerable areas), with values further below 1 interpreted as wider inverted disparities. We repeated the RII analysis for the four other contextual variables, but first rescaled the variables into quintiles to allow the shape between the exposure and outcome to be as linear as possible. For MHI we inverted the quintiles, so that higher values represented lower MHI and exponentiated coefficients greater than one were interpreted as disparities. We conducted all analyses in R version 4.0.2. Code for replication is available at: https://github.com/alinasmahl1/COVID_Louisiana_Suburban. This study was exempt from IRB review as we used publicly available de-identified data.

3. Results

Sample characteristics. We include data from all 64 parishes and 1,117 census tracts in the state. The median parish population was 33,206 (range: 4,561 to 443,763), and median tract population was 3,726 (range: 932 to 18,933). We designated 15% (164) of all census tracts as part of NOLA, 53% (587) as other urban, 23% (257) as suburban, and 9.4% (106) as rural; for parishes, the corresponding percentages were 1.5%, 39%, 45%, and 14% respectively. For political context, we designated 4.7% (Zhang and Schwartz, 2020) of parishes as Democratic, 68.8% (Haddow et al., 2020) as Republican, and 26.5% (Bassett, 2020) as mixed. Appendix Table 4 shows the overlap of geographies with political context. There were 9,546,147 total Covid-19 tests, 838,060 of them positive, 657,712 confirmed Covid-19 cases, and 14,506 Covid-19 deaths in Louisiana during the study period.

Cases by geography and time. Louisiana experienced four waves of Covid-19, with case numbers increasing from the first to fourth wave (Fig. 1, top panel**)**. In all geographies cases dropped precipitously after February 2021 and continued to decrease until June 2021, but then grew to the largest totals of the pandemic in July to September of 2021. The proportion and number of cases in NOLA was high in the first months of the pandemic but decreased by May 2020 and remained low throughout the rest of the pandemic (Fig. 1, bottom panel). After the first wave, the number and percentage of cases in other urban, suburban, and rural areas increased, with suburban and other urban areas accounting for the majority of cases throughout the pandemic. These patterns were similar when exploring a categorization by political context (see Appendix Fig. 1, top and bottom panel), with results in Democratic areas following the patterns for NOLA, and results in Mixed and Republican areas following a pattern similar to other urban, suburban, and rural areas.

Temporal trends in positivity, incidence, and mortality by geography. Fig. 2 shows temporal trends in positivity ratios, incidence rates, and mortality rates by geography. During the first wave, NOLA had the highest incidence (11.5 cases/10,000), positivity ratios (13.5%), and mortality rates (0.85 deaths/10,000). Other urban, suburban, and rural areas had case rates of 6.9, 5.1, and 5.9 per 10,000, and positivity at 11.7%, 11.0%, and 10.8% respectively. Mortality rates in suburban and rural areas increased from 0.29 and 0.24 in the first wave to 0.48 and 0.58/10,000 in the second, while mortality rates in NOLA dropped substantially (0.85 to 0.10 per 10,000) and other urban rates dropped slightly (from 0.43 to 0.30 per 10,000). In the second wave, incidence rates declined in NOLA, while steadily increasing for all other geographies from the first to third waves. For example, incidence increased from 6.9 to 15.7 to 20 in other urban areas, from 5.1 to 16.5 to 18.2 in suburban areas, from 5.9 to 17.1 to 19.9 in rural areas, while decreasing and then increasing in NOLA from 11.5 to 8.6 to 14.7 cases/10,000, in the first, second and third waves, respectively. Across geographies, all outcomes decreased in the vaccine rollout wave, with smaller differences between geographies than in the previous waves. All three outcomes increased precipitously in the fourth wave (July - October 2021), to the highest incidence and positivity rates for all outcomes and geographies other than positivity in NOLA in the first wave. Mortality also substantially increased in the fourth wave, remained below the levels seen in the second wave in rural areas, and were the highest yet in suburban (0.64/10,000) and other urban (0.6/10,000), and higher than any wave except the first in NOLA (0.3/10,000). As with weekly trends in cases, these patterns were similar by political context (see Fig. 2).

Relative disparities in social vulnerability and geography over time. We observed relative disparities (RII > 1) in incidence and positivity across all geographies, and nearly all contextual variables, during the first wave (Fig. 3). In NOLA, the SVI RII for incidence was 2.2 (95% CI:2.0, 2.4), indicating 2.2 times higher incidence in the most versus least vulnerable neighborhoods of NOLA. In the second wave, we observed relative disparities for incidence in suburban (RII:1.3, CI:1.1, 1.4) and rural areas (RII: 2.0, CI: 1.6, 2.5), and narrow disparities in

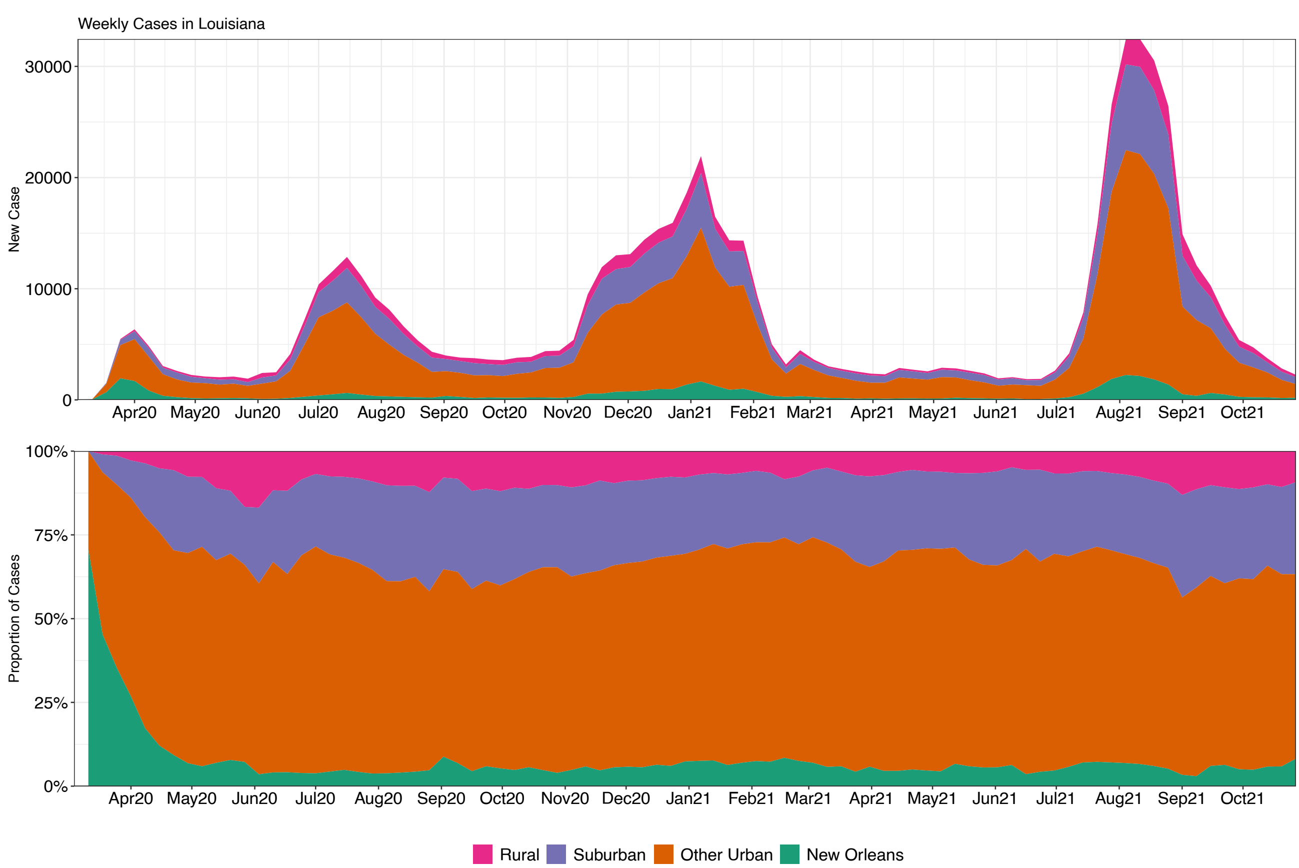

Fig. 1. Number and Proportion of Covid-19 Cases by Geography from February 27th, 2020 to October 27th, 2021 In the top panel the height of the graph indicates the total number of cases and the height of each color indicates the number of cases for that geography at each time point.

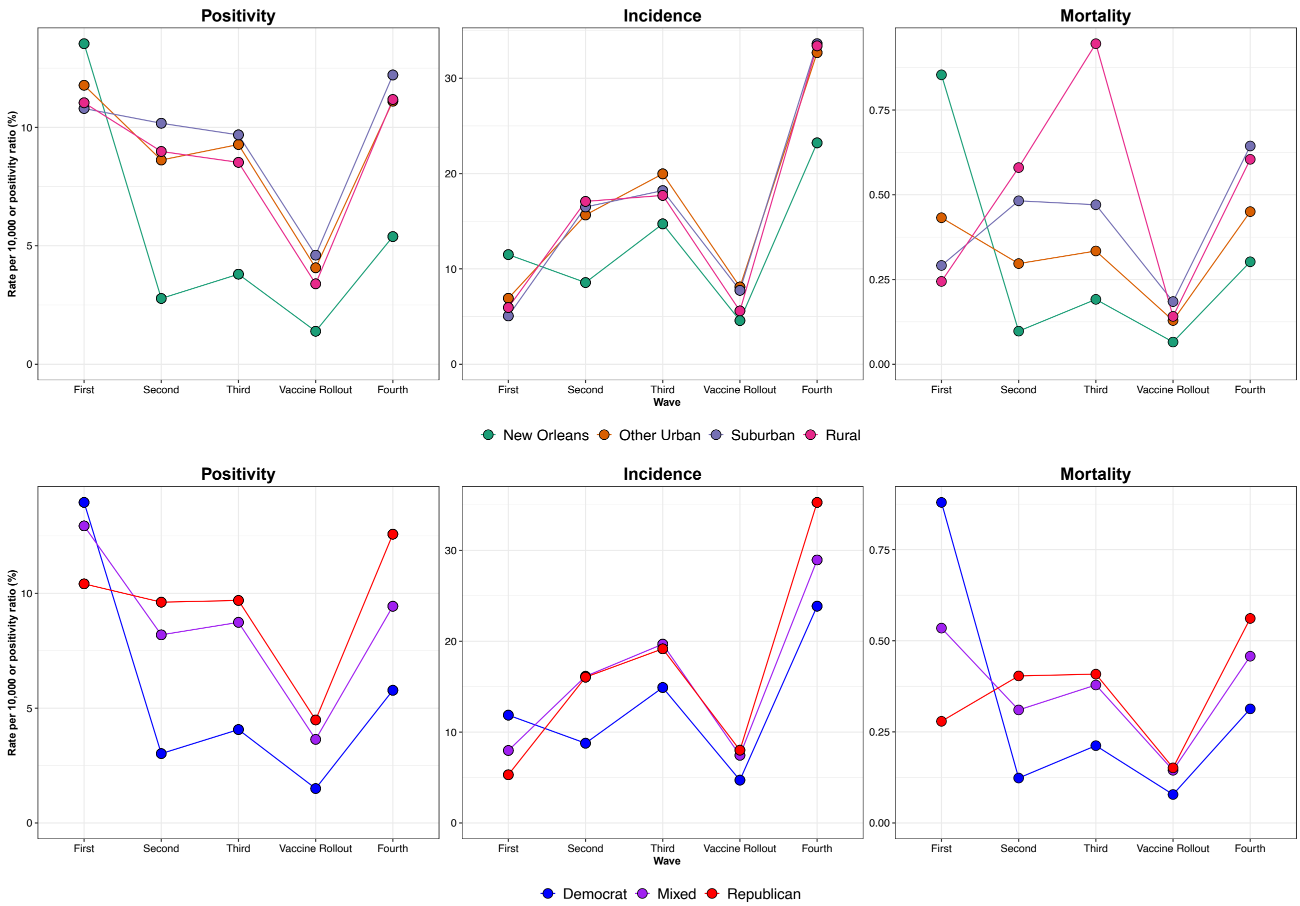

Fig. 2. Covid-19 Monthly Outcomes by Geography and Wave, and Political Context and Wave in Louisiana.

other urban areas (RII:1.02, CI: 0.98, 1.1), and inverted disparities in NOLA (RII:0.58, CI:0.51, 0.64). In the first wave, we observed SVI positivity disparities for all geographies, with the widest disparities in NOLA (RII: 2.0, CI: 1.8, 2.1). In the second wave there were inverted disparities for positivity in all geographies except NOLA (RII:1.1, CI:0.99, 1.2). For example, in rural areas during the vaccine rollout, positivity rates were 54% lower (IRR: 0.46, CI: 0.35, 0.62) in the most compared to the least vulnerable rural neighborhoods. These patterns continued throughout the rest of the pandemic for positivity, with disparities for NOLA, and inverted disparities in the other geographies. In the third wave all geographies except rural showed inverted disparities in incidence by SVI, while all geographies except NOLA showed inverted disparities in positivity. During vaccine rollout, incidence disparities weakened for rural places (RII:1.1, CI:0.80, 1.5), markedly increased in NOLA (RII:1.6, CI: 1.5, 1.9) and other urban areas (RII:1.3, CI: 1.2, 1.4), and were inverted in suburban areas (RII: 0.6, CI: 0.58, 0.74). Last, patterns changed again in the fourth wave, as NOLA, rural areas, and other urban areas showed disparities, or higher incidence in the most vulnerable compared to the least vulnerable neighborhoods. However, suburban areas showed wide inverted disparities (RII:0.69, CI: 0.65, 0.75), meaning there was a 31% lower incidence in the most compared to the least vulnerable suburban neighborhoods. The patterns and directions of disparities and inverted disparities were similar with the alternative measures, though the magnitude of disparities was narrower for MHI and less than high school, and was narrower or did not emerge for percent service and overcrowded.

Relative disparities in social vulnerability and political context over time. Democratic areas showed consistent relative disparities in positivity by SVI across waves, though the magnitude of disparities differed by wave (Wave 1:RII:1.9, CI:1.7, 2.3; Wave 3:RII:1.1, CI: 0.91, 1.3) (Fig. 4). Conversely, after the first wave, all other political contexts showed inverted positivity disparities by SVI, again with variable magnitudes across waves. For example, Republican areas had 0.58 (CI: 0.52, 0.64) times lower positivity in the most compared to least vulnerable parishes in the third wave, and by the fourth wave the RII for positivity shrank to 0.62 (CI: 0.58, 0.72). For incidence, during the first wave all political contexts experienced disparities, with higher incidence rates in the most socially vulnerable parishes. However, over the second and third waves, incidence disparities shrank considerably, and inverted in all geographies by the third wave. During the Vaccine rollout and fourth wave disparities again changed, with disparities emerging in Democratic (Wave 4:RII:1.65, CI: 1.4, 1.9) and mixed areas (fourth wave:RII:1.2 CI:1.1, 1.3), and narrow inverted disparities in Republican areas (Wave 4:RII:0.96, CI: 0.88, 1.06), meaning the most vulnerable parishes had 4% lower incidence compared to the least vulnerable. For most of the study period the direction of disparities remained the same with the alternative measures, though the inverted disparities in Republican areas in the vaccine rollout and fourth wave shifted to narrow disparities (RII > 1) in the less than high school and overcrowded housing analyses. RII's were also closer to 1 across waves for the crowding and service analyses.

4. Discussion

In this article we examined the interplay of geography, time, and social factors, including political context and social vulnerability in association with Covid-19 outcomes in Louisiana. Using census tract- and parish-level data, we found that Covid-19 cases increased each wave, with the highest number of cases in the fourth wave, after vaccines became widely available. In the first wave of the pandemic a high

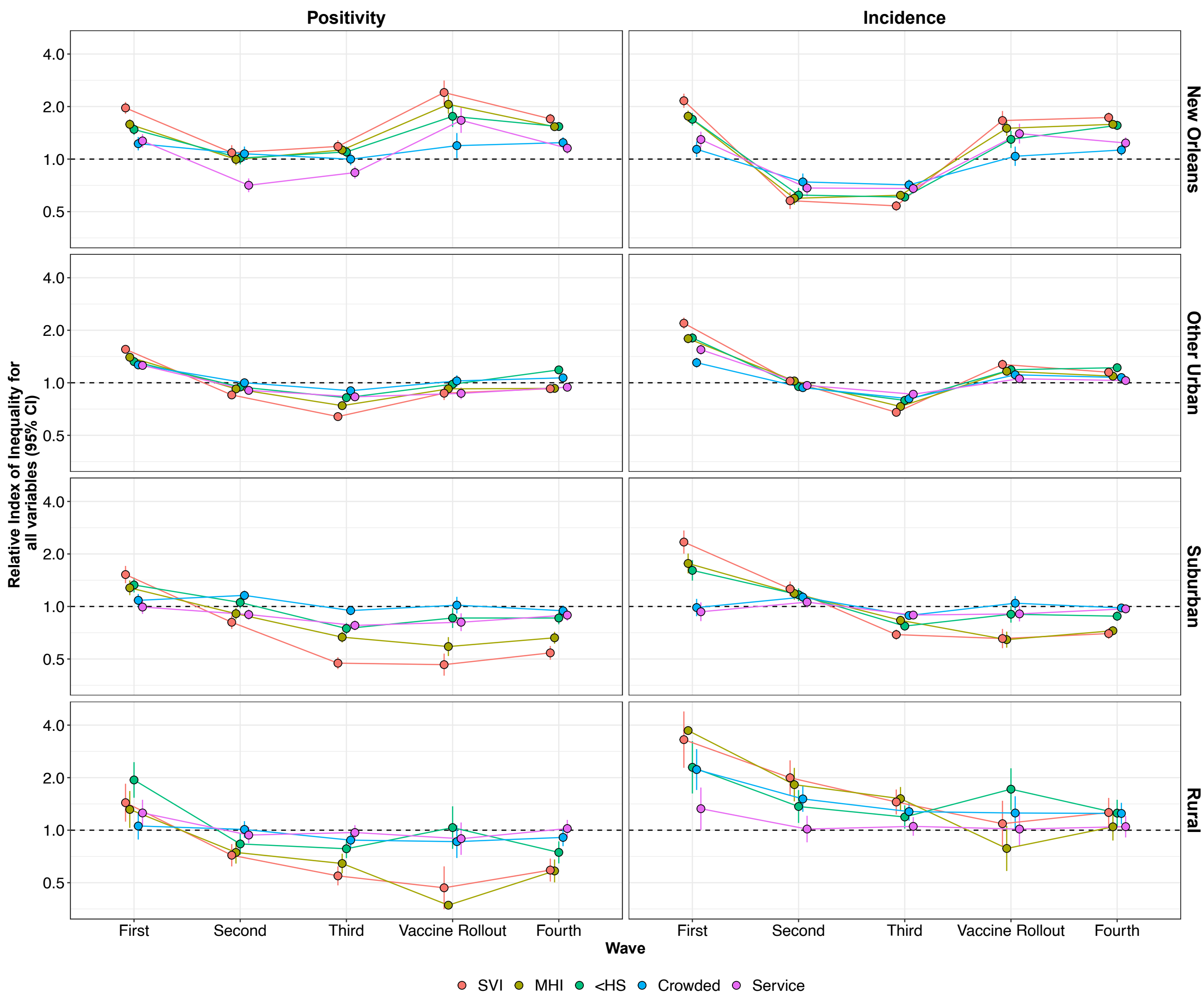

Fig. 3. Covid-19 Outcomes by Wave, Geography, and Social Vulnerability in Louisiana.

proportion of cases occurred in NOLA and Democratic areas, but subsequent waves have predominantly occurred in other urban and suburban areas and in Republican and Mixed political contexts. Following the first Covid-19 wave in March and April of 2020, incidence rates, positivity ratios, and mortality were higher in suburban, other urban, and rural areas as compared to NOLA, and these differences increased during the second, third, and fourth waves, but were nearly eliminated during the vaccine rollout phase. The same is true for different political contexts; we found substantially higher rates for all outcomes in the second, third, and fourth waves in Republican and Mixed contexts than Democratic. We also found disparities in incidence and positivity by social vulnerability during the first wave, but these patterns changed during subsequent waves, with NOLA often showing the opposite relationships to the other geographies. Similarly, all political contexts showed relative disparities by social vulnerability during the first wave, limited or inverted relative disparities in the second and third waves, and diverging patterns in the vaccine rollout and fourth wave. During the fourth wave, Democratic parishes with the lowest social vulnerability showed the highest incidence and positivity rates, while Republican areas of low social vulnerability showed no relative disparities in incidence and slightly higher positivity than areas of high vulnerability.

The high death rate in NOLA and Democratic areas in the first wave was likely driven by large case rates in the first months of the pandemic, accelerated by Mardi Gras (Zeller et al., 2021), prior to implementation of any stay-at-home order or non-pharmaceutical interventions. The lower incidence rates and positivity ratios in NOLA in subsequent waves may have resulted from more strict mitigation and suppression policies in the city than the suburbs or other areas of Louisiana (City of New Orleans, 2020), as changes in rates followed changes to policies (Yamana et al., 2020). Throughout the pandemic, politically progressive areas have shown greater willingness to enact stringent non-pharmaceutical interventions (Adolph et al., 2021; Adolph et al., 2021), though ability to enact policies was often limited by the state (Haddow et al., 2020). Many of the large cities worst impacted in the first wave (e.g., NYC or Seattle), were able to maintain relatively low infection and death rates in subsequent waves (Jones and Kiley, 2020), and our study suggests the same was true for NOLA and other Democratic parishes in the state. Nationally, Republican leaning counties experienced higher death rates between October 2020 and February 2021 (Kaashoek et al., 2021), and in Louisiana the same seems to hold true: after the first wave, Republican and Mixed contexts consistently experienced higher positivity, cases, and deaths than Democratic contexts.

Our findings also show lower incidence rates in more vulnerable neighborhoods of NOLA between the first and fourth waves, while other highly vulnerable neighborhoods of Louisiana had higher incidence during the second and third waves. While this suggests that stricter Covid-19 prevention policies may protect the most vulnerable

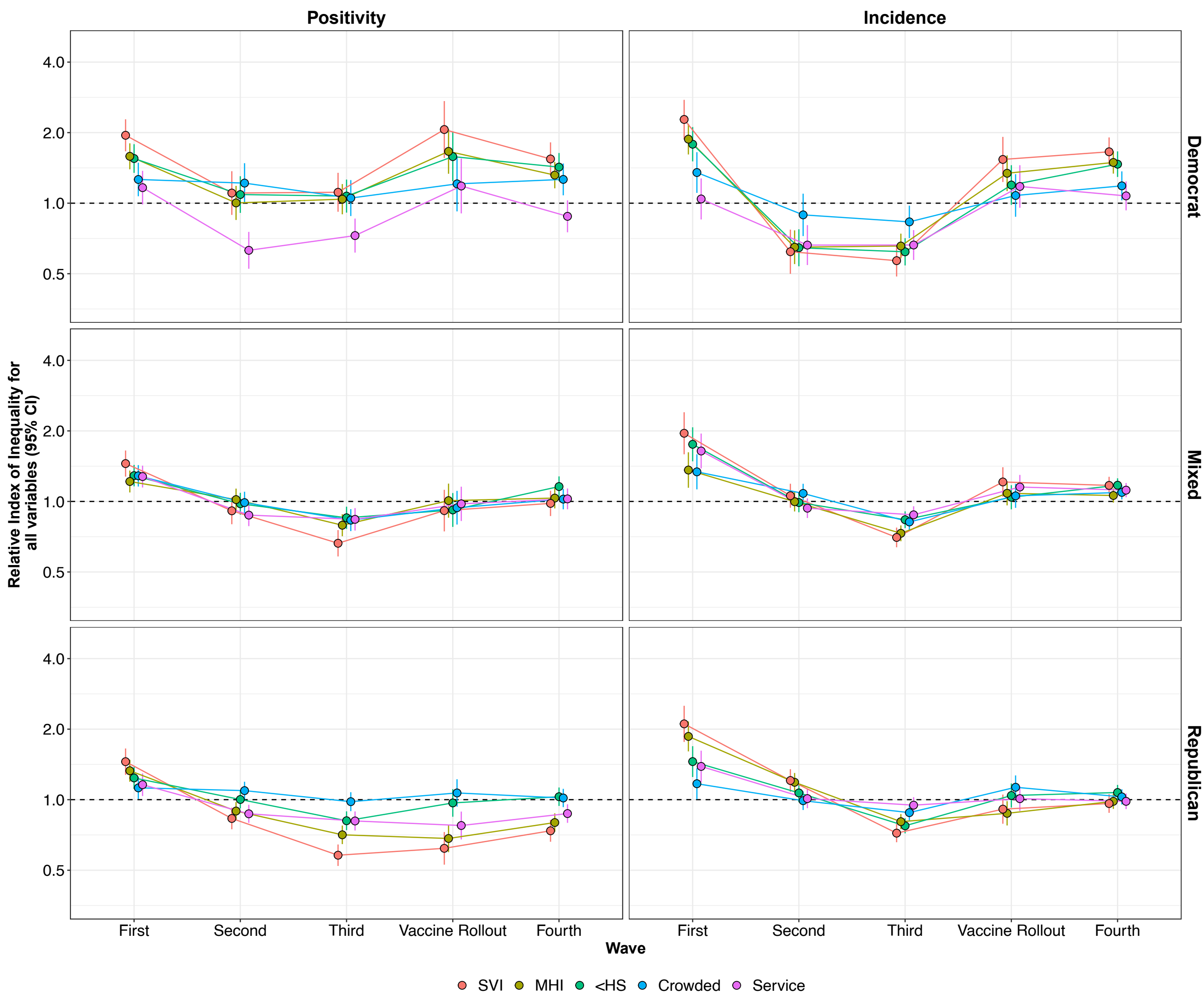

Fig. 4. Covid-19 Outcomes by Wave, Political Context, and Social Vulnerability in Louisiana.

individuals, our study cannot answer this causal question. Recent research has shown that racial disparities in Covid-19 mortality are mostly driven by differences in infection rates (Zelner et al., 2020). If this is the case, factors driving disparities in infection rates, such as occupational differences (McClure et al., 2020), may be modified by mitigation policies in ways that reduce these disparities. For example, mask mandates may benefit those that have to work in person, as opposed to those working from home. This evidence is consistent with other research, mostly in chronic diseases, showing that population-level interventions tend to reduce inequalities (Frohlich, 2014; McLaren et al., 2010).

We observed strong similarities between geographic and political patterns, reinforcing the idea of increasing political polarization of geography (Scala and Johnson, 2017). Moreover, we also observed a dynamic relationship between political lean, vulnerability, and Covid-19 outcomes throughout the pandemic. Research suggests that vaccination rates are generally lower in more vulnerable and low SES communities (Brown et al., 2021), often because of systematic barriers to vaccination (Bibbins-Domingo et al., 2021), mistrust of government (Quinn et al., 2019), the healthcare system (Strully et al., 2021) and pharmaceutical companies (Akhtar, 2021), and lack of insurance (Hamel et al., 2021). The weakening of the inverted disparities in Republican areas points towards this same idea, as it may signify lower vaccination rates in *more* vulnerable Republican contexts (Leonhardt, 2021; Kates et al., 2021), likely leading to higher case rates in those more vulnerable neighborhoods, if current patterns continue. Vaccination is extremely effective at preventing hospitalizations and deaths (Polack et al., 2020) and reduces transmission (Shah et al., 2021), and research suggests that places with higher vaccination rates have lower case rates (Chen, 2021; Samson et al., 2021). Additionally, vaccination rates and vaccination policies have been politically polarized, with substantially lower vaccine rates in Republican compared to Democratic areas across the country (Leonhardt, 2021; Kates et al., 2021), and in Louisiana parishes (Ivory et al., 2021). While prior work has shown that vaccination rates are lower in more politically conservative areas (Leonhardt, 2021), the inverted relationship between neighborhood social vulnerability and Republican lean has not been documented, nor has the heterogeneity of patterns of disparities over time and context. Importantly, these inverted disparities in Republican areas are sensitive to the choice of socioeconomic indicator, as we found the most extreme inverted disparities with the SVI, with weaker disparities when using median household income and occupation, and no disparities with overcrowding and educational attainment. These patterns indicate that the patterning of Covid-19 cases is driven by multiple factors, and that a single socioeconomic indicator may not capture all complexities of this social patterning.

Our findings of far lower rates in NOLA than suburban areas suggests that the geographic boundaries defining NOLA from surrounding suburbs has substantive implications. While suburbs and urban areas are often combined in epidemiologic analysis (Soni et al., 2017), disaggregating cities from suburbs is important for Covid-19, because policies that impacted Covid-19 rates differed by geography. Moreover, our results show higher incidence in more socially vulnerable suburban neighborhoods during the first two waves of the pandemic, and a recent analysis found that socially vulnerable suburban and rural areas showed the largest vaccine disparities (Barry et al., 2021), suggesting these geographies may be particularly vulnerable to new variants, and reinforcing the importance of disaggregating analysis of Covid-19 rates and disparities by geography.

Our analysis has several limitations. Like most surveillance data, there are several discrepancies, including backlogs to case reporting, that may impact the accuracy of monthly counts. Surveillance data likely undercounts true cases, particularly early in the pandemic when testing access was limited. If access to testing differs by geography, for example, fewer testing sites in low-income suburban areas, the data may differentially undercount tests by geography. However, the positivity ratio should account for these differences by normalizing positive tests by the total number of tests. We additionally include mortality at the parish level because sub-parish mortality data was not available, and likely miss important Covid-19 mortality heterogeneities within parishes. The same is true for political lean, which is not available at the census tract level in Louisiana. Despite the lack of within parish disaggregation, parish-level mortality still shows important heterogeneity across wave, urbanicity, and political lean, differences that are missed when only examining cumulative measures. Our main contextual variable, the SVI, provides a summary measure of social vulnerability, but previous work has questioned the theoretical and internal consistency of the SVI and similar measures (Spielman et al., 2020); we include a set of additional contextual and compositional variables, but future research should explore heterogeneity in disparities using other measures of contextual disparities, as disparity patterns may vary by measure.

5. Conclusions

The lack of uniformity in our findings by wave, geography, political lean, or social vulnerability reinforce the importance of examining disaggregated Covid-19 rates. Accurately understanding historical and current rates is itself an important epidemiologic goal for endemic Covid-19, for other epidemic infectious disease outcomes such as influenza, and for chronic conditions that follow social patterns. Continued examination of outcomes disaggregated by geography can help to determine how to target interventions by geography; solutions for urban areas may be different than suburban areas or rural areas. Louisiana provided data allowing for hyper-local monitoring of Covid-19 rates, while most other states only provided publicly available county-level data. As the pandemic continues, and Covid-19 shifts to an endemic disease, and other disease outbreaks impact the nation in the future, other states can learn from the data reporting process implemented by Louisiana. Future research should replicate disaggregated analysis for other states to better understand the scope, scale, and heterogeneity of Covid-19 impacts across the country.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2022.101833.

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