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Reparations for Black American descendants of persons enslaved in the U.S. and their potential impact on SARS-CoV-2 transmission

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ABSTRACT

Background: In the United States, Black Americans are suffering from a significantly disproportionate incidence of COVID-19. Going beyond mere epidemiological tallying, the potential for racial-justice interventions, including reparations payments, to ameliorate these disparities has not been adequately explored.
Methods: We compared the COVID-19 time-varying R_t curves of relatively disparate polities in terms of social equity (South Korea vs. Louisiana). Next, we considered a range of reproductive ratios to back-calculate the transmission rates $\beta_{i\rightarrow j}$ for 4 cells of the simplified next-generation matrix (from which R_0 is calculated for structured models) for the outbreak in Louisiana. Lastly, we considered the potential structural effects monetary payments as reparations for Black American descendants of persons enslaved in the U.S. would have had on pre-intervention $\beta_{i\rightarrow j}$ and consequently R_0.
Results: Once their respective epidemics begin to propagate, Louisiana displays R_t values with an absolute difference of 1.3–2.5 compared to South Korea. It also takes Louisiana more than twice as long to bring R_t below 1. Reasoning through the consequences of increased equity via matrix transmission models, we demonstrate how the benefits of a successful reparations program (reflected in the ratio $\beta_{b\rightarrow b}/\beta_{w\rightarrow w}$) could reduce R_0 by 31–68%.
Discussion: While there are compelling moral and historical arguments for racial-injustice interventions such as reparations, our study considers potential health benefits in the form of reduced SARS-CoV-2 transmission risk. A restitutive program targeted towards Black individuals would not only decrease COVID-19 risk for recipients of the wealth redistribution; the mitigating effects would also be distributed across racial groups, benefiting the population at large.

1. Background

The novel coronavirus which causes COVID-19 was first reported in Hubei Province, China in December 2019 (World Health Organization, 2020). In the ensuing 5 months, the outbreak spread to nearly every country in the world (Centers for Disease Control and Prevention, 2020a). As of December 11, 2020, the United States had the highest number of reported cases with 15,474,800 confirmed infections and

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291,522 total deaths (Centers for Disease Control and Prevention, 2020b)—although this certainly represents an underestimate of the true number of cases given the poor scale-up of testing coupled with a high rate of asymptomatic infection (Shear et al., 2020; Day, 2020).

As has been the case in previous pandemics, communities of color are suffering from an increased incidence of COVID-19—and therefore disproportionate mortality—when compared to white people (Quinn et al., 2011; Ogedegbe et al., 2020; Rentsch et al., 2020). Early in the outbreak, the aggregated relative risk of death for Black people compared to white people was 3.57 (95% CI: 2.84–4.48) (Gross et al., 2020). Such a difference is the product of, and further contributes to, vast disparities in Black and white health that are a concatenation of legacies of enslavement, legal segregation, white terrorism (e.g., lynchings during the Jim Crow period), hyperincarceration, lethal policing, and ongoing discrimination in housing, employment, policing, credit markets, and health care (Darity and Mullen, 2020a; Noonan et al., 2016; Braithwaite and Warren, 2020; Wrigley-Field, 2020). The mismanagement of the SARS-CoV-2 response in the U.S. has exacerbated these disparities (NEJM Editors, 2020), but at the immediate outset, path-dependent structural inequalities such as overcrowded housing, concentration in frontline work, and hyperincarceration led directly to greater exposure and transmission among Black people.

While frameworks for understanding the mechanisms through which biosocial forces become embodied as pathology are inchoate, allostatic load (the physiological profile influenced by repeated or chronic life stressors) can be used to demonstrate how the continuous trauma of oppression can lead to disparities in health by race (Farmer, 2001; Green and Darity, 2010; Crimmins and Seeman, 2004; Richardson et al., 2016; Bailey et al., 2017; Duru et al., 2012; Gravlee et al., 2005; Beatty Moody et al., 2019). The causes of health disparities are also locked in a pernicious feedback loop with wealth, wherein forms of ongoing discrimination deprive the Black population of the assets and generational wealth that they might use to ameliorate the sources of these health disparities (Darity and Mullen, 2020b).

The potential health impacts of racial-justice interventions, including reparations payments, have not been adequately explored (Morgan and Reid, 2020; Bassett and Galea, 2020). Mathematical and computational models of infectious disease transmission dynamics are increasingly being used to determine the potential impact of interventions on incidence and mortality (Kelly et al., 2019). Fundamental to this work is calculation of the basic reproductive number R_0, which is defined as the expected number of secondary cases caused by a typical infected individual in a fully susceptible population (Heesterbeek, 2002). While R_0 provides theoretical information about an epidemic, practical control ultimately depends on the expected infections generated later in the outbreak prompting epidemiologists to utilize the effective reproduction number R_t (i.e., the average number of secondary cases generated by an infectious individual at time t), which obviates the assumption of a fully susceptible population and allows for the temporal dynamics to be followed in the setting of various interventions (Liu et al., 2018).

Models must make assumptions about how people interact with others (Holmdahl and Buckee, 2020), but they rarely account for social forces like institutional and cultural racism that structure such interactions (Williams and Mohammed, 2013). Therefore, they can obfuscate such forces in their attempts to describe outbreak transmission dynamics (Levins and Lewontin, 1985; Farmer, 2005; Richardson, 2019, 2020a).

Nonetheless, it is possible to incorporate risk heterogeneities into models and to use this information to identify more just measures for disease prevention/control (Keeling and Rohani, 2007; Jones and Brown, 2008; Koopman et al., 1991; Koopman and Lynch, 1999; Morris, 1993). For example, Black workers are overrepresented in front-line sectors like food service and delivery, healthcare, and child-care, which places them at higher risk of SARS-CoV-2 infection. Black individuals also have a higher likelihood of living in dense, precarious housing where effective social distancing is hindered. These risks are structural—that is, not determined by personal choice or rational assessment, as models often assume (what Koopman and Longini refer to as "the erroneous attribution of individual effects" (Koopman and Longini, 1994)) (Diez-Roux, 1998; Farmer et al., 2006); they can therefore benefit from structural interventions.

2. Methods

For a representative inegalitarian state in the U.S., we chose Louisiana as a unit of analysis due to the availability of COVID-19 data compiled by race. Louisiana has one of the highest GINI coefficients (a measure for household income distribution inequality—a value of 0 represents total income equality [all households have an equal share of income], while a value of 1 represents total income inequality [one household has all the income]) among the American states (0.5) (Guzman, 2017), has a very small population of non-Black people of color (Supplemental Materials Section 3), is highly segregated between Black and non-Black populations (Supplemental Materials Section 4), has significant differences in the average number of persons per room (PPR: a measure of overcrowding (Blake et al., 2007) that recent reports indicate might be more important for risk of infection than urban density (Coryne, 2020)) for Black and non-Black populations (Fig. 1; see also Supplemental Materials Section 5), and areas with higher Black populations also have higher proportions of frontline workers (Supplemental Materials Section 6).

We focus on the early part of the epidemic, during the first wave of infection in Spring 2020. By May 28, 2020, the state had reported 38,802 SARS-CoV-2 infections (Louisiana Department of Health, 2020). We estimated time-varying R_t using the method of Wallinga and Teunis (2004), which uses a probability distribution for the serial interval (i.e., the time, in days, between symptom onset in an index case and symptom onset in a person infected by that index case). Confidence intervals for R_t were calculated using a normal approximation for the estimated number of secondary cases per case (i.e., approximating the 95% confidence interval by the expected value R_t ± 1.96 times the standard error). Following current best estimates of the serial interval, we chose a gamma distribution with a mean of 5 and standard deviation of 2 days (Li et al., 2020; He et al., 2020). (While one would expect a longer serial interval for Black people given the structural barriers to care outlined in

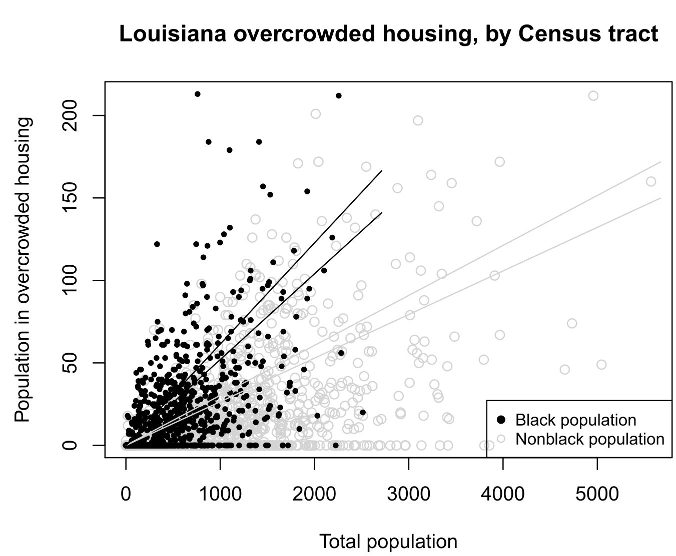

Fig. 1. Fitted 95% confidence intervals for the ratio of the population in overcrowded housing to total population by Louisiana Census tract. In tracts where overcrowded housing is documented, the estimated ratio of Black population in overcrowded housing to total Black population is 0.0565, double that of the non-Black population (0.0283).

the Background, our analysis aims to capture the beginning of the outbreak in Louisiana, before therapies shown to potentially shorten the course of COVID-19 such as dexamethasone (The RECOVERY Collaborative Group, 2020) and remdesivir (Beigel et al., 2020) were in use; presentation to care at that time improved an individual's chance of survival, but likely did not shorten their recovery from SARS-CoV-2 infection *per se*.)

To juxtapose these data with those reported from a relatively egalitarian polity, we conducted a similar analysis of the outbreak in South Korea (Korea Centers for Disease Control & Prevention, 2020), which in contrast to Louisiana, has a GINI coefficient of 0.32 (The World Bank, 2012) and no large, segregated subgroup of the population composed of the descendants of enslaved persons. South Korea nonetheless has 10 times the population density of Louisiana such that, if density by itself were the major determinant of epidemic severity, we would expect rates of infection to be much higher in the former compared to the latter, which is not the case (in Spring 2020, Louisiana reported nearly 40 times the number of cases per 100,000 people as South Korea). (Louisiana Department of Health, 2020; Korea Centers for Disease Control & Prevention, 2020; United States Census Bureau, 2019; The World Bank, 2018).

From the theory of epidemics in structured populations, we know that R_0 is given by the dominant eigenvalue of the next-generation matrix, **G**, a k x k matrix (Equation (1)) that accounts for the movement into and between the k infection states in the population. The matrix is comprised of elements $g_{i \to j}$, which are the expected number of type-j cases caused by contact with infectious individuals of type i (Diekmann et al., 1990). With the assumed values of R_0, we could analyze risk structure by back-calculating the transmission rates $\beta_{i \to j}$ (which are equal to the contact rate $c_{i \to j}$ multiplied by the transmissibility τ [i.e., the probability of infection given contact between a susceptible and infected individual]—Equation (2)) for 4 cells of the next-generation matrix, with the following constraints: $b \to b \gg w \to w \gg w \to b > b \to w$ (where b = Black and w = white); the quantity $\beta_{w \to w}\pi_w/\gamma$, which is the expected number of secondary cases caused by a typical infected individual within the white subgroup, was held constant at 1.5 (the median R_t value for the first 2 weeks of the South Korea outbreak once daily reported cases were greater than 50[57]); the population proportion π was determined using data from the U.S. Census American Community Survey 5-year estimates for 2018 (Black = 0.36 and white/other = 0.64); and the recovery rate γ (the inverse of the infectious period) was held constant at a value of 0.06 (Wang et al., 2020).

$$R = \begin{pmatrix} \beta_{b \to b}\pi_b/\gamma & \beta_{b \to w}\pi_b/\gamma \\ \beta_{w \to b}\pi_w/\gamma & \beta_{w \to w}\pi_w/\gamma \end{pmatrix} \qquad \text{Equation 1}$$

$$\beta_{i \to j} = c_{i \to j} \times \tau \qquad \text{Equation 2}$$

We analyze a specific program of reparations: one that aims to close the racial wealth gap between Black American descendants of persons enslaved in the U.S. and white Americans via monetary payments in the amount of $250,000 per individual or $800,000 per household (see Supplemental Materials Section 3) (Darity and Mullen, 2020c). Had such a program already been in place prior to the onset of the COVID-19 pandemic, we estimate its effects on pre-intervention $c_{i \to j}$ and τ (see Supplemental Materials Section 7 for more detailed methodology). We assume that post-reparations R_0 for the population would have a lower bound of 1.5 (not a mean) since wealth redistribution would decrease the ability of affluent whites to cloister themselves in a setting of relative exclusivity (Shim et al., 2020).

We conducted all analyses in R (v. 4.0.0) for Macintosh (R Foundation for Statistical Computing, Vienna, Austria) using code written by the authors.

3. Results

Fig. 2 presents time-varying R_t for the COVID-19 outbreaks in

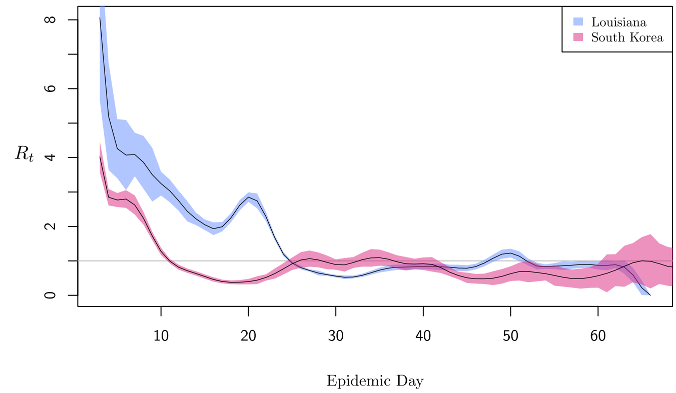

Fig. 2. Estimated time-varying R_t for the COVID-19 outbreaks in Louisiana (blue) and South Korea (red). Shaded areas represent 95% confidence intervals.

Louisiana and South Korea on a common scale of epidemic-days. Once the respective epidemics begin to propagate, Louisiana displays R_t values with an absolute difference of 1.3–2.5 compared to South Korea. It also takes Louisiana more than twice as long to bring R_t below 1, the critical value at which an outbreak will die out in a population (24 days vs 11).

Our next-generation matrix analysis shows that, in a segregated society like the U.S. where SARS-CoV-2 transmission rates are disproportionate across racial groups, small changes in the ratio between $\beta_{b \to b}$ and $\beta_{w \to w}$ can result in large changes in the reproductive ratio for the population (Fig. 3a), due mainly to 1) the effects of high assortative mixing structured by racism on the value of $c_{b \to b}$; and 2) the fact that the expected number of secondary infections generated within high-risk subgroups (i.e., the value $g_{b \to b}$ in the next generation matrix—in this case driven by high relative values of $c_{b \to b}$) comes to dominate R_0 for a population (Keeling and Rohani, 2007; Caswell, 2019; Jones et al., 2020).

A program of reparations has the potential to reduce several variables that determine the COVID-19 reproductive ratio in such a segregated society. These include.

i) reducing $c_{i \to j}$ significantly for Black people by decreasing overcrowded housing (this also has the benefit of improving an individual's ability to social distance once stay-at-home orders are enacted);
ii) reducing $\beta_{w \to b}$ as Black individuals would not be forced as frequently into high-risk frontline work—with both attendant exposure and psychosocial stress;
iii) decreasing τ slightly on account of people's ability to access preventive modalities like masks, hand sanitizer, etc.

Accordingly, the arrow in Fig. 3b shows how different assumptions regarding the effects of reparations could play out: It begins within the range of R_0 we selected from the Louisiana outbreak pre-intervention (i. e., before the stay-at-home order was enacted); it ends within our estimates for R_0 in the setting of reparations, which are consistent with early values of R_t estimated for South Korea and are 31–68% lower than pre-intervention estimates for Louisiana. This is achieved by the transmission rate $\beta_{b \to b}$ decreasing to near parity with $\beta_{w \to w}$, *which reflects the anticipated mitigation in structural racism a successful reparations program would engender*.

4. Discussion

4.1. The color line

In the United States, where the problem of the 21st century is still the problem of the color line, 400 years of structural racism, violently-seized

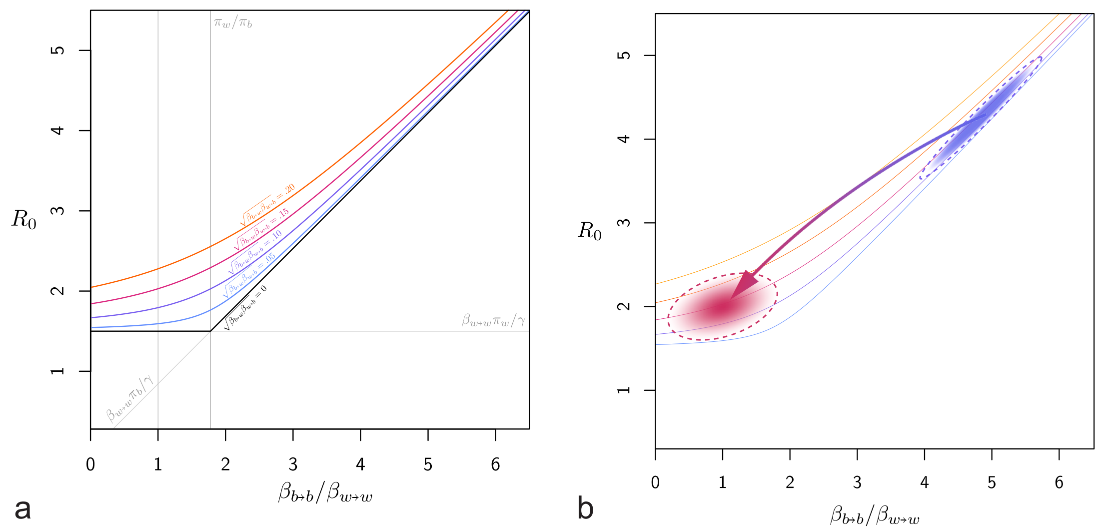

Fig. 3. a. If we assume the lower bound on the basic reproduction number reflects the risk of the non-Black population, then to explain an estimated R_t of 4, $\beta_{b\to b}$ would have to be more than quadruple that of $\beta_{w\to w}$. This holds across different values of the off-diagonal terms (which affect the curve only through their geometric mean $(\beta_{b\to w}\,\beta_{w\to b})^{1/2}$. b. Arrow shows the potential effects of reparations for a range of R_0 derived from the Louisiana outbreak. Arrowhead ends in a shaded area that represents the range of transmission ratios ($\beta_{b\to b}/\beta_{w\to w}$) assumed to obtain from a successful reparations program, and the decreases in R_0 that would result.

privilege, and continuous trauma from racial terror and dehumanization are clearly manifested in the disproportionate incidence and mortality rates of COVID-19 among Black Americans (Dubois, 1987; Richardson, 2020b). While there are compelling moral and historical arguments for racial injustice interventions such as reparations (Darity and Mullen, 2020b; Coates, 2014), our study describes potential health benefits in the form of reduced SARS-CoV-2 transmission risk. We illustrate how a reparative program targeted towards Black individuals would not only decrease COVID-19 risk for recipients of the wealth redistribution; the mitigating effects would be distributed across racial groups, benefitting the population at large.

Populations become entrained by the dynamics of the highest-risk segment of the population (Wallace and Wallace, 1999). This can be seen when a single diagonal element of the next generation matrix dominates the eigenstructure of that matrix (Jones et al., 2020). Overall, reducing the infectious burden on the most at-risk segment of the population has the greatest impact on the epidemic for the population at large. Reducing severe inequalities is thus not simply just, it is epidemiologically efficacious for outbreak containment.

4.2. Reparations

Through a novel combination of empirical evidence and structural reasoning based on the properties of mathematical models of infectious disease, we illustrate how pandemic containment policy can go beyond the wearing of masks and stay-at-home orders: *interventions in risk structure*—that is, the way people are enabled or constrained in their associations with others—are crucial to pandemic preparedness, the ability to comply with containment policy once it is decreed, and racial justice in general. Such an amelioration of structural risk can be achieved with reparations.

In general, a program of reparations is intended to achieve three objectives: acknowledgment of a grievous injustice, redress for the injustice, and closure of the grievances held by the group subjected to the injustice (Darity, 2008). Potential mechanisms by which reparations—through both monetary compensation and acknowledgment of injustice—could have suppressed the COVID-19 pandemic include:

1) narrowing of the path-dependent racial wealth divide;
2) changes in the built environment, fostering the ability to social distance;
3) spreading out of front-line work across racial groups;
4) decreased race-based allostatic load.

4.3. Disproportionate incidence vs. mortality

Current explanations of excess COVID-19 risk for Black Americans focus on personal failure to follow public health advice and lifestyle choices that result in co-morbid conditions (e.g., coronary artery disease and diabetes) (Chowkwanyun and Reed, 2020). Neither, however, addresses excess exposure, which is structured by institutional racism (and captured in the parameters $\beta_{i\to j}$). Indeed, reported mortality rates up to 7 times that of white populations likely reflect considerable underdiagnosis of cases in Black communities (APM Research Lab, 2020), rather than intrinsic differences in risk of death once infected (Ogedegbe et al., 2020). In other words, while there may be some differential mortality by race for COVID-19 (exacerbated by allostatic load), incidence is likely much higher in Black communities than we appreciate.

4.4. The symbolic violence of R_0

Contrary to the way it is often depicted popularly, R_0 is not an intrinsic property of a particular pathogen (nor are mortality rates (Richardson et al., 2017a)). Rather, the reproduction ratio encapsulates social structure, behavior, and differential risk in a population (Arthur et al., 2017). Such risk is often structural (Farmer, 2004), however, and modeling studies seldom capture oppressive social forces including institutionalized racism and sexism in their emphasis on 'objective,' well-defined parameters. While some scholars attribute this to the inherent conservatism of causal reasoning (Schwartz et al., 2016; Ruhm, 2018), it may be more justly described as a form of symbolic violence, referring to the ways naturalized symbols and language sustain relations of oppression (Swartz, 1997; Žižek, 2008; Maxwell, 2014; Richardson et al., 2017b). In the case of epidemic modeling, we are rarely presented with racial-justice interventions as ways of preventing and containing outbreaks. And because real racial-justice interventions have been inadequately explored empirically in an anti-Black world, we need to turn to creative means of imagining alternatives (McKittrick, 2015; Mignolo and Walsh, 2018).

Since reparations had not been enacted, however, 'reopening' American society early (after coronavirus-forced shutdowns) had a disproportionate adverse mortality effect on Black people, an effect that was predictable (Hsiang et al., 2020). Therefore, de facto, it resembled a modern Tuskegee experiment, since massive wealth redistribution could have averted these deaths, just as penicillin to treat syphilis would have averted deaths in the nearby state of Alabama (Alsan and Wanamaker, 2017; Brandt, 1978). As the APM Research Lab reported in August 2020, "If they had died of COVID-19 at the same rate as White Americans, about 18,000 Black, 6000 Latino, 600 Indigenous, and 70 Pacific Islander Americans would still be alive" (APM Research Lab, 2020)—and this was before even 5% of the national population had been infected. The appalling evidence of racism embodied as disproportionate COVID-19 incidence and mortality for Black Americans should add to moral, historical, and legal arguments for reparations for descendants of people enslaved in the U.S.

5. Authors' contributions

ETR, MMM, WAD, AKM, PEF, MTB, LW, and JHJ designed the study. ETR, MMM, WAD, AKM, MEM, MM, AM, MTB, PEF, LW, and JHJ conducted the literature search. ETR, MMM, WAD, MTB, LW, and JHJ collected data. MMM, LW, and JHJ wrote the R code. ETR, MMM, WAD, AKM, MEM, MM, AM, MTB, PEF, LW, and JHJ interpreted the results. ETR wrote the article. MMM and JHJ designed the figures. MMM wrote the Supplementary Material. ETR, MMM, WAD, AKM, MEM, MM, AM, MTB, PEF, LW, and JHJ edited and revised the article.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2021.113741.

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