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Original Contribution

The mental health consequences of George Floyd's murder in Minneapolis in Black, Latine, and White communities

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Abstract

The high-profile police murder of George Floyd is likely to have an aftermath of negative health consequences, particularly among Black people. Our study evaluates the impact of the murder of Floyd on mental health in Black, Latine, and White communities in Minneapolis, Minnesota. We constructed a panel data set merging data from the Minnesota Hospital Association, Minnesota Department of Natural Resources, Minneapolis Police Department, and American Community Survey. First, we specify an overall and racial subgroup, autoregressive, interrupted time-series design to identify the impact of the murder on rates of mental health hospital discharge at the city level. We then examine the spatial heterogeneity in the impact of the murder by specifying zip code tabulation area (ZCTA)-level panel models. We find an increase of 0.23 per 1000 residents in mental health conditions among Black people in the immediate postmurder period, followed by a weekly decline (−0.007) in mental health diagnoses. We do not find a substantial rate increase in White or Latine residents. Furthermore, our analyses at the ZCTA-week level corroborate these findings and show that the increase for Black residents was global. These findings speak to the traumatizing effects of police violence and the short- and longer-term public health consequences for Black communities.

This article is part of a Special Collection on Mental Health.

Key words: police violence; structural racism; mental health.

Introduction

Racialized police violence has been pervasive throughout US history. As James Baldwin noted, "History is not something you read about in a book; history is not even the past, it's the present, because everybody operates, whether or not we know it, out of assumptions which are produced only, and only by our history."[1] America's history of slave patrols is reflected in the police violence against Black people today.[2] Black people are 5 times more likely than White people to sustain an injury during a police encounter that requires emergency room care,[3] are disproportionately subject to police use of force,[4] and face substantially higher lifetime risks of being killed by police.[5] Bowleg et al[6] introduced the concept of the Anti-Black Police Violence Continuum, which underscores that the range of violence inflicted by police is a manifestation of anti-Black structural racism. A large proportion of police violence is targeted against Black people; however, individuals with other marginalized identities (eg, other racial/ethnic groups, sex workers, transgender people) are affected disproportionally as well. For example, people of color compose approximately 40% of the US population but account for more than half of the years of life lost due to police violence.[7]

Police violence uniquely worsens population mental health because of its state-sanctioned nature.[3,8-10] Direct exposure to police violence increases individuals' reports of general anxiety, depression, trauma symptoms, suicide attempts, and anticipation of future police violence victimization.[8,9,11,12] The health effects of police violence extend beyond individual injury to influence population health outcomes.[12-15] Vicarious exposure to police violence, such as witnessing or hearing about a police violence event, is associated with increased anxiety, depression, trauma symptoms, and suicide attempts.[12-14] For instance, 1 study of a population-representative sample of Black people found that exposure to a police killing of an unarmed Black person was associated with 0.14 additional poor mental health–days per month.[16] However, in that same study, there were no mental health impacts among White individuals.[16] Furthermore, a recent review found that police violence has significant negative health effects, particularly for Black, Latine, and other marginalized communities.[10,17] The full physical and mental trauma caused by police is unknown because of poorly documented or comprehensively collected data.[18] One study examining county-specific risk of police shootings found that the probability of being Black, unarmed, and shot by police was 3.49 times higher than the probability of being White, unarmed, and shot by police.[19] However, current research lacks more resolute spatial and temporal data, which limits the ability for more sensitive analyses to expand beyond the current

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body of literature, which is made up of predominantly descriptive or cross-sectional studies conducted at the state-level and above.

The murder of George Floyd brought mainstream visibility to the health burden of police violence predominantly borne by racialized marginalized communities.[14] An approximately 10-minute long video by Darnella Frazier of this murder was posted on Facebook and watched by millions of people. The video and story were subsequently replayed on news outlets and across social media platforms, potentially further traumatizing marginalized communities. Research shows in the week after the murder of Floyd, there was an unprecedented nationwide increase—above existing COVID-19 pandemic highs—in reports of anger and sadness.[14] Reports of anxiety and depression also increased during this time, especially among Black Americans.[14]

Geographic proximity also shapes responses to police violence. Minnesota reported the largest decline in mental health compared with other states, and Black people living in Minnesota likely experienced the most substantial mental health effects after Floyd's murder.[14] This reaction to a highly visible example of police violence is consistent with findings from a recent nationally representative study that found most Black people live in fear of the police killing them or their family members.[16] However, most of the research conducted to date has been based on cross-sectional studies, self-reported measures, and limited consideration of geography.[10,17]

To fill these gaps, we evaluated the rate of mental health diagnoses over time and space after the murder of Floyd on May 25, 2020, in communities in Minneapolis, MN. We contribute to the existing literature by (1) using 5 years of time series and panel data to examine changes in response to the police murder; (2) using an alternative measure of mental health diagnosis, which provides population-based estimates of mental health diagnoses that are potentially less susceptible to social disability bias than self-reports; and (3) examining the hyperlocal impact, and spatial heterogeneity therein, of the murder across Minneapolis, MN.

Methods

Data

We leverage Minnesota Hospital Discharge data from the Minnesota Hospital Administration (MHA) to create our dependent variable: mental health hospital diagnoses per 1000 residents. All Minnesota hospitals submit inpatient, outpatient, and emergency department claims data to the MHA. The MHA collects these data into a statewide administrative claims database. This database includes a data point for each patient encounter with a health care provider, the diagnosis(es) during that encounter specified with *International Classification of Diseases* (ICD) codes, as well as basic demographic information, such as age, sex/gender, and race. Hospital discharge data have the advantage of being population representative. Using ICD-10 codes, data from 2016-2020 were used to define mental health diagnoses.[20] They are categorized on the basis of established mental, behavioral, and neurodevelopmental disorders diagnoses groupings using ICD-10 codes F01-F99.[20,21] A table of the codes can be found in Table S1.

We also calculate race-specific measures of mental health diagnoses incidence per 1000 residents. In our interrupted time-series design (discussed later in this section), the key time indicators are a baseline weekly linear trend (*T*), an exposure indicator of the police murder of Floyd on May 25, 2020 (post-killing), and a linear time trend post-killing (T post-killing). The weekly time trend captures the overall linear trend in mental health discharges across 2016-2020, the binary exposure variable indicates the discontinuous change in the week of the police murder of Floyd, and the post-killing term describes the linear trend in mental health discharges after the murder.

In addition to our focal time measures, we further improve our identification of the post-killing effect in our interrupted time-series design by controlling for time-varying changes in COVID-19–related policy, police behavior, and seasonality. We create 2 event indicators related to the COVID-19 pandemic: (1) March 13, 2020, at the inception of Minnesota Governor Tim Walz's State of Emergency order, and (2) from March 28, 2020, to May 28, 2020, at the introduction and conclusion of Minnesota's stay-at-home order. These time indicators adjust for changes in mental health discharges related to key policy events in the course of the COVID-19 pandemic and related patterns of social interaction and movement. We also incorporate measures of police behavior from the Minneapolis Police Department's open access data. Specifically, we aggregate and spatially locate reported use of force incidents, police stops, and officer-involved shootings to both the week and zip code tabulation area (ZCTA)-week level from 2016-2020, placing each incident in each ZCTA-week by the date of incident and the spatial intersection of each ZCTA and the longitude and latitude coordinates of the location of the recorded police event. We then express these measures as rates per 1000 residents. Furthermore, we lag each measure of police behavior by 1 week to account for the potential simultaneity between police behavior and mental health incidence. These measures serve as our indicators of policing activity in Minneapolis and adjust our event coefficients for any concurrent changes in police stops, uses of force, or shootings. In other words, these measures allow us to further isolate the effect of the focal police killing above and beyond changes in routine police behavior.

Previous research shows that mental health discharges exhibit a seasonal pattern,[22] and we merge measures of seasonality onto the weekly hospital data. To capture weekly changes in seasonality, we include the weekly maximum temperature (degrees Fahrenheit), snowfall (inches), and precipitation (inches) from the Minnesota Department of Natural Resources as measured at the Minneapolis/St. Paul Threaded Record station.

The ZCTA simple feature boundary attributes and each geography's corresponding yearly American Community Survey data were accessed from the Census Bureau's Application Programming Interface using the "tidycensus" package in R.[23] The ZCTAs representing Minneapolis were determined by spatial intersection with the Minneapolis city boundary. Additionally, intersecting neighbors were defined as having at least 5% spatial overlap to identify ZCTAs that contain enough spatial overlap to have records in the Minneapolis Police Department data. Similar to previous research on neighborhood effects,[24,25] we create a construct of concentrated disadvantage using time-varying indicators from the American Community Survey 5-year estimates using 5 indicators: the unemployment rate, percentage below the poverty line, the percentage of female-headed households, the percentage of the population with no high school diploma, and the population of Black residents. We construct this measure using a confirmatory factor analysis to explicitly account for measurement error in this construct (see Table S2 for model specification). This measure serves as our proxy for structural racism and disadvantage in our tests of spatial heterogeneity.

Statistical method

We first construct time-series plots of mental health diagnoses incidence over the period from 2016 to 2020. Figure 1 displays the

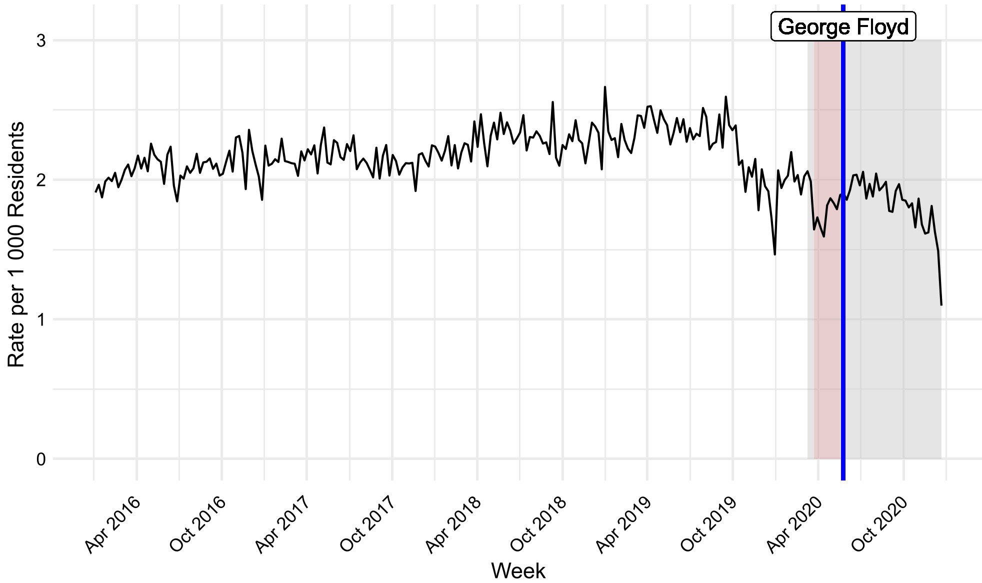

Figure 1. Overall time trend in mental health diagnoses per 1000 residents across Minneapolis. The gray period represents the COVID-19 state of emergency order, and the red represents the COVID-19 stay-at-home order.

overall time trend in mental health diagnoses per 1000 residents across Minneapolis, and Figure 2 displays the time series by racial subgroup. We then estimate autoregressive, interrupted time-series models on week-level data in Minneapolis. Interrupted time-series designs compare the levels of outcomes after a treatment or intervention with the outcome level in the preintervention period. The pretreatment trend is assumed to serve as the counterfactual should treatment not have occurred (ie, the trend in mental health discharges in the counterfactual scenario where the police killing of Floyd did not occur).

The design exclusively uses within-unit over time variation, so time-stable confounders are uncorrelated with the time-varying treatment. However, the design is susceptible to time-varying confounders, which can vary alongside treatment timing. Therefore, we include a suite of time-varying controls to strengthen our causal identification in the interrupted time-series (ITS) design. Furthermore, the design is susceptible to temporal autocorrelation in the series; therefore, we include temporal autoregressive lags of mental health discharges in the *t-lag* week to adjust for the impact of previous mental health diagnoses on contemporaneous diagnoses, effectively controlling for the possibility of the focal event timing being confounded with recent changes in mental health diagnoses. In sum, our causal identification assumes that the police killing, and its consequences, are the only exposures that change at the time of the event, when we include the observed time-varying covariates. Thus, we specify the following model:

$$y_t = \beta_0 + \beta_1 Time_t + \theta Event_t + \beta_2 TimePost_t + \varnothing X_t + \rho_1 y_{t-1} + \rho_2 y_{t-2} + \rho_3 y_{t-3} + \epsilon_t$$

where θ represents the focal parameter of interest: the change in the time series of mental health discharge rates in response to the police killing. We specify models for Minneapolis overall as well as subgroup models for White, Black, and Latine residents, and the results of each are presented in Table 1.

We subsequently estimate random coefficient, interrupted-time series panel models for the White, Black, and Latine racial subgroups with random ZCTA intercepts and ZCTA random event coefficients on ZCTA-week level data. This ITS specification using the panel data allows the intercept and focal event coefficients to vary by ZCTA, in turn allowing us to (1) estimate the association of the police killing within each ZCTA and account for baseline ZCTA differences in mental health (random intercept), as well as (2) examine the spatial heterogeneity in the post-killing effect (random coefficient) for each racial subgroup. The RE panel model for each subgroup is specified as follows:

$$y_{ti} = \beta_{0i} + \beta_1 Time_t + \theta_i Event_t + \beta_2 TimePost_t + \varnothing X_{ti} + \rho y_{t-1} + \rho y_{t-2} + \rho y_{t-3} + \epsilon_{ti}$$

$$\beta_{0i} = \gamma_{00} + u_{oi}$$

$$\theta_i = \gamma_{10} + u_i$$

where θ_i represents the estimated post-killing increase in each respective ZCTA. We also specify the random-effects models to have correlated random effects so the random intercepts and slopes may be related in some manner. These random effects (RE) panel specifications include the full suite of controls for time-varying seasonality, police behavior, and COVID-19 policy, as well as 3 lagged autoregressive (AR) terms to control for autocorrelation structure in the data.

We also estimate a random coefficient model for each racial subgroup with a cross-level interaction between the post-killing indicator and concentrated disadvantage to examine the spatial heterogeneity in the post-killing effect across communities and to assess the moderating influence of structural racism and disadvantage on the effect of the police killing. In other words, we explicitly test the extent to which the post-killing increase was different in areas of higher concentrated disadvantage and to what extent concentrated disadvantage may explain any post-killing effect heterogeneity. Finally, we construct choropleth maps of both the estimated random coefficients from the base random coefficient models and latent concentrated disadvantage measure by ZCTA to visually contextualize the spatial heterogeneity of the post-killing effect across Minneapolis.

We conducted 4 additional sensitivity analyses. First, we included a quadratic polynomial in the pre- and posttreatment periods and then 3 additional models with 3 largest mental health

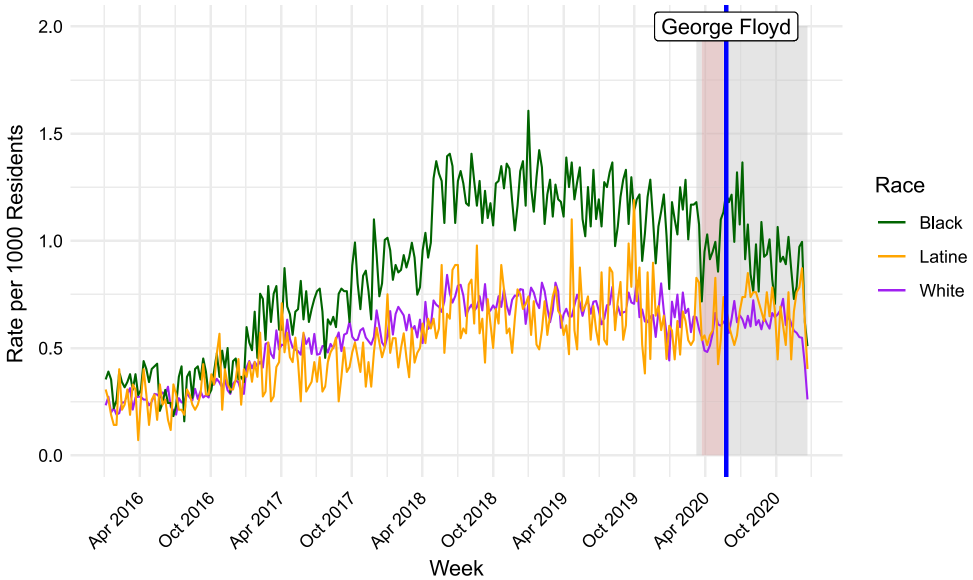

Figure 2. Time series by racial subgroup. The gray period represents the COVID-19 state of emergency order, and the red represents the COVID-19 stay-at-home order.

subtypes (anxiety disorders, depression disorders, and alcohol disorders). Results are presented in Figures S1-S15 and Tables S3-10. Because of the increasing concern about null-hypothesis significance testing,[26] we focus here on estimation of associations and the broad pattern of results, as opposed to significance testing. All data and code for data manipulation, merging, and analysis, apart from the restricted MHA data, are available in an online GitHub repository (https://github.com/ryanplarson).

Table 1. Interrupted time-series models of mental health diagnoses, Minneapolis, MN, 2016-2020.

	Mental health diagnoses per 1000 residents, by race/ethnicity (95% CI)			
	Model 1: Overall	**Model 2: White**	**Model 3: Black**	**Model 4: Latine**
T	−0.0001 (−0.001 to 0.0004)	0.0003 (−0.00001 to 0.001)	0.001 (0.0004–0.002)	0.002 (0.001–0.002)
Post-killing	0.152 (−0.015 to 0.319)	0.061 (−0.022 to 0.144)	0.228 (0.042–0.413)	0.022 (−0.159 to 0.203)
T post-killing	−0.010 (−0.015 to −0.004)	−0.005 (−0.007 to −0.002)	−0.006 (−0.013 to 0.0002)	−0.001 (−0.007– to 0.005)
COVID-19: state of emergency	−0.198 (−0.357 to −0.039)	−0.057 (−0.136 to 0.022)	−0.278 (−0.451 to −0.104)	−0.096 (−0.263 to 0.071)
COVID-19: stay at home	0.066 (−0.096 to 0.228)	0.016 (−0.064 to 0.095)	0.193 (0.015–0.372)	−0.025 (−0.199 to 0.148)
MPD use of force t-1	0.395 (0.023–0.767)	0.233 (0.046–0.419)	0.100 (−0.312 to 0.512)	−0.060 (−0.463 to 0.342)
MPD stops t-1	−0.030 (−0.091 to 0.031)	0.003 (−0.028 to 0.034)	0.040 (−0.028 to 0.108)	0.024 (−0.042 to 0.091)
MPD OIS t-1	−11.110 (−21.844 to −0.377)	−3.596 (−8.951 to 1.759)	0.936 (−10.904 to 12.775)	−0.741 (−12.308 to 10.826)
Mean maximum temperature	0.002 (0.0004–0.003)	0.0004 (−0.0001 to 0.001)	0.0002 (−0.001 to 0.001)	0.001 (−0.001 to 0.002)
Snow (in.)	0.011 (−0.036 to 0.057)	0.012 (−0.012 to 0.035)	−0.002 (−0.053 to 0.050)	−0.017 (−0.067 to 0.034)
Precipitation (in.)	−0.260 (−0.425 to −0.094)	−0.077 (−0.159 to 0.004)	−0.155 (−0.335 to 0.026)	−0.014 (−0.192 to 0.164)
AR(1)[a] overall	0.316 (0.181–0.452)			
AR(2) overall	0.268 (0.131–0.404)			
AR(3) overall	0.134 (0.0001–0.269)			
AR(1) White		0.458 (0.322–0.595)		
AR(2) White		0.200 (0.052–0.348)		
AR(3) White		0.110 (−0.030 to 0.250)		
AR(1) Black			0.340 (0.206–0.475)	
AR(2) Black			0.175 (0.035–0.314)	
AR(3) Black			0.230 (0.095–0.366)	
AR(1) Latine				0.076 (−0.063 to 0.215)
AR(2) Latine				0.122 (−0.016 to 0.260)
AR(3) Latine				0.101 (−0.037 to 0.240)
Constant	0.603 (0.257–0.948)	0.058 (−0.026 to 0.143)	0.014 (−0.160 to −0.188)	0.121 (−0.053 to 0.295)
Observations	216	216	216	216
R^2	0.724	0.711	0.749	0.395
Residual SE (df = 201)	0.126	0.063	0.140	0.137

Abbreviations: AR, autoregressive; df, degrees of freedom; MPD, Minneapolis Police Department; OIS, Officer involved shootings; T, Time.
[a]AR1 refers to AR model 1, AR2 refers to AR model 2, and so forth.

Results

Temporal pattern of mental health diagnoses

Figure 1 displays the weekly incidence of mental health hospital diagnoses in Minneapolis from 2016 to 2020. The series exhibits a fairly consistent pattern in the pretreatment period, followed by a decline in the weeks preceding the COVID-19 pandemic, alongside a modest increase in mental health diagnoses post-killing. In the month before Floyd's killing, we observe a rate of mental health diagnoses overall of about 1.85 per 1000 residents, as compared with a rate of 1.93 per 1000 post-killing—a modest overall increase of 0.08 per 1000 residents. After this initial modest increase of approximately 4%, the rate modestly declined to levels roughly commensurate with the month before the Floyd killing.

Figure 2 shows the racial group–specific time series of mental health hospital diagnoses. The beginning of the series exhibits fairly similar mental health rates across racial groups, with a divergence happening in 2017 between the rate for Black residents as compared with White and Latine residents. Although both the White and Latine time series do not visually appear to have large increases post-killing, with differences of 0.02 and −0.03 in the month before compared with the month after the Floyd killing for each group, respectively. However, the discontinuity in the Black time series is substantially larger, with a post-killing rate of 1.15 per /1000 residents as compared with a weekly rate of 1.02 in the month before the killing (a 12.7% increase).

Autoregressive interrupted time-series models

Table 1 presents AR model 3 [AR(3)] interrupted time-series models of the mental health diagnosis rate in Minneapolis from 2016 to 2020. Model 1 regresses the overall mental health diagnosis rate per 1000 on the time measures, as discussed earlier, as well as the time-varying controls for seasonality, police behavior, and COVID-19–related policy. The model also adjusts the estimates for temporal autocorrelation with 3 lagged AR terms, effectively providing an impact of previous mental health diagnoses on future discharges. Our focal parameter estimate of interest, post-killing, represents an instantaneous increase of 0.152 mental health discharges per 1000, followed by weekly linear average declines of 0.01 per week. Effectively, this means that it took approximately 15 weeks for the post-killing effect to dissipate to comparable pretreatment levels.

The racial subgroup models highlight the racial heterogeneity in the effect of police killing on mental health diagnoses. Models 2 and 4, models for the White and Latine mental health discharges, respectively, show weak post-killing increases of 0.061 and 0.022, respectively. In contrast, model 2, which models the Black mental health diagnosis rate, demonstrated a quite large increase of 0.228 mental health diagnoses per 1000 Black residents post-killing. Furthermore, this post-killing increase has some longevity: our estimates suggest that the Black mental health diagnosis rate has not returned to pretreatment levels. At a weak weekly decrease of 0.0067 mental health discharges per 1000, the model estimates that it would take approximately 382.6 weeks for discharge rates to return to pretreatment levels (although this extrapolates beyond the observed series, because the decreases could have "sped up" in the early part of 2021). This suggests the post-killing effect was driven primarily by increases in Black mental health discharges, and suggests the police murder of George Floyd had a disproportionate, and substantially lengthy, negative impact on the Black community in Minneapolis in terms of hospitalized cases of mental health as compared with the other racial subgroups.

Table 2 presents the ITS random coefficient models for White and Black race subgroups, which use the within-neighborhood variation to estimate the post-killing effect and allow for both the model intercept (ie, the baseline level of mental health discharges) and post-killing coefficients to vary by ZCTA. Corroborating the results of the pooled Minneapolis ITS models (Table 1), within-neighborhood comparisons show a post-killing decrease of 0.01302 for White residents, indicating that hospital mental health diagnoses for White residents did not appreciably change, on average, in the wake of the police killing of George Floyd. In contrast, model 2 indicates a substantial increase in Black residents' mental health hospital diagnoses after the killing, with an increase of 2.539 per 1000 Black residents. This substantiates at the neighborhood-level the racially bifurcated effect of the police murder of Floyd in Minneapolis. The Latine model (model 3) indicates a modest reduction in mental health diagnoses after the killing, although the 95% CIs indicate a wide variance in this estimate and the interval includes 0. Models 4, 5, and 6 add the aforementioned interaction term between the post-killing term and concentrated disadvantage to each racial subgroup RE model. The interaction term in model 4 indicates the post-killing effect for White residents exhibits heterogeneity by disadvantage, with a 1 SD increase in concentrated disadvantage leading to a 0.3419 greater post-killing increase in White residents' mental health diagnoses. Similarly, model 6 exhibits a positive interaction term wherein the slight decreases in Latine residents' mental health diagnoses after the killing were smaller in areas of higher disadvantage (although the 95% CI for this estimate includes 0). In contrast, model 5 shows that, although still positive in magnitude, the interaction term is much smaller in magnitude comparatively (and the 95% CI for this estimate includes 0), suggesting that the post-killing increases did not vary appreciably by the level of concentrated disadvantage for Black residents to the same extent they did for White residents. In sum, these models illustrate that the deleterious mental health impacts of the police killing (1) were concentrated among Black residents, (2) were observed city-wide, and (3) were spatially located, for white residents, in areas characterized by high levels of concentrated disadvantage.

Figure 3 contextualizes these patterns by plotting the spatial distribution of post-killing random coefficients from the base RE models for White (Figure 3A), Black (Figure 3B), and Latine (Figure 3C) residents alongside levels of concentrated disadvantage (Figure 3D). In general, the White and Latine post-killing effects tend to be stronger (or less negative in the case of Latine residents) in areas of higher concentrated disadvantage, such as North Minneapolis and the East Phillips neighborhood (the red and orange areas in Figure 3D). Although the Latine post-killing effects tended to be less negative in areas of higher concentrated disadvantage (as depicted in Figure 3C), all the estimated ZCTA-specific random coefficients for the Latine post-killing effect were negative. In contrast, the post-killing increases in Black mental health discharges were remarkably stable across space, with the exception of a smaller increase in downtown Minneapolis, and a quite large increase in mental health diagnosis rates for Black residents in ZCTA 55455, which is the ZCTA that contains the University of Minnesota–Twin Cities campus. Note also the magnitude and scale of the estimated effects shown in Figure 3B relative to the more modest effects in Figure 3A and 3C. In general, these patterns of results establish the spatially racialized character of the harmful effects of police violence, whereby Black residents experience a universal harm and the negative effects for White residents are confined to those located in disadvantaged spaces.

Table 2. Interrupted time-series RE models of mental health diagnoses, Minneapolis, MN, 2016-2020.

	Mental health diagnoses per 1000 residents, by race/ethnicity (95% CI)					
	Model 1: White	**Model 2: Black**	**Model 3: Latine**	**Model 4: White with int.**	**Model 5: Black with int.**	**Model 6: Latine with int.**
T	0.003 (0.003–0.003)	0.007 (0.005–0.008)	0.007 (0.003–0.011)	0.003 (0.002–0.003)	0.007 (0.005–0.008)	0.007 (0.003–0.011)
Post-killing	−0.131 (−0.379 to 0.118)	2.529 (1.492–3.566)	−0.219 (−2.702 to 2.263)	−0.117 (−0.381 to 0.148)	2.530 (1.490–3.569)	−0.211 (−2.695 to 2.273)
T post-killing	−0.014 (−0.021 to −0.006)	−0.073 (−0.106 to −0.041)	0.015 (−0.063 to 0.093)	−0.013 (−0.021 to −0.006)	−0.073 (−0.106 to −0.041)	0.015 (−0.063 to 0.093)
COVID-19: state of emergency	−0.101 (−0.320 to 0.117)	−2.241 (−3.207 to −1.274)	−0.994 (−3.345 to 1.356)	−0.108 (−0.327 to 0.110)	−2.242 (−3.209 to −1.275)	−1.004 (−3.354 to 1.347)
COVID-19: stay at home	−0.162 (−0.387 to 0.064)	1.972 (0.973–2.971)	0.466 (−1.959 to 2.891)	−0.161 (−0.386 to 0.064)	1.972 (0.973–2.971)	0.467 (−1.958 to 2.892)
MPD use of force t-1	−0.029 (−0.038 to −0.020)	−0.063 (−0.102 to −0.024)	0.513 (0.373–0.654)	−0.029 (−0.038 to −0.020)	−0.063 (−0.102 to −0.024)	0.514 (0.373–0.655)
MPD stops t-1	0.010 (0.005–0.014)	0.015 (−0.003 to 0.033)	−0.067 (−0.120 to −0.014)	0.007 (0.003–0.012)	0.015 (−0.003 to 0.033)	−0.072 (−0.126 to −0.017)
MPD OIS t-1	−0.666 (−2.406 to 1.074)	−1.809 (−9.537 to 5.919)	−4.344 (−23.090 to 14.402)	−0.631 (−2.367 to 1.105)	−1.804 (−9.532 to 5.925)	−4.309 (−23.055 to 14.436)
Mean maximum temperature	0.001 (0.0001–0.003)	−0.001 (−0.007 to 0.005)	−0.006 (−0.020 to 0.008)	0.001 (0.0001–0.003)	−0.001 (−0.007 to 0.005)	−0.006 (−0.020 to 0.008)
Snow (in.)	0.023 (−0.040 to 0.087)	−0.078 (−0.359 to 0.204)	−0.453 (−1.143 to 0.237)	0.023 (−0.040 to 0.087)	−0.078 (−0.359 to 0.204)	−0.454 (−1.144 to 0.236)
Precipitation (in.)	−0.075 (−0.288 to 0.139)	−0.437 (−1.383 to 0.509)	5.901 (3.551–8.251)	−0.070 (−0.283 to 0.143)	−0.436 (−1.382 to 0.509)	5.905 (3.555–8.254)
Concentrated disadvantage	−0.293 (−0.487 to −0.098)	−0.708 (−1.122 to −0.293)	−0.630 (−1.388 to 0.127)	−0.657 (−0.898 to −0.416)	−0.746 (−1.270 to −0.221)	−0.760 (−1.589 to 0.069)
AR(1)[a] White	0.002 (−0.024 to 0.027)			0.002 (−0.024 to 0.027)		
AR(2) White	0.035 (0.010–0.061)			0.037 (0.011–0.062)		
AR(3) White	0.002 (−0.024 to 0.027)			0.0002 (−0.025 to 0.026)		
AR(1) Black		−0.009 (−0.035 to 0.017)			−0.009 (−0.035 to 0.017)	
AR(2) Black		0.022 (−0.004 to 0.048)			0.022 (−0.004 to 0.048)	
AR(3) Black		0.005 (−0.020 to 0.031)			0.006 (−0.020 to 0.031)	
AR(1) Latine			−0.003 (−0.030 to 0.023)			−0.003 (−0.030 to 0.023)
AR(2) Latine			−0.011 (−0.037 to 0.015)			−0.011 (−0.037 to 0.015)
AR(3) Latine			−0.007 (−0.033 to 0.020)			−0.007 (−0.033 to 0.020)
Post-killing × concentrated disadvantage				0.340 (0.231–0.448)	0.039 (−0.324 to 0.402)	0.301 (−0.458 to 1.060)
Constant	0.300 (−0.032 to 0.631)	0.565 (−0.087 to 1.217)	0.200 (−1.038 to 1.437)	0.323 (−0.093 to 0.739)	0.568 (−0.092 to 1.229)	0.219 (−1.033 to 1.470)
Resid. var.	0.72	0.72	14.12	14.12	83.22	83.21
ZCTA var.	0.58	0.94	1.56	1.62	3.19	3.39
Post-Floyd var.	0.05	0.1	0.19	0.22	0.13	0.17
Observations	5720	5720	5516	5720	5720	5516
Log likelihood	−7287.256	−15 748.440	−20 059.630	−7273.912	−15 749.200	−20 059.370
Akaike information criterion	14 614.510	31 536.880	40 159.260	14 589.820	31 540.400	40 160.750
Bayesian information criterion	14 747.550	31 669.920	40 291.570	14 729.510	31 680.090	40 299.670

Abbreviations: AR, autoregressive; MPD, Minneapolis Police Department; OIS, Officer invovled shootings; T, time; ZCTA, zip code tabulation area.
[a]AR1 refers to AR model 1, AR2 refers to AR model 2, and so forth.

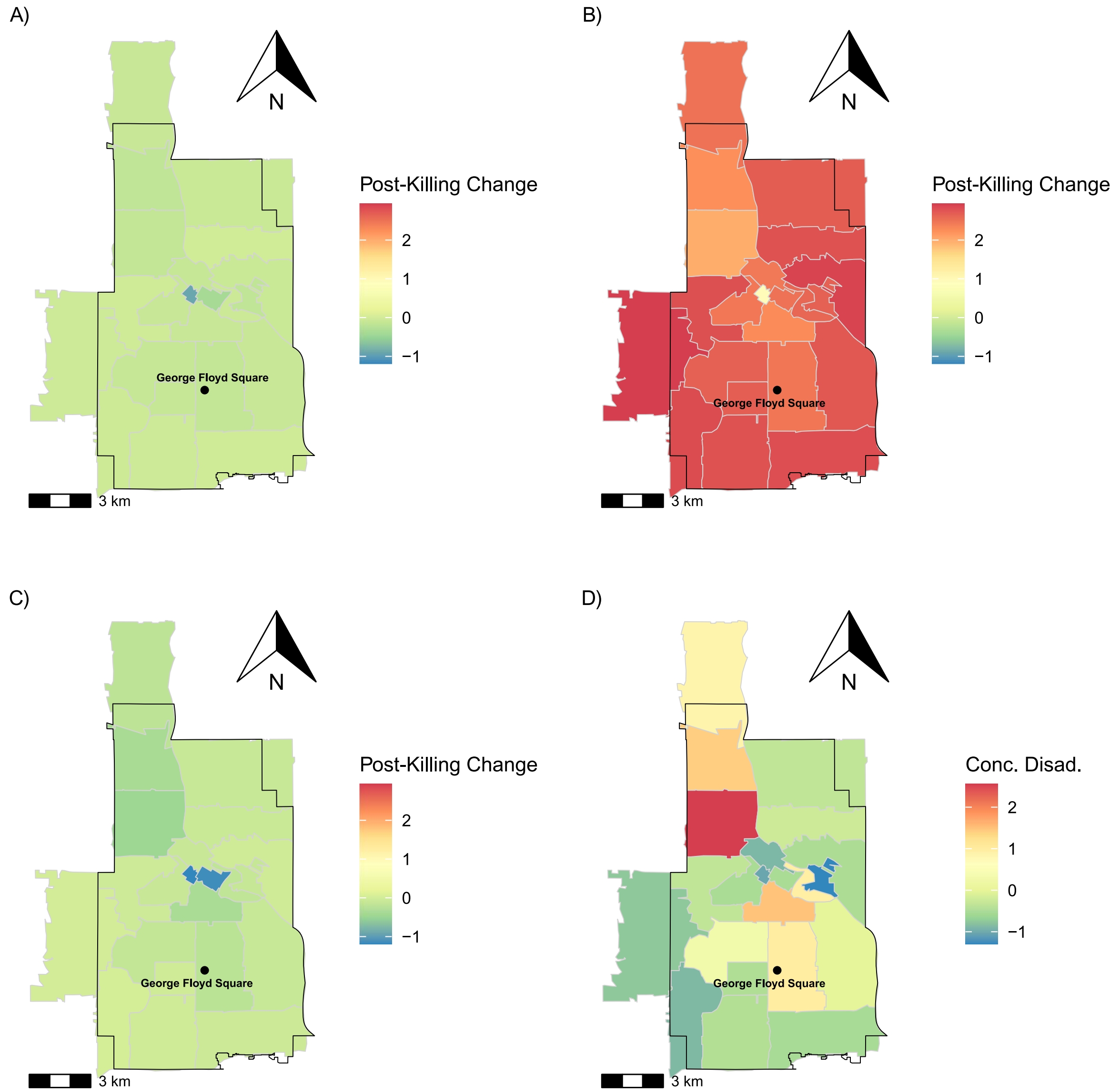

Figure 3. Maps of spatial distribution of post-killing random coefficients from the base random effect (RE) models for (A) White, (B) Black, and (C) Latine residents, alongside (D) levels of concentrated disadvantage (Conc. Disad.) (standard deviation (SD) units)

Discussion

In the wake of George Floyd's murder, we found a modest overall increase in mental health diagnoses followed by a decline to levels approximating those observed in the period before his killing. However, our racially stratified analysis finds much larger deleterious impacts of the police murder among Black residents. Specifically, we find Black residents experienced a universal (spatially) and long-standing harm, whereas there was little impact for Latine and White residents. The harmful effects for the latter 2 groups were spatially located in areas characterized by high levels of concentrated disadvantage.

Our results suggest that residing in advantaged neighborhoods did not insulate Black people from experiencing mental health diagnoses after the murder of Floyd. The global effects of his murder on Black people's mental health are likely reflective of structural racism, which Bailey et al define as "the totality of ways in which societies foster racial discrimination through mutually reinforcing systems of housing, education, employment, earnings, benefits, credit, media, health care, and criminal justice."[27] Structural racism is a fundamental cause of health inequity that undermines health through a series of interdependent pathways, including (but not limited to) economic injustice and social deprivation, inadequate health care, maladaptive coping mechanisms, and psychosocial trauma.[28,29] Our work adds further evidence that police violence operates as a fundamental mechanism in the structural racism-health pathway that (re)produces, in part, the racial disparities in health we observe. These structural racism-health pathways create, in part, racial disparities in police contact and downstream disparities in mental health concerns. Economic injustice and social deprivation increase the chances that Black neighborhoods experience high concentrations of community and police violence.[29] As such, vicarious police-violence exposures may exacerbate symptoms of untreated psychological distress and foster psychosocial trauma. Black people in and out of advantaged contexts can experience this psychosocial trauma; each police murder of an unarmed Black person adds another racial injustice to the nation's legacy of limited accountability for anti-Black violence.[30] The resulting racial trauma manifests itself in the increased worry, anticipatory stress, and adverse mental health we found in our analysis.

Our study is not without limitations. First, hospital discharge data only capture mental health diagnoses among those who went to the hospital for care (ie, more serious cases). Mental health stigma, a lack of health insurance, or medical mistrust, which is fostered by police-violence exposure, could be barriers to seeking hospital care.[31] This self-selection of not receiving health care also could have been exacerbated because of COVID-19. However, our study found an increase in rates of diagnosis among Black individuals despite prior evidence that police violence can lead to greater rates of medical mistrust, suggesting that these effects may understate the true increase in distress and mental health symptoms in the wake of the murder of Floyd. Second, despite our efforts to adjust estimates for changes in COVID-19–related policy, police behavior, and seasonality, we cannot rule out other unmeasured confounders that could represent a threat to internal validity. Our identification strategy in the ITS model assumes that the event shift in mental health diagnoses is fully attributable to the event. However, if other changes contemporaneous with the event week took place (eg, changes in population composition, other exogenous events), accounting for our time-varying controls, our estimates would be biased. Third, although our models focus on Black, White, and Latine residents, our analysis does not examine associations among Indigenous residents, who have been historic targets of police violence in Minneapolis[32] and elsewhere.[5] This historical trauma could have also worsened this group's mental health, due to the murder of Floyd. However, because of sparse data on this subpopulation, we were not able to explore this.

In conclusion, the findings of our study speak to the traumatizing effects of police violence and the short- and longer-term public health consequences for communities, particularly Black communities. We have much historical and contemporary evidence that Black residents are disproportionately the targets of police violence. Our study adds to the mounting evidence showing the disproportionate mental health consequences of this violence.

Supplementary material

Supplementary material is available at *American Journal of Epidemiology* online

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Conflict of interest

The authors declare no conflicts of interest.

Data availability

The outcome data that support the findings of this study are available from the Minnesota Hospital Association (https://github.com/ryanplarson), but restrictions apply to the availability of these data, which were used under license for the present study and so are not publicly available. The remaining data are publicly available.

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