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The Health Consequences of Structural Racism: Implications for Anti-Racism Policy and Practices in Social Institutions

Author
Thomas, Marilyn Denise

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The Health Consequences of Structural Racism: Implications for Anti-Racism Policy and Practices in Social Institutions

By

Marilyn D. Thomas

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Committee in Charge:

Professor Amani Allen, Chair
Professor Rodolfo Mendoza-Denton
Professor Nicholas Jewell

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Abstract

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Doctor of Philosophy in Epidemiology

University of California, Berkeley

Professor Amani Allen, Chair

The main objective of this dissertation was to investigate the health consequences of structural racism operating implicitly as racist law enforcement practices and agency policies, and as explicit forms of racial discrimination that have become systematic, or normalized, for US Blacks. Public health interventions targeting proximal risk factors such as behaviors have effectively reduced overall morbidity, mortality, and high-risk behaviors yet Black-White differences in health persist even after adjusting for sociodemographic and health system factors, as well as health behaviors.

Structural racism—ongoing interactions between macrosystems and institutions to constrain the opportunities, resources, and power of marginalized racial groups—likely functions to prevent the elimination of Black-White gaps in health by unfairly burdening Blacks with high-risk exposures. Epidemiologic studies examining structural racism have largely demonstrated Black-White health disparities associated with ecological exposures (e.g. educational attainment) and community or interpersonal predictors (e.g. segregation, racial bias and discrimination). Few studies have examined the health effects of underlying racist policies and practices.

Evidence suggests that along with explicit racial discrimination, implicit racism operating within the criminal system is among the strongest drivers of racial inequalities by shaping exposures to health-promoting opportunities and burden-bearing liabilities over the life course and across generations, such as the disproportional police arrests and killings of Blacks. The negative health effects of pervasive racial discrimination are theorized to be cumulative over the life course potentially resulting in *allostatic load*—multisystem physiologic dysregulation due to chronic adaptation to stress. Allostatic load is highest among Black women though they may not be aware of being at an elevated risk (e.g. having high cholesterol).

Consequently, three potential mechanisms that link structural racism to racial health disparities include (1) racial bias against Blacks in officer use of deadly force, (2) underlying racist law enforcement agency policies and practices, and (3) everyday and institutional-specific racial discrimination. Data are from *The Guardian*, *The Washington Post*, the Law Enforcement Management and Administrative Statistics (LEMAS), and the African American Women's Heart & Health Study. This research was the first to estimate (1) interaction effects between

race/ethnicity and being unarmed among men shot and killed by US law enforcement, (2) US law enforcement policies that contribute to Black-White disparities in police killings using *The Guardian* and LEMAS databases, and (3) the association between everyday versus institutional racial discrimination, allostatic load, and self-reported health among at-risk Black women. Study findings present novel approaches to examining mechanisms by which structural racism impacts health disparities and may help reduce several leading causes of US Black-White disparities in death and disease.

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Background and Significance

Structural racism—ongoing interactions between macrosystems and institutions to constrain the opportunities, resources, and power of marginalized racial groups—is considered a fundamental cause of US racial disparities in health. Structural racism influences a broad range of health-promoting resources that unfairly advantage Whites and disadvantage Blacks.[1-8] Based on Link & Phelan's (1995) fundamental cause theory,[9] a social cause of health disparities is comprised of four key constructs: (1) multiple disease outcomes are possible, (2) these outcomes are affected by multiple risk factors, (3) access to resources can mitigate disease sequelae or avoid risk all together, and (4) the cause—health association can be reproduced through new mechanisms.[10] Accordingly, Phelan & Link (2015) posit that racism is a fundamental cause of racial health inequalities.[5] Consistent with the theory, (1) racism causes several Black-White differences in health independent of socioeconomic position (SEP, i.e. power, prestige, healthcare, economic and neighborhood factors), (2) these health disparities are driven by a variety of social, economic, environmental, psychological, behavioral, and physiological predictors, (3) quality health-promoting resources that protect against disease risk are predetermined and allocated by race/ethnicity (i.e. education, housing), and (4) Black-White health gaps persist even when the profile of risk factors presumed to explain the disparities dramatically change. Structural racism is thereby theorized to continuously and unjustly burden Blacks (vs. Whites) with fewer opportunities, resources, and power to avoid high-risk exposures regardless of SEP, though SEP alone is a well-established source of unhealthy behaviors and adverse health outcomes.[11-33]

Epidemiologic studies have demonstrated numerous Black-White disparities in health associated with structural racism including cardiovascular disease,[23,34-43] breast cancer[44-46] poor infant health and birth outcomes,[47-54] psychological distress,[55-60] hostile judicial treatment,[61-65] and health-damaging urban planning[66-68] among others. Structural racism has been operationalized using community or interpersonal predictors (e.g. mortgage lending, segregation, redlining, racial bias and discrimination),[23,34,37,38,44,48-50,56-60,69-76] institutional-level indicators (e.g. immigration, police use of force restrictions)[77-84] and population-level exposures (e.g. police killings, educational attainment, political participation, employment rates).[34,38-40,51,52,61-63,78,85-91] Scholars propose that racial disparities may be explained in part by normalized racism operating as social policies within institutions[2,3,5,41,84,92] which interventions targeting proximal risk factors (e.g. behavior) fail to address. The lack of literature on the physical and mental health effects of racist policies, practices, and norms permeating within social institutions is a major limitation.

Because social, political, and economic policies implemented within macrosystems and institutions can determine health whether intended or not,[93,94] underlying racist societal policies and conventions that have become normalized likely prevent the elimination of Black-White gaps in health and in SEP by reinforcing or generating new mechanisms for structural racism to maintain the status quo.[2-5,9,21,29,37,41,43,45,84,92,95-109] As a result, US Blacks are largely underrepresented in social positions associated with good health benefits and are overrepresented in social positions associated with deleterious health conditions. For instance, Blacks make up 13.5% of the US population yet comprise 35.4% of prison inmates, 0.8% of Fortune 500 CEOs, 3.0% of US congressional senators, 10.3% of conferred Bachelor's degrees, and compared to Whites, have lower median wages and income, and one-thirteenth the wealth (historically accumulated through property ownership).[110-116] Moreover, evidence consistently demonstrates

racial disparities in health and life expectancy even after adjusting for sociodemographic and health system factors, as well as health behaviors.[30,34,38,39,108,117-126]

Research suggests that along with explicit racial discrimination, implicit racist policies and practices that pervade in criminal, educational, and labor market systems are among the strongest drivers of racial inequalities.[2,3,5,8,14,25-27,31-33,41,61,64,70,84,91,94,98,99,107,127-132] These macrosystems and institutions regulate the racial distribution of asset-building opportunities (e.g. college degree) and burden-bearing liabilities (e.g. incarceration) within and between systems over the life course and across generations. For example, convicted felons can lose the right to vote, earn lower wages, and be denied student loan funding and employment.[133,134] Compared to Whites, Blacks are more likely to be stopped by police, to experience use of force, to experience lethal force, and to be killed when unarmed[61,63-65,87,91,135-137] thereby placing Black felons at higher risk of lifetime political and economic disadvantage, as well as a lower life expectancy. Further, experiences of racial discrimination within social institutions have been linked to multiple chronic diseases and unhealthy behaviors with Blacks bearing more of the burden.[36,38,75,119,138-148] Hence, racist policies, practices, and norms can unduly expose Blacks (vs. Whites) to greater risk of having lower SEP (i.e. fewer health-promoting resources) and higher disease and death.

A primary focus of current public health concern is the disproportional killing of Blacks by law enforcement,[63,64,81,135,149-161] which is defined by the US government as *legal intervention*—"injuries inflicted by the police or other law-enforcing agents, including military on duty, in the course of arresting or attempting to arrest lawbreakers, suppressing disturbances, maintaining order, and other legal action".[162] Evidence shows that federal systems consistently underreport police homicides largely from the misclassification of cases as not involving law enforcement.[163-165] As a result, media organizations such as *The Guardian* and *The Washington Post* began counting the number of people killed by police in 2015[152,166] and these databases have shown to be substantially more reliable than federal reports.[137,163] Using these data, researchers have discovered stark Black-White inequalities in legal intervention and deadly use of force[64,91,128,158,167,168] yet few studies have offered much evidence to explain why.

Predictors shown to influence police killings include officer and civilian behavior during encounters,[169-177] neighborhood characteristics,[80,170,178,179] and police agency culture.[180-182] However, organizational policies and training programs are implemented as a result of police agency culture which contributes to officer use of force behavior.[183-185 65,80,170,172,173,175,179,186-193] Moreover, scholars assert that racial bias against Blacks by police and within police agency policies likely drives racial inequities in lethal and non-lethal intervention, including among those who are unarmed.[62-64,155-158,160,161,168,194,195] This growing body of evidence suggests that the intersection between being Black and being unarmed may interact to increase the risk of deadly use of force by police beyond the sum of each independent risk. In addition, police agency policies and practices may directly contribute to higher incidence of avoidable police killings, warranting further study.

The cumulative effects of the stress experienced from such pervasive structural racism likely "gets under the skin" to heighten chronic disease risk for Blacks as well. The majority of health literature has focused on interpersonal *racial discrimination*—the process by which members of a racial/ethnic group are treated unfairly based on their race/ethnicity—which is linked to a wide

variety of adverse health outcomes and unhealthy behaviors.[36,47,59,72,119,196-198] Experts posit that institutional experiences of racial discrimination (vs. interpersonal mistreatment) may be a key risk factor for developing chronic health conditions among Blacks.[2,5,38,41,50,78,199] Institutional racial discrimination can operate covertly within societal organizations (e.g. universities, the workplace) to shape access to health-supporting resources whereas day-to-day experiences are more mundane, explicit interpersonal experiences that generally occur in public.[200] Structural racism functioning as normalized racial discrimination within social institutions, as opposed to between individuals, has received much less attention yet may have broader implications for Black-White gaps in chronic disease risk.

The experience of racial discrimination has been associated with *allostatic load*[201,202]—the physiologic long-term wear and tear on multiple bodily systems from chronic adaptation to stress.[203] Studies show that allostatic load can lead to increased risk of many chronic illnesses such as heart disease, diabetes, and even mortality.[203-207] Self-perceived health status is also predictive of chronic disease risk and mortality[208-210] but associations with everyday versus institutional racial discrimination are mixed.[49,60,138,211-215] Furthermore, evidence suggests that discrepancies between self-perceived health status and underlying allostatic load levels can widen disparities in disease prevention, detection, and treatment,[122,216-218] especially if those at higher risk (e.g. elevated blood pressure) are not be aware of it. Black women have the highest predicted allostatic load (vs. Black and White men and women)[108,122] however the effects of racial discrimination on allostatic load among this at-risk group is weakly understood.

This dissertation aimed to address these gaps by (1) examining whether race/ethnicity and being unarmed interact among males modify the risk of being shot and killed by US law enforcement, (2) examining the US law enforcement agency policies and practices expected to contribute to Black-White differences in police killings, and (3) examining the association between institution-specific versus everyday racial discrimination, allostatic load, and self-reported health status among Black women. Study findings present novel mechanisms by which structural racism directly influences racial health disparities. The results of this research can help advance our limited understanding of the negative health effects of structural systems that promote societal racism and may inform the development and implementation of anti-racism policies, practices, and risk assessment strategies for public health intervention. This research also has the potential to significantly contribute to reducing persistent Black-White disparities amid several leading causes of morbidity and mortality in the US.

AIM #1: Black and unarmed: Statistical interaction with aging and with perceived mental illness among males fatally shot by US law enforcement during 2015-18 using case-only design

INTRODUCTION

Following numerous high-profile police shootings of unarmed Black men in recent years, the unduly killing of unarmed Blacks at the hands of law enforcement has become a primary focus of public health and social justice concern in the US.[63,64,81,135,149-161] Establishing whether true disparities exist by race/ethnicity (hereafter race) and gender has been challenging using government databases due to inaccuracies in the reporting of deaths from *legal intervention*[137,163-165,219-222]—"injuries inflicted by the police or other law-enforcing agents, including military on duty, in the course of arresting or attempting to arrest lawbreakers, suppressing disturbances, maintaining order, and other legal action".[163] For instance, though the National Vital Statistics System (NVSS) has assigned ICD-10 codes to properly record deaths from legal intervention, evidence has consistently shown that NVSS underreports police killings largely from the misclassification of cases as not involving law enforcement.[163,164] As a result, media organizations such as *The Washington Post* and *The Guardian* began counting the number of people killed by police in 2015, along with other concomitant information[152,166] Notably, *The Guardian's* database has been shown to be substantially more reliable than the NVSS.[163]

Given the public outrage about police killings of unarmed Black men, and the emergence of reliable data sources, researchers have scrambled to answer two fundamental questions: (1) *Do US racial and gender disparities exist in the use of lethal force by law enforcement?* and (2) *Are there racial differences in the police killings of those who are unarmed?* Findings across various sources reveal that compared to Whites, Blacks are more likely to be stopped,[65,136,223] to be arrested,[223,224] to experience police use of force,[87,136,178,225] to experience lethal force,[61,63,64,128,135,158,167] and to be shot and killed when unarmed.[64,91,135,168] In addition, about half of police homicide cases are under the age of 35 and are overwhelmingly male (96%).[91,128] This growing body of evidence suggests that the intersection between being Black and being unarmed may interact to increase the risk of being fatally shot by police (i.e. becoming a police homicide *case*) beyond the sum of each independent risk. Moreover, age and gender appear to play a role.

Finding an appropriate reference group or adequate *controls*—a sample of the armed and unarmed US population who were at risk of being shot by police but were not—to test for statistical interaction between race and armed status is problematic. Population-level measures are the most robust[226] but unfortunately, unlike gun ownership,[227] the racial population distribution of *armed status*—those perceived by police to have a weapon—has not been reported. Too, US law enforcement agencies are not required to collect nor report demographic or armed status information associated with each police encounter with the public.[228] Moreover, because police encounters and arrests are systemically biased against minorities,[65,226,229] demographic and armed status data collected by agencies on police arrests, traffic stops, and police contact used in research has been shown to underestimate or report "reversed" racial disparities.[226] This type of *Simpson's paradox*[230] results from conditioning on police encounter rates which are systemically higher for Blacks (inflated denominator) and lower for Whites (deflated denominator) thereby making the groups appear more statistically similar.[226] Consequently, establishing an adequate reference or control group to estimate race and armed status interaction is fraught with challenges.

The case-only study design is an efficient and innovative approach to evaluate potential multiplicative statistical interaction between being Black and being unarmed among police homicide cases. Commonly used to examine gene-environment interaction among cancer patients,[231-233] case-only design has been applied to study social-environmental multiplicative interaction that can be interpreted as *mechanistic* interaction.[234-236] Mechanistic interaction differs from multiplicative in that it implies that, for some people in the population, race and armed status truly interact to cause one to be fatally shot by police whereas multiplicative interaction offers no guarantee.[232] Therefore, the case-only design eliminates the need of a reference or control group to evaluate the modifying causal effect that race may have on being unarmed among those shot and killed by police.

The interpretation of the "causal effect of race" has been hotly debated among biomedical and epidemiologic researchers.[237-240] As a result, racial disparities researchers do well to establish a clear distinction when classifying "race" as one's genetic heritage (e.g. biologic material), regional or cultural population (e.g. Afro-Caribbean), or social identity (e.g. Black in America). Ongoing racism operating within and between macrosystems and institutions to constrain the opportunities, resources, and power of marginalized racial groups likely function to prevent the elimination of Black-White gaps in being unarmed and shot by US law enforcement by unfairly burdening Blacks with high-risk exposures.[1,2,4,7,8,241] Hence, consistent with its definition by the Office of Management and Budget Federal Directive No. 15[242] and with Critical Race Praxis for social epidemiologic research,[243,244] in this study, race was conceptualized as a social construct representing the race-based social experience of being identified as Black or as White in the US.

The main objective of this study was to examine the risk of being Black versus White given that one was unarmed and fatally shot by US law enforcement during 2015-18 among cases in *The Washington Post* database. Potential variation in regional factors and case-specific characteristics (i.e. age, signs of mental illness) were also considered. It was hypothesized that a positive multiplicative and/or mechanistic interaction would predict an increased risk of being Black, and that associations would differ within strata of relevant regional and case-specific factors. Regions with more killings were expected to have greater racial gaps. Case-specific age was theorized to mitigate disparities whereas showing signs of mental illness would exacerbate racial differences.

MATERIALS AND METHODS

Study Sample

Data are from *The Washington Post* (WaPo).[166] WaPo maintains an online public-use database of all on-duty police-involved shooting deaths since January 1, 2015 which has been utilized in several recent publications.[91,168,221,223,245] WaPo regularly collects, updates, and maintains information from every fatal shooting (i.e. shot or tasered and shot) by US law enforcement. The database includes case-specific demographic information, armed status, threat-level, fleeing status, as well as officer body-camera data. WaPo validates reported killings using local news reports, law enforcement websites, social media, and by monitoring various independent media sites. Cases from January 1, 2015 through December 31, 2018 were analyzed (*N=3,931*). Given that gender was a strong statistical confounder (female <5%), the study sample was restricted to Black and White males with known armed status. The final sample size was comprised of 2,442 police homicide cases (Figure 1).

Outcome Assessment

Using a case-only design, race was modeled as the outcome variable as the dataset was comprised of all males fatally shot and killed by police. WaPo used various resources to obtain data on the race of each homicide case such as police and coroners' reports, voter registration information, witness statements, as well as photographic evidence. The two racial categories identified in WaPo (Non-Hispanic [NH] White, NH Black) were collapsed into a dichotomous *race* variable (Black=0 [i.e. White], Black=1).

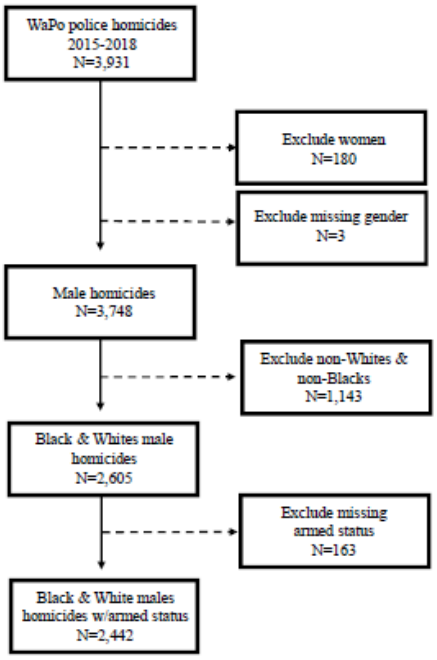

Figure 1. *The Washington Post* (WaPo) study sample selection process.

Exposure Assessment

Armed status. Using similar strategies described, WaPo recorded 80 categories for being armed (ranged from an "air conditioner" to a "vehicle"). Unarmed status was assessed dichotomously by grouping all "armed" categories together, separate from those reportedly "unarmed"; unarmed=0 (i.e. armed) and unarmed=1.

Covariates

Theoretical and empirical variables considered to confound the risk of being unarmed and experiencing officer use of force include case-specific characteristics,[128,175,186,246,247] population demographic factors[61,80,81,167,222] crime rates[80,187] and the economy[167] (see Appendix 1.A). Attacking and fleeing status were identified as behaviors on the pathway between armed status and being shot and were therefore not included in this analysis to avoid over-controlling.

Case-specific characteristics. Race was used as the outcome variable and gender was restricted to males; hence *age* was assessed continuously and as a 3-level ordinal variable (≤24=1, 25-44=2, ≥45=3). Those reportedly to show *signs of mental illness* was coded dichotomously (No=0, Yes=1).

Population demographics. Racial composition, educational attainment, median household income, federal poverty rate, and unemployment status were assessed using data from the 2010 US Census.[248] Each variable was generated as a composite measure representing the population demographics of states within each US region. *US region* was comprised of the Midwest (IA, IL, IN, KS, MI, MN, MO, ND, NE, OH, SD, WI), Northeast (CT, ME, MA, NH, NJ, NY, PA, RI, VT), South (AR, AL, DE, DC, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN, TX, VA, WV), and West (AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY). Except for *median income* which was reported using medians, proportions were used for racial composition, poverty rate, educational attainment, and unemployment status. Consistent with prior work utilizing various minority density or population indices,[37,48,85,88,98,119] the Black or African American category under "One Race" of the total population accounted for *racial composition* as non-Whites were expected to have higher risk. *Poverty rate* was assessed using the proportion of households below the federal poverty threshold. *Educational attainment* included the proportion

of those with (a) at least a high school (H.S.) diploma and (b) at least a Bachelor's (B.A.) degree. The number of unemployed as a percent of the labor force was used to measure *unemployment rate*. Population demographics within US regions were analyzed as continuous measures.

Crime rates. The Federal Bureau of Investigation's (FBI) Uniform Crime Reports (UCR) was used to account for crime rates.[249] UCR collects monthly data from US law enforcement reports or incidents recorded by the FBI. *Violent* and *property crime rates* were reported as the average crimes reported per 100,000 people and were coded continuously within US regions.

Economy. Economic strength was evaluated using 2015 GDP (Gross Domestic Product) estimates—the most commonly used measure to assess the state of an economy, an economy's growth, and to compare economies across the country.[250] GDP is comprised of the total market value of goods and services produced within a year and is generally reported in billions of dollars. Within US region *GDP* was analyzed as a continuous measure.

Statistical Analysis

STATA 15.1 was used for statistical analyses. The calculated *a priori* required sample size was N=1,188 with the parameters set at 15 predictors, 1-β=0.80, α=0.05, and effect size f^2=0.01.[251] To account for missingness (<7%), complete case analysis was employed, except for age in which missing values (*n=26*) were replaced with the sample mean (age 37). Univariable regression assessed potential confounders of the exposure—outcome association. Variance inflation factors were used to identify collinearity between potential covariates. Given that being shot by police while unarmed is a rare event, odds ratios provided pseudo-risk interaction estimates.[231,232] Unadjusted odds ratios estimated the pseudo-risk of being Black (vs. White) conditional on being unarmed among those fatally shot by law enforcement, stratified by relevant covariates (P<0.05). Logistic regression was used to estimate pseudo-risk (hereafter risk) ratios adjusted for covariates significant at P<0.05. Postestimation model diagnostics included correct classification, Pearson's goodness of fit and Cook's D confirming a good model fit.

The specified reduced form equation for a standard logistic regression with one interaction = $\log(\Pr[D|G, E]/1- \Pr[D|G, E]) = \beta_0 + \beta_1*G + \beta_2*E + \beta_3*G*E + \text{Covariates} + \varepsilon$;
$\log(\Pr[\text{Shot}|\text{Black, Unarmed}]/1-\Pr[\text{Shot}|\text{Black, Unarmed}]) = \beta_0 + \beta_1*\text{Black} + \beta_2*\text{Unarmed} + \beta_3*\text{Black}*\text{Unarmed} + \text{Covariates} + \varepsilon$

The specified reduced form equation for a case-only design for logistic regression with one interaction = $\log(\Pr[G|E, D=1]/1-\Pr[G|E, D=1]) = \alpha_0 + \alpha_1*E + \text{Covariates} + \varepsilon$;
$\log(\Pr[\text{Black}|\text{Unarmed, Shot}=1]/1-\Pr[\text{Black}|\text{Unarmed, Shot}=1]) = \alpha_0 + \alpha_1*\text{Unarmed} + \text{Covariates} + \varepsilon$;
where $\alpha_1 = \beta_3$ in the standard equation.

Statistical mechanistic interaction (S_{OR}) = $OR_{Black*unarmed}/OR_{Black}*OR_{unarmed} > 1$; where independence holds under *monotonicity*—a sufficient-cause interaction is present.[232]

RESULTS

Sample Characteristics

Age and signs of mental illness (MI) were case-specific characteristics confounding the interaction between race and armed status (P<0.05). Several regional covariates were weaker confounders (P<0.20 to P>0.05) and collinear which included educational attainment, median

income, poverty rate, GDP, violent crime, US region, and percent Black population. Model building procedures indicated that the US region and the percent Black population covariates best fit the final model. Thus, covariates reported in this analysis were significant at $P<0.01$ and included age, signs of MI, US region, and percent Black population.

Table 1 shows the distribution of the study sample characteristics and relevant regional covariates.

Table 1. WaPo sample characteristics of White and Black males fatally shot by US law enforcement during 2015-18 (*N=2,442*)

Variable		Total	White	Black
		n (%)		
Cases	n (row %)	2,442 (100)	1,617 (66)	825 (34)
Armed status				
	Armed	2258 (92)	1521 (94)	737 (89)
	Unarmed	184 (8)	96 (6)	88 (11)
Age				
	mean (±sd)	37 (13)	40 (14)	32 (11)
	≤24	404 (17)	183 (11)	221 (27)
	25-44	1321 (54)	845 (52)	476 (57)
	≥45	717 (29)	589 (37)	128 (16)
Mental Illness Signs				
	No	1822 (75)	1126 (70)	696 (84)
	Yes	620 (25)	491 (30)	129 (16)
US Region				
	West	502 (21)	492 (30)	131 (16)
	Midwest	198 (8)	314 (19)	188 (23)
	South	1119 (46)	696 (43)	423 (51)
	Northeast	623 (25)	115 (7)	83 (10)
Black Population	% (±sd)	13 (9)	12 (9)	14 (8)

sd=standard deviation; WaPo=The Washington Post

Black males comprised over one-third of homicide cases (34%) and 13% of the average Black population. For every 100 males fatally shot, 8 were unarmed. Mean age was 37 years with the majority between 25 and 44 years (54%). Signs of MI were reported in 1 in 4 cases. Almost half of all killings occurred in the Southern US region (46%) with the fewest in the West (8%).

Blacks were almost twice as likely to be fatally shot while unarmed compared to Whites (11% and 6% respectively). Over 1 in 4 Black males (27%) were under age 25 years compared to about 1 in 10 White males (11%). Double the amount of Whites (vs. Blacks) were reported to show signs of MI (30% vs. 16% respectively). Black deaths in the West were half that of Whites (16% and 30% respectively). The percent Black population was slightly lower among White (vs. Black) killings (12% vs. 14% respectively).

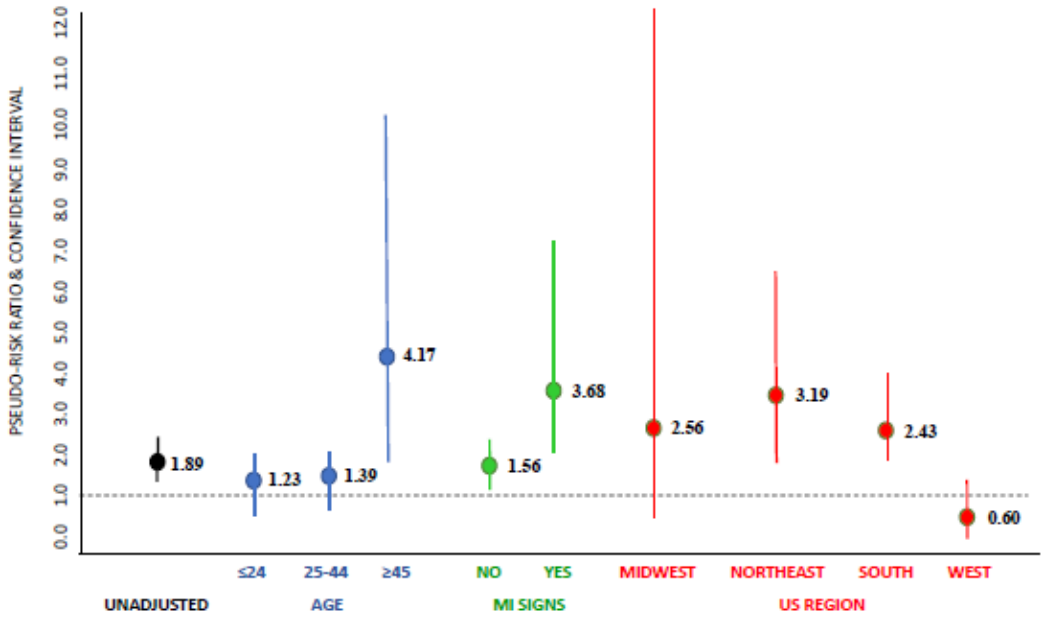

Figure 2. Unadjusted relative pseudo-risk of being Black (vs. White) among unarmed males fatally shot by US law enforcement 2015-18 in WaPo, and estimates stratified by age, mental illness (MI) signs, and US region (*N=2,442*)

Univariable (unadjusted) logistic regression

Figure 2 shows the crude (i.e. unadjusted) relative risk of being Black (vs. White) among unarmed males fatally shot by US law enforcement, as well as estimates stratified by covariates. There was 89% higher (crude) risk of being Black among unarmed males fatally shot by US law enforcement (OR=1.89; 95% confidence interval [CI] [1.38, 2.59]). Mantel-Haenszel chi-square tests of homogeneity showed significant differences within the strata of all covariates ($P<0.05$). Risk of being Black (vs. White) was over 4 times higher for males age 45 years or older (OR=4.17; 95% CI [1.64, 10.33]). Risk was 56% greater among those showing no MI signs (OR=1.56; 95% CI [1.09, 2.24]) and 3.7 times greater among those showing MI signs (OR=3.68; 95% CI [1.81, 7.39]). Over 3 times higher risk of being Black was found within the Northeast (OR=3.19; 95% CI [1.53, 6.50]) and approximately 2.5 times higher risk within the South (OR=2.43; 95% CI [1.53, 3.86]). Data are shown in Appendix 1.B.

Multivariable logistic regression

Table 2 shows forward stepwise multivariable logistic regression adjusted for covariates. Model 1 shows the unadjusted estimate (OR=1.89; 95% CI [1.40, 2.56]). Model 2 adjusted for case-specific age which accounted for 34% of the interaction effect (OR=1.55; 95% CI [1.14, 2.12]). Model 3 adjusted for model 2 and case-specific signs of MI which slightly reduced the main estimate (OR=1.54; 95% CI [1.12, 2.12]). Model 4 adjusted for model 3 and region which accounted for an additional 2% of the interaction (OR=1.52; 95% CI [1.11, 2.10]). The final and best fit model (model 5) adjusted for model 4 and percent Black population revealing that the risk of being Black among unarmed males fatally shot by US law enforcement was 50% higher compared to being White (OR=1.50; 95% CI [1.09, 2.07]).

Table 2. Logistic regression of being Black (vs. White) among unarmed males fatally shot by US law enforcement 2015-18 in WaPo (*N=2,442*)

	Model 1	Model 2	Model 3	Model 4	Model 5
	OR (95% CI)				
Unarmed	**1.89 (1.40, 2.56)**	**1.55 (1.14, 2.12)**	**1.54 (1.12, 2.12)**	**1.52 (1.11, 2.10)**	**1.50 (1.09, 2.07)**
Age		0.95 (0.94, 0.96)	0.95 (0.95, 0.96)	0.95 (0.94, 0.96)	0.95 (0.94, 0.96)
Mental Illness Signs			0.45 (0.36, 0.56)	0.45 (0.36, 0.59)	0.46 (0.37, 0.57)
US Region				0.81 (0.75, 0.89)	0.80 (0.73, 0.87)
Black Population					1.03 (1.02, 1.04)
Log-likelihood	-1553.51	-1458.56	-1431.76	-1420.13	-1405.06
P-value	0.0000	0.0000	0.0000	0.0000	0.0000

WaPo=The Washington Post; OR=odds ratio; CI=confident interval; ***Bolded=P~0.01***

Tables 3 & 4 show the adjusted relative risk of being Black (vs. White) among males fatally shot by US law enforcement stratified by age and by those showing signs of MI, respectively. Adjusted regressions excluded age in Table 3 and excluded MI signs in Table 4.

Table 3. Logistic regression of being Black (vs. White) among unarmed males shot by US law enforcement 2015-18 in WaPo, stratified by age (*N=2,442*)

	Unadjusted	Adjusted	Age ≤24 *(n=404)*	Age 25-44 *(n=1,321)*	Age ≥45 *(n=717)*
	OR (95% CI)				
Unarmed	**1.89 (1.40, 2.56)**	**1.82 (1.34, 2.49)**	1.14 (0.61, 2.16)	1.35 (0.90, 2.01)	**4.23 (1.80, 10.09)**
Mental Illness Signs		0.43 (0.35, 0.54)	0.25 (0.15, 0.44)	0.52 (0.39, 0.70)	0.50 (0.31, 0.81)
US Region		0.79 (0.72, 0.85)	0.84 (0.70, 1.02)	0.80 (0.72, 0.89)	0.73 (0.59, 0.90)
Black Population		1.03 (1.02, 1.04)	1.03 (1.00, 1.05)	1.03 (1.01, 1.04)	1.04 (1.02, 1.07)

Stratified estimates are adjusted; WaPo=The Washington Post; OR=odds ratio; CI=confident interval; ***Bolded=P<0.01***

Table 4. Logistic regression of being Black (vs. White) among unarmed males shot by US law enforcement 2015-18 in WaPo, stratified by signs of mental illness (*N=2,442*)

	Unadjusted	Adjusted	No MI Signs *(n=1,822)*	MI Signs *(n=620)*
	OR (95% CI)			
Unarmed	**1.89 (1.40, 2.56)**	**1.51 (1.10, 2.07)**	1.18 (0.82, 1.70)	**3.36 (1.73, 6.51)**
Age		0.95 (0.94, 0.96)	0.95 (0.94, 0.96)	0.97 (0.95, 0.98)
US Region		0.80 (0.73, 0.87)	0.77 (0.70, 0.85)	0.87 (0.73, 1.07)
Black Population		1.03 (1.02, 1.04)	1.03 (1.02, 1.05)	1.02 (1.00, 1.05)

Stratified estimates are adjusted; WaPo=The Washington Post; OR=odds ratio; CI=confident interval; MI=mental illness; ***Bolded=P<0.05***

Interaction effects within age and within signs of MI categories varied somewhat between unadjusted and adjusted models. Older males maintained over 4 times higher risk of being Black (OR=4.23; 95% CI [1.80, 10.09]) while those with MI signs had over triple the risk (OR=3.36; 95% CI [1.73, 6.51]) (see Figure 3). Compared to the main estimate adjusted for signs of MI, region, and the Black population (OR=1.82; 95% CI [1.34, 2.49]), the risk of being Black (vs. White) was almost 2.5 times higher for males aged 45 or older. Males showing signs of MI had close to double the risk of being Black compared to the main estimate adjusted for age, region, the Black population and OR=1.51; 95% CI [1.10, 2.07] respectively).

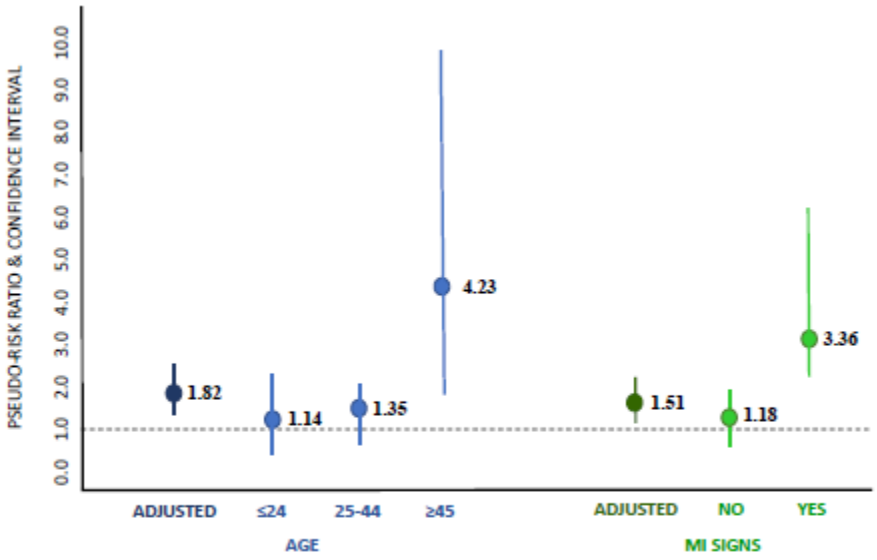

Figure 3. Adjusted relative pseudo-risk of being Black (vs. White) among unarmed males fatally shot by US law enforcement 2015-18 in WaPo, and estimates stratified by age and mental illness (MI) signs (*N=2,442*)

DISCUSSION

Summary of findings

This is the first study to apply a case-only design to evaluate multiplicative and/or mechanistic interaction between being Black and being unarmed among males fatally shot by US law enforcement. There were several important and novel findings. As hypothesized, (1) positive multiplicative interaction estimated a 50% increased risk of being Black (vs. White), (2) there was significant variation within case-specific characteristics, and (3) mechanistic interaction was found but only within estimates stratified by age and by signs of MI. Adjusted stratified estimates were above and below the main adjusted estimates, suggesting 3-way interaction effects with age and with MI signs. As expected, males perceived to have MI had over 3 times higher risk of being Black (vs. White). However, opposite of what was hypothesized, older males (≥45 years) had over quadruple the risk while the younger age groups showed no Black-White differences. Findings suggest that being a Black male has a causal interaction effect with being unarmed that significantly increases the risk of being fatally shot by police for those over age 44 years and for those perceived to be mentally ill.

Mechanistic interaction

To conclude whether mechanistic interaction was present using case-only design in this study, race and armed status must be independent under monotonicity.[231,232] Monotonicity holds, as it implies that there is a mechanism by which males can be shot by police if they are considered Black and unarmed ($OR_{Black*unarmed}$) but who would not be shot if they are only considered Black (OR_{Black}) or only considered unarmed ($OR_{unarmed}$). If both assumptions hold, then the required magnitude of an interaction effect (S) > 1.[232] In this study, race was conceptualized as a social identity that may explain racial disparities in unarmed police killings.[241] Race as a social construct may violate the independence assumption as one's racial identity could plausibly influence whether one might arm themselves, though researchers have not established this link. Regardless, the assumption can be relaxed if race and armed status can independently cause one

to be shot by police, *and* if $(S) > 2$.[232] Therefore, the estimate found in the fully adjusted model of this study (OR=1.50) did not met the criteria required to confirm the presence of mechanistic interaction rendering the estimate non-interpretable for causal effects.

However, once the adjusted models were stratified by age and by signs of MI, strong mechanistic interactions emerged. Within the adjusted strata of older males, risk increased by 5% compared to unadjusted (4.17 to 4.23). Further, the racial difference found within the strata of males without signs of MI became insignificant after adjusting for age. Conversely, the risk among those perceived to have MI decreased by 32% in adjusted (vs. unadjusted) estimates (3.68 to 3.36). These results reveal that controlling for age and signs of MI in regression models masked significant 3-way mechanistic interaction effects that contributed to increased risk of being Black versus being White among unarmed males fatally shot by police. Researchers should consider stratifying police homicide cases for those who are unarmed by race, by age, and by signs of MI, when possible, to avoid biased estimates.

Interaction with aging

The higher risk of being Black (vs. White) found among *older* unarmed males was novel. Much of the current literature point to younger, not older, unarmed Black males being at higher risk of a fatal shooting by police compared to Whites.[61,135,151,155,159,222] Despite the reduced precision of the adjusted estimate (95% CI [1.80, 10.09]) due to the modest sample size of older males (*n=717*), the lower bound CI was quite close to $(S) = 2$, strengthening the likelihood of true causal interaction. In addition, there were significant differences between age groups and armed status ($P<0.05$; data not shown). Older males were the least likely to be unarmed when fatally shot (3%) compared to those under 25 years (12%) and aged 25-44 years (8%) yet their risk of being Black and unarmed was the highest. Together, these indicators point to a potential racial bias by law enforcement against older unarmed Black males. Police officers may perceive older Blacks to be a substantial threat despite being unarmed, seemingly more so than older unarmed Whites.[157,252] More research should focus on mechanisms between officer threat appraisal and/or evaluation associated with various racial and age groups (e.g. qualitative interviews, training programs) and use of lethal force, particularly against aging Black men.

Interaction with mental illness signs

Racial bias may also play a role in elevated officer threat appraisal of Black males perceived to have MI. Evidence shows that officer use of force is generally higher against mentally impaired people with disparities among males, non-Whites, and those with weapons.[177,253-255] Studies have also indicated that officers trained to believe that people with MI are too irrational to reason with, and are more likely to possess a weapon and act violently, are compelled to physically subdue a suspect as quickly as possible to protect public safety.[253,256,257] Investigators propose that this working hypothesis perpetuated within law enforcement agencies fosters an increased sense of officer fear and anxiety which may encourage more aggressive tactics.[177,256] Such officer concerns may be heightened when the suspect is Black, even when unarmed. Combined, these aspects may exacerbate Black-White disparities in experiencing lethal police force among unarmed males showing signs of MI. More study among Black men with diagnosed MI may help disentangle the factors that may drive officers to fatally shoot this highly vulnerable population.

LIMITATIONS AND STRENGTHS

This study has notable methodological considerations. The restricted time period in the WaPo database limited the sample size likely reducing the power to detect mechanistic interaction. Causal inference can be inferred using this sampling strategy and cross-sectional study design comparing racial groups as: (a) race and armed status preceded being shot by police, (b) mechanistic interaction implies causal interpretation, and (c) disparities are described between racial groups experiencing the same exposure and outcome.[232,237-239] Study findings are generalizable as the sample includes all US gunshot homicides in 2015-18 and was nationally representative. Odds ratios likely provided somewhat inflated pseudo-risk ratios. Study validity largely depends on accurate data collection and proper validation of cases by *The Washington Post* such as race. To assess internal validity, the number of cases in this study were cross-referenced with cases in The Counted database by *The Guardian* newspaper which has been shown to be highly reliable.[137,163] The Counted contains the total number of people killed by US law enforcement agencies during 2015-16 (*N=2,238*).[258] Thus, the number of 2015-16 WaPo cases included in the current study (*N=1,958*) were compared to the number reportedly shot in The Counted (*N=2,027*) and showed 97% agreement. This finding suggests that the current study's validity was improved by using WaPo data although it is unlikely that all known cases have been accurately reported to any system.

CONCLUSION

This study used case-only design to provide new evidence that being a Black male has a causal interaction effect with being unarmed that significantly increases the risk of being fatally shot by police for those over age 44 years and for those perceived to be mentally ill. These findings introduce a novel approach to investigating social-environmental statistical interactions that exacerbate racial disparities in police killings. Further, law enforcement agency programs and officer training and evaluation focused on addressing racial bias in use of force may buffer Black-White gaps in police killings. More robust law enforcement data collection systems are needed for future research focused on lethal force against unarmed Black men in the US.

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AIM #2: The role of US law enforcement agency policies and practices on police killings during 2015-16, stratified by Black and White deaths

INTRODUCTION

Public concern over recent police killings, particularly among racial minorities, has inspired numerous epidemiologic investigations to identify key factors that may drive police deadly use of force from *legal intervention*. Legal intervention is defined by the US government as "injuries inflicted by the police or other law-enforcing agents, including military on duty, in the course of arresting or attempting to arrest lawbreakers, suppressing disturbances, maintaining order, and other legal action".[162] Research has demonstrated stark Black-White disparities in police use of force,[87,136,178,225] lethal intervention,[61,63,64,91,128,135,158,167,225,259,260] and killing those who were unarmed.[64,91,135,168,261] Moreover, Blacks are more likely to be killed in places with a higher Black population[83,183,261-263] and higher crime rates.[83] Thus, scholars have identified four central determinants of deadly legal intervention; (1) individual officer characteristics, (2) situational factors during encounters, (3) neighborhood context, and (4) law enforcement organizational policies, practices, and norms.[65,80,170,172,173,175,179,186-193] Institutional- and individual-level racial bias against Blacks likely drives racial inequities in lethal and non-lethal intervention.[62-64,155-158,160,161,168,194,195]

Much of the literature on reducing police killings has focused on predictors of officer and civilian behavior during encounters,[169-177] neighborhood characteristics,[80,170,178,179] and police culture.[180-182] However, organizational policies and training programs result from police culture and also shape officer behavior.[183-185] Thus, agency policies may directly contribute to higher incidence of avoidable police killings yet receive less epidemiologic research attention.

In seminal work, Uelmen (1973) concluded that agency policies regulating officer use of deadly force are manifestations of the underlying institutional attitudes that permeate within an agency.[185] He reported that officer restraint in use of deadly force is proportional to the degree of the policy's restrictiveness.[185] Uelmen (1973) advocated for state-wide deadly force policy reform "to achieve uniformity by controlling the exercise of individual discretion" to address avoidable fatalities.[185] Price & Payton (2017) further posit that policy uniformity would help differentiate "justifiable" homicides from those likely influenced by implicit racial bias.[63]

Following a review of contemporary deterrence models, Sherman (2018) recently developed the "system-crash" prevention framework which maps a pathway to reduce fatal shootings by law enforcement.[184] The adapted theory describes how rare catastrophes (i.e. unjustified shootings) are inevitable (or predictable) as a result of "too much complexity in organizational systems".[184] Like Uelmen (1973), Sherman (2018) encouraged researchers to consider changes in complex institutional systems and policies to mitigate avoidable shootings (e.g. certain types of training, on-the-scene protocols, organizational incentives) rather than solely holding individual officers accountable for preventable events. In sum, experts have continuously and invariably called for more focused research on policy indicators that may help prevent needless police killings.

Organizational policies have been shown to impact officer use of force,[80-83,180,185,187,189,192,245,263-270] lending credence to system-crash theory. For instance, Terrill and Paoline III (2017) report significant reductions in lethal force among officers within agencies that have more restrictive

versus permissive lethal force policies.[192] Similar findings surrounding restrictive policies[82,185,264,271-273] and supervisor oversight of officer use of force[81,173,180,187] have also been shown to mitigate police killings. Too, Nowacki (2015) demonstrated that Blacks benefited more than Whites from restrictive officer use of deadly force policies whereas larger departments predicted more police killings (except for Blacks).[82] Though findings are mixed, researchers have also considered officer field training, officer minimum educational requirements, community policing, collective bargaining, and less lethal weapon use.[80,81,83,172,259] A major contribution to this growing body of evidence would be a national examination of these and other law enforcement administrative policies and practices thought to reduce police killings and racial disparities more broadly.

The objective of this exploratory study was to compare the rates of police killings during 2015-16 within US law enforcement agencies that have a selected policy and/or practice (implemented as late as 2013) with rates among agencies that do not have that policy and/or practice (hereafter policy). Potential Black-White differences in police homicide rates were also evaluated. Each policy was hypothesized to mitigate police killings for all agencies. Because use of force policies have been linked to lower police killings for Blacks but not Whites,[82] policies were hypothesized to benefit agencies involved in Blacks deaths more than those involved in White deaths.

MATERIALS AND METHODS

Study Sample

Data are from two widely used data sources; The Counted and the 2013 Law Enforcement Management and Administrative Statistics (LEMAS).[137,274-276] The Counted by *The Guardian* newspaper is a database of the total number of people killed by US law enforcement agencies during 2015-16 (*N=2,238*), including case-specific demographic information, armed status, and the law enforcement agencies involved.[152,258,275] The Counted database is promptly maintained and updated by *The Guardian* reporters and interactive journalists by collecting tips from the public, information from multimedia sources, and from the FBI's annual reporting of "justifiable homicides" of law enforcement agencies defined as "the killing of a felon in the line of duty". Reporters validate data through open source reporting, police records, voter registration information, witness accounts, by family/friends and by monitoring regional news outlets.

The US Department of Justice periodically collects public-use LEMAS data. LEMAS is a cross-section of surveyed information from a nationally representative sample of ~3,000 state and local US police agencies regarding agency type, administration, review boards, budgets, management, weapons, equipment, personnel, hours, wages, and agency and officer requirements.[274] Using the 2013 LEMAS database, 2,826 agencies were matched to each death in The Counted according to the agency name(s) reported and the state in which the homicide occurred. Because the unit of analysis was any law enforcement agency involved, multiple agencies could be linked to one police killing. The final sample size generated was a cross-section of 481 agencies that were involved in 1,187 police homicides (hereafter homicides).

Exposure Assessment

Organizational characteristics shown to influence officer use of force include racial bias, departmental racial diversity, internal and external review boards (e.g. complaint analysis), collective bargaining agreement, the number of full-time sworn officers, type of weapon use, and

officer requirements (e.g. hours of field training) among others.[63,80,81,83,172-174,187,189,274,277] Thus, 14 LEMAS-reported agency policies/practices expected to reduce lethal intervention were evaluated. All survey questions included the modifier "As of January 1, 2013" before each base question asked except for the exposures "College-educated officers", "Community policing", "Community evaluation" and "External statistical analysis" (below) which prefaced "During the 12-month period ending December 31, 2012". Each risk exposure was coded on a decreasing risk scale (i.e. higher values represent lower risk). Overall missingness was less than 2% thus missing values were replaced with zeros for count variables to represent unknown values or were categorized as *Unknown*, as appropriate.

Bureaucratic control. Strong supervision and explicit rules and regulations provide officers with structure and oversight that can promote cautiousness and lower homicide rates.[83,187] To evaluate the strength of bureaucratic control within each agency, the total number of *intermediate supervisors* (e.g. captains) and *first-line supervisors* (e.g. sergeants) among full-time (FT) sworn personnel were measured as a continuous variables. Zeros replaced missing values.

Collective bargaining. General complaints against officers by the public are lower among agencies that use labor unions to negotiate terms for employees (i.e. collective bargaining agreements).[80] Agencies respond yes or no to whether the interests of officers are represented by collective bargaining. The status of a collective bargaining agreement was assessed among each agency's sworn personnel and included four categories: "Active"=1, "Expired"=2, "No collective bargaining agreement"=3 and "Not Applicable" (No collective bargaining)=-8. *Interests represented by collective bargaining* was coded dichotomously (No/Unknown [No, missing]=1; Yes=2). *Active collective bargaining* was coded dichotomously (No/Unknown ["Expired", "No collective bargaining agreement", "Not Applicable", missing]=1; Yes ["Active"]=2).

Officer educational requirement. Minimum training and education standards differ by agency[278-280] and having educated officers predicts excessive and lethal use of force.[172,174,189] Six survey questions captured education requirements for sworn new hires. Each requirement was coded "Yes"=1 and "No"=2 and included no minimum requirement, H.S. diploma or equivalent, some college but no degree, associate's degree of equivalent, B.A. degree or equivalent, and other. Studies have operationalized officer education in a variety of ways;[172,174,189] however, for this analysis, a conservative coding strategy was used to capture the independent role of having any minimum requirement as well as a potential dose-response. Hence, two variables were generated to assess educational requirements; (1) a 4-category ordinal variable indicating *minimum educational requirements* using none as the reference group (None/Unknown ["No minimum requirement", missing]=1, "H.S. diploma"=2, some college ["Some college but no degree", "Associate's degree of equivalent"]=3, "B.A. degree"=4) and (2) a dichotomous variable to evaluate *any college* educational requirements (No college/Unknown ["No minimum requirement", "H.S. diploma", missing]=1; Some college ["Some college but no degree", "Associate's degree of equivalent", "B.A. degree"]=2).

Community policing. Community policing—training focused on building relationships between community members and police—was not found to influence homicides using 2013 LEMAS data and cases from the Fatal Encounters Project (collecting officer-involved homicides since

2000).[81] Fatal Encounters acknowledges that its data on race/ethnicity prior to 2013 was weakly validated,[281] hence *community policing* was assessed in this study. Agencies selected the proportion of FT personnel that received at least 8 hours of training on community policing issues from 5 categories: "All=1", "Half or more"=2, "Less than half"=3, "None"=4, "Not applicable"=5. Similar to prior literature,[81] a dichotomous variable (No/Unknown ["None", "Not applicable", missing]=1; Yes ["Half or more", "Less than half", "All"]=2) and a three-category ordinal variable was created ranging from 1 to 3 (None/Unknown ["None", "Not applicable", missing]=1, Some ["Half or more", "Less than half"]=2, All=3) with higher values indicating a larger proportion of personnel with ≥8 hours of training.

Officer additional training. Appropriate police training can reduce discriminatory lethal intervention, particularly against Blacks.[63,173] Additional law enforcement training requirements for lateral or pre-service hires was listed as no additional training required. The response choices were "Yes-none" (i.e. no additional training)=1 and "No" (i.e. additional training required)=2. A dichotomous score was generated (No/Unknown additional training ["Yes-none", missing]=1; Additional training required ["No"]=2).

Community evaluation. Given that the civilian review boards predicts officer use of force,[80,173] whether an agency collected and reviewed evaluations from the community on resident satisfaction was assessed. Agencies were asked whether they utilized information from a survey of local residents about crime, fear of crime, or satisfaction with law enforcement and recorded "Yes"=1 and "No"=2, thus *community evaluation* was assessed dichotomously (No/Unknown ["No", missing]=1; Yes=2).

External statistical analysis. Use of force can be mitigated by internal and external evaluation practices,[173] thus research and statistical analysis of criminal incidents conducted by external organizations may contribute to officer behavior. Agencies reported whether statistical analysis using computerized records was conducted by agency staff or by external organizations using "Yes"=1, "No"=2, and "Not applicable" (no analysis conducted)=-8. *Any analysis* was coded as a dichotomous variable (No/Unknown ["No", "Not applicable", missing]=1; Yes=2). Among a subsample of the agencies reporting any statistical analysis, *external analysis* was evaluated dichotomously (No=1, Yes=2).

Full-time sworn personnel. Because employee benefits (e.g. collective bargaining) can influence officer complaints by the public, which in turn can lower officer use of force,[80] the amount of FT (vs. part-time [PT]) personnel may predict homicides. Agencies were asked about the number of paid FT sworn personnel that worked in the agency. Zeros replaced missing values. FT personnel was calculated by dividing that total number of FT personnel by the total number of FT and PT paid sworn and nonsworn personnel (both range 0-49). *Personnel* was coded continuously.

Incentives. Given that collective bargaining and having a college education buffers officer use of force,[80,174,189] agency incentives for personnel may impact disparities in homicides for minorities. Agencies were asked to specify incentives for FT sworn personnel within 9 domains: "Educational attainment" (e.g. college degree), "Special skills or vocational training", Bi/multi-lingual ability", "Special duties" (e.g. horse patrol), "Hazardous duties", "Shift differential", "Residential location incentive", "Merit/performance", and "Other considerations". Each

incentive was coded "Yes"=1 and "No"=2 thus a summary score was recoded No/Unknown ("No", missing)=1 and Yes=2. Scores ranged from 9 to 18 with higher values representing a greater number of incentive programs.

Mission statement. Given that agency policy can impact officer behavior in minority communities,[80,81,187] the inclusion of a mission statement was analyzed. Agencies were asked to select their written mission statement on policing from the following: "No written statement"=1, "Written statement, no community policing component"=2, "Written statement, yes community policing component"=3. A dichotomous *mission statement* variable (No/Unknown statement ["No written statement", missing]=1; Statement=2) was assessed.

Less-lethal weapon use. Injury to officers and civilians have been reduced when officers use conducted energy devices (e.g., taser)[277] which could buffer homicides. Authorized non-lethal weapons potentially used by each agency were comprised of soft projectiles, OC spray/foam, other chemical agents, and conducted energy devices. The amount of personnel authorized to use less-lethal devices were reported as "Not authorized", "Some sworn", and "All sworn". Therefore, 2 sets of *less lethal* summary scores were generated; (1) using 3 ordinal levels (None/Unknown ["Not authorized", missing] =1; Some=2; All=3) with a score ranging 9 to 27 and (2) using dichotomously coded levels (No/Unknown=1 and Yes [Some, All]=2) with a score ranging from 9 to 18, both with higher values representing increasing use of less lethal weapons.

Video use. Evidence supporting that officer use of body-cameras reduces officer use of force is mixed at best.[265,282-284] Therefore, video use was assessed. Camera use was coded dichotomously as "Yes"=1 and "No"=2, and included patrol vehicles, patrol officers, weapons, and other types. A recoded summary score was created (No/Unknown ["No", missing]=1; Yes=2) ranging 4 to 8 with higher scores reflecting greater use of video recordings.

Outcome Assessment

Population-level measures are the most robust to evaluation police use of force.[226] Therefore, homicide rates were calculated using the total number of homicides within an agency divided by the 2016 population size of the jurisdiction in which the agency patrolled. Social Explorer, a contemporary tool providing demographic and socio-economic information for a given geography using data from the 2016 American Community Survey,[285,286] was used to determine each agency's population size.

Covariates

Empirically established and theoretical confounders of the association between US law enforcement policy and homicide rates are shown in Appendix 2.A.

Race/ethnicity. Associations were also reported stratified by agencies involved with Black and White homicides. *The Guardian* used various resources to obtain data on each case-specific race/ethnicity such as police and coroners' reports, voter registration information, witness statements, as well as photographic evidence. The seven racial categories identified in The Counted included White, Black, Hispanic/Latino, Asian/Pacific Islander, Native American, Arab-American and Other/Unknown. A 3-category nominal variable was generated for analysis

(White=1, Black=2, Other [*Asian/Pacific Islander, Hispanic, Native American, Arab-American, Other/Unknown,* missing]=3).

Law Enforcement Agency Characteristics

Agency type. Agencies patrolling large suburban or urban populations have an increased likelihood of having greater numbers of homicides. Moreover, smaller (vs. larger) or more rural agencies may not require the implementation of certain policies (e.g. community policing). Therefore, *agency type* may account for some policy—homicide rate associations. A nominal variable was generated to account for the 3 agency types reported in LEMAS: municipal (e.g. local, city), county (e.g. sheriff), and state (e.g. state troopers).

US Region. Like agency type, variation in regional differences can contribute to law enforcement policy implementation as well as homicide rates. The four *US regions* considered in this study were the Midwest (IA, IL, IN, KS, MI, MN, MO, ND, NE, OH, SD, WI), Northeast (CT, ME, MA, NH, NJ, NY, PA, RI, VT), South (AR, AL, DE, DC, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN, TX, VA, WV), and West (AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA,WY).

College-educated officers. Officers with a 4-year college degree show lower use of physical force than those without a degree.[172,174,189] Having more highly educated officers may confound the association between implementing policies requiring stringent officer criteria (e.g. educational, training) and the number of police killings.[83] Three variables were generated to account for *college-educated officers*: (1) a dichotomous variable representing having any officers with a B.A. (No ["No", missing]=1; Yes=2), (2) a continuous measure representing the number of officers with a B.A., and (3) a percentage measure indicating the proportion of officers with a B.A. among FT sworn personnel.

All remaining covariates were evaluated as continuous variables.

Gender diversity. Diversity is generally encouraged in law enforcement and increased gender diversity is thought to reduce citizen complaints of police use of force and mitigate police killings.[83,268] However, the implementation of policing to promote more women in law enforcement may be directly impacted by the presence or absence of women within an agency. Therefore, gender diversity was assessed using the proportion of *female personnel* by dividing FT and PT female personnel by the total number. Missing values were replaced with zeros.

Racial diversity. Though racial diversity within policing agencies is encouraged, its actual impact on homicides is mixed.[83,270] Assuming there is a linear relationship between having White personnel and use of force on minorities, the degree of agency-specific racial diversity was assessed using the percentage of the "White" FT sworn personnel among all racial groups within each agency as has been done in previous work.[81] Zero values accounted for missingness.

Jurisdiction Characteristics

Sociodemographic factors. Patterns of sociodemographic factors have been shown to contribute to homicides by US law enforcement.[61,80,81,167,222] Jurisdiction-specific nativity, median age, educational attainment, median household income, federal poverty rate, Gini index, owner occupied housing units, and marital status were assessed using data from the ACS.[286] Except for

age and *income* which were reported using medians, proportions were used for *nativity, educational attainment (≥H.S. diploma & ≥B.A. degree), poverty rate, GINI index, owner occupied housing units,* and *marital status*.
Economy. Economic strength can be related to both agency policy and homicides.[222] Thus, *GDP* was evaluated using 2015 GDP estimates from the US Energy Information Administration.[287]

Crime rates. Community violence can influence both organizational policies aimed to protect the public (e.g. community policing) and officer behavior.[83,179,187] Given that crime rates predict officer use of force,[80,187] the Federal Bureau of Investigation's (FBI) Uniform Crime Reports (UCR) was used to account for the rate of violent crime within a given jursidication.[249] UCR collects monthly data from US law enforcement reports or incidents recorded by the FBI. *Violent crime rate* was reported as the average crimes reported per 100,000 people. Zeros replaced missing values.

Statistical Analysis
STATA 15.1 was utilized to conduct all statistical analyses. The *a priori* minimum sample size required was calculated as 388 agencies with the parameters set at 15 predictors, $1\text{-}\beta=0.80$, $\alpha=0.05$, and $f^2=0.05$.[251] One tribal agency with one Native American homicide case was excluded from the final analyses due to inaccessibility of information on jurisdiction characteristics. A series of model building strategies were employed to assess confounding (e.g. univariable regression), collinearity (e.g. variance inflation factors), and best model fits (e.g. stepwise regression). Pearson correlation, ANOVA, and chi-square tests of homogeneity evaluated statistical correlations between covariates and each policy and each homicide group, as appropriate. Negative binomial regression using robust standard errors estimated homicide (incidence) rate ratios among all cases and estimates for race/ethnicity strata, adjusted for covariates. One model per policy was analyzed. Postestimation analysis confirmed the final model fit (e.g. Cook's D) using confounders significant at $P<0.05$.

RESULTS
Sample Characteristics
Table 1 shows the sample distribution of US law enforcement policies stratified by agencies involved in all homicides, White homicides, and Black homicides.

Table 1. Distribution of US Law Enforcement Agency Policy by Homicide Group in The Counted during 2015-16

Policy	**Agencies w/Homicides** (*N=480*)	**Agencies w/White Homicides** (*n=323*)	**Agencies w/Black Homicides** (*n=181*)
Bureaucratic control (mean±sd)	***n (%)***		
Number of intermediate supervisors	33 (119)	37 (143)	49 (65)
Number of first-line supervisors	74 (250)	88 (301)	115 (182)
Collective bargaining offered			
No/Unknown	86 (18)	63 (20)	25 (14)
Yes	394 (82)	260 (80)	156 (86)
Collective bargaining active *(n=394)*			
Inactive/Unknown	167 (42)	104 (40)	70 (45)
Active	227 (58)	156 (60)	86 (55)
Minimum educational requirement			
None/Unknown	18 (4)	14 (4)	3 (2)
HS diploma	385 (80)	251 (78)	142 (79)
Some college	68 (14)	50 (15)	32 (17)
BS/BA	9 (2)	8 (3)	4 (2)
Any college required			
No/Unknown	403 (84)	265 (82)	145 (80)
Yes	77 (16)	58 (18)	36 (20)
≥ 8 Hours Community policing training			
No/Unknown	179 (37)	124 (38)	68 (38)
Yes	301 (63)	199 (62)	113 (62)
Additional training for new hires			
No/Unknown	52 (11)	35 (11)	15 (8)
Yes	428 (89)	288 (89)	166 (92)
Community evaluation utilization			
No/Unknown	275 (57)	187 (58)	87 (48)
Yes	205 (43)	136 (42)	94 (52)
Any statistical analysis			
No/Unknown	49 (10)	38 (12)	9 (5)
Yes	431 (90)	285 (88)	172 (95)
External statistical analysis *(n=431)*			
No/Unknown	325 (75)	214 (75)	118 (69)
Yes	106 (25)	71 (25)	54 (31)
Full-time personnel (mean±sd)			
(%)	95 (0.07)	95 (0.08)	96 (0.06)
Incentives (mean±sd)			
range 9-18	12.1 (1.9)	12.0 (1.9)	12.3 (1.8)
Mission statement			
No/Unknown	28 (6)	22 (7)	5 (3)
Yes	452 (94)	301 (93)	176 (97)
Less-lethal weapon authorized (mean±sd)			
range 9-18	16.0 (1.8)	16.0 (1.8)	16.1 (1.5)
Video use (mean±sd)			
range 4-8	5.4 (0.9)	5.4 (0.9)	5.4 (0.9)

sd=standard deviation; K=1,000

Agencies had double the mean of first-line supervisors (mean=74) than of intermediate supervisors (mean=33). A clear majority of agencies offered collective bargaining (82%) though 58% were classified as being in an *active* status. Most agencies had a minimum requirement that officers have a HS diploma (80%) with 16% having any college-level educational requirement. Additional training for new hires was required in about 9 out of 10 agencies (89%). Just under two-thirds of agencies offered community policing training (63%) while fewer utilized community review boards or evaluation (43%). Although 9 in 10 agencies conducted computerized research, only 1 in 4 of those agencies utilized external organizations. Proportions of agencies with FT personnel and those with mission statements were very high (95% and 94% respectively). The frequency of officers authorized to use less lethal weapons was also high (mean=16, range 9-18). Conversely, there were lower frequencies of officer incentives (mean=12, range 9-18) and officer video use (mean=5, range 4-8).

There were observed differences between policies among agencies involved in White versus Black homicides, most notably between intermediate supervisors (mean+*12 [i.e. direction of the difference from White to Black cases]*), first-line supervisors (mean+27), active collective bargaining (-15%), and community evaluation utilization (+10%).

Table 2. Distribution of Covariates by Homicide Group in The Counted during 2015-16

Covariate	**Agencies w/Homicides** *(N=480)*	**Agencies w/White Homicides** *(n=323)*	**Agencies w/Black Homicides** *(n=181)*
Agency Characteristic	***n (%)***		
Agency type			
County	127 (27)	94 (29)	36 (20)
Municipal	323 (67)	204 (63)	129 (71)
State	30 (6)	25 (8)	16 (9)
US region			
West	149 (31)	101 (31)	35 (19)
Midwest	78 (16)	60 (19)	27 (15)
South	220 (46)	142 (44)	105 (58)
Northeast	33 (7)	20 (6)	14 (8)
	(mean±sd)		
Percent BA/BS Degree	2.6 (4.6)	2.6 (4.2)	2.1 (3.4)
Percent female personnel	10.7 (5.6)	10.5 (5.2)	12.7 (6.0)
Percent full-time White personnel	75.0 (24.6)	78.2 (24.8)	70.5 (21.2)
Jurisdiction Characteristic			
Median age	36.8 (5.1)	37.3 (5.3)	36.4 (4.6)
Percent US native	86.8 (10.9)	88.0 (10.1)	85.6 (10.7)
Percent HS Diploma	86.1 (7.52)	87.2 (6.0)	85.7 (6.9)
Percent BA/BS Degree	28.6 (11.6)	29.2 (11.2)	30.2 (11.2)
Gini index	0.47 (0.21)	0.47 (0.26)	0.50 (0.34)
Median income (K)	54.2 (16.7)	55.3 (16.5)	51.7 (15.1)
Percent below poverty	16.62 (7.0)	15.6 (6.3)	18.5 (7.3)
Percent married	47.0 (7.8)	48.3 (7.1)	43.4 (7.7)
Percent owner occupied housing units	57.9 (12.0)	59.7 (11.7)	53.5 (12.2)
Violent crime rate (per 100K)	409 (354)	360 (307)	566 (411)

sd=standard deviation; K=1,000

Table 2 shows the stratified sample distribution of covariates. About 2 in 3 of all agencies involved were municipal agencies (67%) with almost half of agencies located in the Southern US region (46%). FT agency personnel were mostly White (75%), male (89%), and had under a B.A degree (97%). Jurisdictions were comprised of mostly US natives (87%), residents with a HS diploma (86%), some income inequality (Gini=0.47), and owner occupied housing (58%). Populations had a mean age of 37 years, a median income of $54,000, an average poverty rate of 17%, and an average violent crime rate of 409 per 100,000.

Covariates that showed variation between agencies involved in White versus Black homicides were observed by agency type (municipal +8%), US region (West -12%; South +14%), FT White personnel (-8%), and violent crime (+206).

Confounder assessment

Bivariate analyses showed covariates significantly associated with 2 or more policies ($P<0.10$) included agency type, US region, female personnel, FT personnel, median age, nativity, percent population with B.A. degree, median income, poverty rate, percent population married, owner occupied housing units and violent crime (see Appendix 2.B). All covariates had negligible Pearson correlations (r) with policies and with homicides.[288]

Univariable and stepwise regression showed that confounders of the policy—homicide rate association significant at $P<0.10$ were FT personnel with a B.A degree, FT female personnel, percent population with a H.S. diploma and with a B.A. degree, Gini index, median income, poverty rate, percent population married, owner occupied units, and violent crime. Owner occupied housing was highly correlated with the married population yet was a much weaker confounder, thus it was excluded from analyses. Final models were adjusted for confounders significant at $P<0.05$ and included percent population with FT personnel with a B.A. degree, Gini index, median income, percent population married, and violent crime. Parameters for *post-hoc* power calculations are presented in Table 3.[289]

Multivariable negative binomial regression

Table 3 shows homicide rate ratios comparing US law enforcement agencies that have a certain policy to agencies that do not have that policy. Lower homicides rates were associated with having more intermediate supervisors (IRR=0.997; 95% confidence interval [CI] 0.996, 0.999), first-line supervisors (IRR=0.999; 95% CI [0.999, 0.999]), and FT personnel (IRR=0.044; 95% CI [0.013, 0.152]). Offering collective bargaining predicted 55% higher homicide rates (IRR=1.549; 95% CI [1.160, 2.067]). A curvilinear trend was found for minimum educational requirements with higher homicide rates associated with HS diploma (IRR=1.935; 95% CI [0.957, 3.909]) and some college requirements (IRR=2.045; 95% CI [0.979, 4.269]) compared to none/unknown requirements. Additional training for new hires was also trended towards higher rates (IRR=1.469; 95% CI [0.982, 2.195]).

Table 3. Multivariable Negative Binomial Regression of US Law Enforcement Agency Policies on The Counted Homicide Rates During 2015-16, Counts by All and Race-specific Homicides

Policy	**Agencies w/Homicides** (N=480)			**Agencies w/White Homicides** (n=323)			ǂ **Agencies w/Black Homicides** (n=181)		
Bureaucratic control	IRR	LB 95% CI	UB 95% CI	IRR	LB 95% CI	UB 95% CI	IRR	LB 95% CI	UB 95% CI
Intermediate supervisors	**0.997**	**0.996**	**0.999**	0.997	0.992	1.002	**0.993**	**0.990**	**0.996**
First-line supervisors	**0.999**	**0.999**	**0.999**	**0.999**	**0.998**	**0.999**	**0.998**	**0.998**	**0.999**
Collective bargaining offered	**1.549**	**1.160**	**2.067**	**1.579**	**1.098**	**2.271**	1.386	0.788	2.437
Collective bargaining active *(n=394)*	1.162	0.953	1.416	1.090	0.802	1.482	1.177	0.767	1.808
Minimum educational requirement	*None/Unknown reference*			*None/Unknown reference*			*None/Unknown reference*		
HS diploma	1.935	0.957	3.909	**2.835**	**1.047**	**7.679**	0.568	0.075	4.295
Some college	2.045	0.979	4.269	2.424	0.852	6.895	0.668	0.084	5.334
Bachelor's degree	1.085	0.363	3.241	1.059	0.266	4.213	0.276	0.027	2.810
Any college education required	1.010	0.789	1.293	0.793	0.564	1.116	1.053	0.647	1.714
≥8 Hours community policing training	1.135	0.936	1.376	1.256	0.966	1.634	1.179	0.796	1.747
Additional training for new hires	1.469	0.982	2.195	1.602	0.968	2.652	2.105	0.695	6.373
Community evaluation used	0.866	0.721	1.041	**0.773**	**0.602**	**0.992**	0.937	0.635	1.381
Any statistical analysis	1.081	0.657	1.779	1.401	0.747	2.626	0.518	0.128	2.106
External statistical analysis *(n=431)*	0.834ǂ	0.659	1.055	0.755ǂ	0.547	1.040	**0.552ǂ**	**0.374**	**0.813**
Full-time personnel	**0.044**	**0.013**	**0.152**	**0.092**	**0.022**	**0.392**	0.027	0.001	1.510
Incentives	1.007	0.953	1.064	0.983	0.914	1.058	1.025	0.901	1.166
Mission statement	0.772	0.492	1.212	0.756	0.429	1.334	0.667	0.207	2.153
Less-lethal weapon authorized	0.986	0.924	1.052	0.971	0.895	1.054	1.063	0.912	1.240
Video use	0.963	0.872	1.064	1.011	0.876	1.166	0.866	0.719	1.043

Estimates adjusted for percent officers with a bachelor's degree within agencies, Gini index, median income, percent married, and violent crime rate IRR=incidence rate ratio; CI=confident interval; LB=lower bound; UB=upper bound; ***Bolded values=P<0.05***
Power=1-β=ranged from 0.92 to 0.97 using N=480 (All Agencies) and N=323 (White cases), 7 to 9 predictors, R^2 ranging from 0.04 to 0.06, and α=0.05
ǂ *Percent married was P>0.05 in regression analyses and was excluded from the final model*
Ɨ *1-β=0.81 using 7 to 9 predictors, R^2 ranging from 0.04 to 0.06, with α=0.10*

Among agencies involved in White homicides, similar protective policy associations were found for more intermediate supervisors (IRR=0.999; 95% CI [0.998, 0.999]) and more FT personnel (IRR=0.092; 95% CI [0.022, 0.392]). In addition, utilizing community evaluation lowered White homicide rates (IRR=0.773; 95% CI [0.602, 0.992]). White homicides rates were almost 3 times higher among agencies with a minimum HS educational requirement compared to no/unknown requirement (IRR=2.835; 95% CI [1.047, 7.679]). The same inverse u-shaped pattern emerged across educational groups. Similar to all cases, agencies offering collective bargaining predicted 58% higher White homicide rates (IRR=1.579; 95% CI [1.098, 2.271]). Policies that trended towards higher White killings included some college educational requirements (IRR=2.424; 95% CI [0.852, 6.895]), at least 8 hours of community policing training (IRR=1.256; 95% CI [0.966, 4.213]), and additional training for new hires (IRR=1.602; 95% CI [2.652]).

Like agencies involved in all and White homicide cases, lower Black homicide rates were linked to having more intermediate supervisors (IRR=0.993; 95% CI [0.990, 0.996]) and more first-line supervisors (IRR=0.998; 95% CI [0.998, 0.999]). However, having external statistical analysis reduced Black homicide rates by nearly half (IRR=0.552; 95% CI [0.374, 0.813]). Having more FT personnel trended toward lower Black homicide rates (IRR=0.027; 95% CI [0.001, 1.510]).

DISCUSSION

This is the first exploratory study to provide preliminary evidence of the role that US law enforcement policies play on police killings by linking 2015-16 deaths in The Counted database with police agencies reportedly involved in each death and participated in the 2013 LEMAS survey. Though each policy preceded all homicides, study results should not be interpreted as an indication of causation, but rather, as a guide to identify administrative policies or practices that have the potential to reduce police killings. As hypothesized, most of the statistically significant policies were protective. However, two polices were unexpectedly associated with higher police homicide rates. Also contrary to what was hypothesized, only one policy significantly benefited agencies involved in Black killings over White killings.

Summary of findings

Agencies with a larger proportion of FT personnel had the greatest reduction in police killings, dropping rates by over 95% for all agencies and 91% for agencies linked to White deaths. Among agencies involved in Black deaths, more FT personnel also trended towards being protective (*i.e. P<0.10*). Having more supervisors reduced homicide rates for all agencies. Utilizing *external* statistical analysis lowered rates for those involved in Black killings by almost half (45%) while rates merely trended lower among agencies associated with White killings. Engaging in community evaluation approached being protective but was only significant amid agencies involved in White deaths, reducing rates by 23%. Agencies that required at least a HS diploma (vs. no/unknown requirements) had almost 3 times higher homicide rates for those involved in White deaths, with an inverse u-shaped pattern trend across all agency groups. Offering collective bargaining was associated with a 55% and a 57% higher rate in agencies linked to all deaths and White deaths respectively. Finally, trends moved in a positive direction for agencies that offered (a) community policing among those involved in White deaths and (b) additional training for new hires amid those associated with all deaths and White deaths.

Full-time personnel

To date, no studies have examined whether the proportion of FT personnel in itself plays a direct role in reducing police killings. In another study that evaluated links between organizational characteristics and citizen complaints of officer use of force, Hickman and Piquero (2009) reported a positive association between agencies with an internal affairs unit involving FT personnel and citizen complaints.[80] When modeled as the primary exposure variable in this study, percent FT personnel had the strongest association with lowering homicide rates (91-96%). Experts have posited that a more structured police organization leads to greater officer accountability and improved officer behavior.[83,180,184,187,267,269] Together, these findings propose that agencies with more FT personnel may function to establish a more formalized organization that results in a stronger bureaucratic infrastructure, which, in turn, might lead to more accountability and lesser officer deadly use of force. The mechanism linking FT personnel and fatal police interventions should be further evaluated within municipal-, county-, and state-level agencies.

External statistical analysis

This study is the first to report an association between agency-specific computerized statistical analysis (or research) and police killings. Statistical analysis conducted by an external (vs. internal) organization was associated with 45% lower homicide rates in agencies involved in

Black deaths. Even though the sample size of agencies involved in Black deaths was low, the upper bound confidence interval was far from the null (95% CI [0.74, 0.813]), strengthening the likelihood that external analysis plays a protective role. Importantly, LEMAS respondents were not asked to specify what type of analyses were conducted, such as crime or geospatial analyses. Therefore, there is no way to identify explicit agency research and/or analysis that may be protective for agencies that engage with Black populations. However, it is plausible that agencies engaged in research also tend to have police cultures that promote practices which generally enhance officer and agency liability (e.g. citizen review boards). Deadly force rates are lower among agencies providing greater officer oversight.[81,82,173,180,187,261] Studies should investigate the impact external research may have on fatal interventions in highly policed minority populations.

Bureaucratic control

Similar to prior studies reporting lower homicide rates among agencies with more bureaucratic oversight, having a greater number of first-line supervisors was protective for all groups. Notably, having more intermediate supervisors lowered killings for agencies involved in all deaths and those involved with Black deaths but not White deaths. These findings support the notion that the underlying culture related to police use of deadly force may be less permissive in agencies with more structured supervision. As Uelmen (1973) and Sherman (2018) posit, officer use of force behavior reflects the level of tolerance infused within an agency despite an officer's general performance.[184,185] Indeed, officer performance has been shown to be mediated through increased supervision and administrative support.[269] Hence, future research should examine officer use of deadly force patterns across agencies that vary in the number of and in levels of occupied supervisor and administrative positions.

Minimum educational requirement

Consistent with previous reporting, agencies in this study that required a minimum HS diploma (vs. no/unknown requirements) had almost triple the rate of police killings. The association was significant among agencies involved in White deaths with a curvilinear trend for all agencies. Similarly, Smith (2004) reported higher police killings associated with agencies with no college education requirement.[83] McElvain (2008) found the same positive association with police shootings.[172] Research shows that officers with Bachelor's degrees engage in lower levels of physical force [174,189] and encounters with officers who have some college education (vs. HS diploma) results in lower verbal force.[189] Too, departmental educational policy requiring officers to have an Associate's degree has predicted lower citizen complaints of officer use of force as well as lower assaults on officers.[190] Together, these findings suggest that requiring a minimum requirement of at least some college education for officers may reduce use of fatal force within some agencies. Further study focused on college-educated officers may help explicate the mechanism by which educational attainment buffers police killings.

Less lethal weapon use

Like other studies, no association was found between having more officers authorized to use less lethal weapons and police homicide rate. Likewise, Baily (1996) found a null association.[259] However, MacDonald and colleagues (2009) reported that officer use of conductive energy devices (e.g. tasers) reduced civilian injuries during use of force events.[277] More recently, Bishopp and colleagues (2015) demonstrated that more restrictive policies on taser use reduced

taser incidents among officers.[264] These mixed findings point to the need for a deeper evaluation, perhaps a *per protocol* analysis, to assess the utility in less lethal weapon use vis-à-vis officer use of lethal and non-lethal use of force.

Community policing

There was no association found for community policing training, which is similar to other literature.[81] Early evaluations of community policing showed promising results[290] however there is little evidence, thus far, to suggest that it reduces police killings. Proponents argue that this absence of evidence is because community policing has not been rolled out efficiently nor on a large enough scale for evaluation while skeptics frame their criticisms around substandard organizational reform programs and implementation.[290-293] In this study, the association between community policing and police killings trended in a positive direction among agencies involved with White deaths only. More research is needed to evaluate to true impact of community policing on police homicides, and whether Whites may be at higher risk.

Additional training for new hires

Another null finding worthy of mention in this study was the role of additional training for new hires, as the association moved in a direction consistent with the literature. Additional training among agencies involved in all deaths and Whites deaths trending towards higher rates. Smith (2004) also demonstrated a positive association between officer field training and police killings using the FBI's Supplemental Homicide Report (1994-98).[83] More officer training is likely confounded by the culture within a particular agency. Police culture has a stronger influence on officer use of lethal force regardless of training policies[183,261] or officer perception of departmental use of lethal force policies.[185] Officers are clustered within agencies that shape their judgement based on an officer's cost-benefit evaluation of their own potential action or conduct.[183] Therefore, more officer training is not likely to change officer behavior unless the agency culture demands it. It should also be noted that apart from community policing training, the LEMAS survey does not include a list of specific training genres for new hires hence there is no way to characterize what "additional training" was required (e.g. racial bias, weapons, de-escalation). Additional research should investigate a variety of officer training programs as possible mediators between and modifiers of agency culture and police killings.

Collective bargaining

Divergent from other work, and from the study hypothesis, offering collective bargaining showed significantly higher police homicide rates among all agencies and those involved with White deaths but not Black deaths. The current study was likely too underpowered to detect an association for agencies involved in Black deaths. Previous research using 2003 LEMAS data, albeit a different study design, showed that offering collective bargaining predicted lower citizen complaints of officer use of force.[80] In that study, Hickman & Piquero (2009) evaluated citizen complaints per 100 FT sworn officers among 496 large municipal agencies that served one-third of the US population as the outcome measure.[80] These conflicting results suggest that collective bargaining likely contributes to officer use of force, including lethal force, however the direction is unclear. Furthermore, differences in population demographics (i.e. size, geography) and police culture may also explain differing findings.

In an early publication titled "Police unions, police culture, and police abuse of force", Kelling and colleagues (1996) present a historical perspective to explicate how unions view that their primary role is to address member concerns related to salaries and working conditions, not necessarily to manage the "quality and substance of policing".[294] In some ways, unions have opposed strong supervisory control and oversight, arguing that officers do "police work", they do not "evaluate any other officer".[294] In addition, unions often defend officers against use of force complaints.[294] These factors align with Paoline III's (2003) conceptual model which identifies police culture as an upstream cause of an officer's individual "style" or occupational behavior.[181] Future work should investigation the pathway leading from police culture to administrative policies (e.g. collective bargaining status) to agency-specific characteristic (e.g. administrative oversight) to a wide range of officer use of force behaviors, including fatal force.

Community evaluation

Also inconsistent with other work, community evaluation was protective in this study, but only for agencies involved in White homicides. In studies examining the role of citizen or community review boards, use of force complaints were positively associated yet were estimates were reported in racial aggregate.[80,295] These differing findings likely result from differences in study design, specifically the measured outcome and the analysis of race/ethnicity. In the current study, (a) police homicides were evaluated as opposed to police use of force and (b) adjusted estimates were reported in aggregate and in groups stratified by the race/ethnicity of the homicide case. Consequently, estimates for agencies involved in all homicides was null but a significant association was detected for those related to White deaths. Thus, differences in the sociodemographic composition of populations may influence whether community evaluation is implemented and whether such policy actually helps racial minorities, warranting further study.

LIMITATIONS AND STRENGTHS

There are several methodological considerations. Causal inference cannot be inferred using this cross-sectional design though temporality was established as each policy was implemented prior to police killings. Study findings are weakly generalizable across all US law enforcement agencies. Though randomly selected by LEMAS, US law enforcement agencies were not required to participate rendering the agencies included in the analysis as not a strict nationally representative sample. Moreover, unknown external factors may disproportionately determine which agencies responded to the survey subjecting the sample to bias from self-selection and minor recall bias. Consequently, several cases were lost in this analysis due to agencies not being surveyed by LEMAS, further comprising external validity. Study validity also largely depended on accurate data collection and proper validation of cases and agencies by *The Guardian*. Given that *The Guardian's* database has been shown to be substantially more reliable than the government's National Vital Statistics System,[163] the study's internal validity was enhanced although it is not likely that all known cases were accurately reported to any system. Last, due to a small sample size, the likelihood of a committing a *Type II error*—failing to reject the null when it is false—was higher for the stratified estimates involving Black cases. Hence, policy—Black police homicide rate associations were underpowered and likely underestimated. The study design helps to inform wide-ranging law enforcement policies and practices that may be involved in the police homicide causal web. Identifying true policy-level indicators that reduce avoidable police killings requires a centralized database that can collect, store, and disseminate

relevant information on police culture, organizational policies and practices, and officer performance from all US law enforcement agencies. One such system does not yet exist.

CONCLUSION

Results from this exploratory analysis suggests that police agencies having more FT personnel, greater supervisor oversight, statistical analysis or research conducted by an external organization, and utilization of community evaluation may help reduce police killings in the US. Further, organizational culture regarding the permissiveness of and officer training related to use of deadly force may contribute to unnecessary police killings more so than initiatives aimed at improving officer performance, including the provision of collective bargaining, officer training programs, and minimum educational requirements for officers. Implications for uniform policies at the federal and/or state-wide level should be explored. Importantly, for disparities researchers to have any hope of making advances in addressing this public health and safety issue, we need reliable data sources, requirements for police organizations to collect and distribute data, and a more robust, wide-reaching record-keeping system that can track all US law enforcement agencies.

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AIM #3: Differential associations between everyday vs. institution-specific versus racial discrimination, self-reported health, and allostatic load among Black women: Implications for clinical assessment and epidemiologic studies

INTRODUCTION

Racial discrimination—the process by which members of a racial/ethnic group are treated unfairly based on their race/ethnicity—is significantly associated with a wide variety of adverse health outcomes and unhealthy behaviors.[36,47,59,72,119,196-198] The negative health consequences of racial discrimination are theorized to be cumulative over the life course with biological dysfunction emerging by mid- to late-life,[41,296,297] eventually resulting in *allostatic load*—multisystem physiologic dysregulation due to chronic adaptation to stress.[108,203,206] Allostatic load can lead to increased risk of numerous chronic diseases such as heart disease and diabetes, and even mortality.[298,299]

Blacks consistently show disproportionately higher allostatic load (AL) compared to other racial/ethnic groups with Black women having the highest predicted values.[30,108,122,300] Researchers suggest that this "weathering" (i.e. physiologic wear-and-tear) observed among Black women may be influenced by lifetime exposure to stressors related to social identity such as gender and racial discrimination.[108,301-303] That is, experiences of social marginalization are likely incorporated biologically, or *embodied*.[304] Self-reported experiences of racist events have been linked to AL.[201,202] Racial discrimination manifests in many forms, which may have differential impacts on health. However, the effects of different types of discrimination (e.g. interpersonal, institutional) have not been parsed analytically; and racial discrimination associations with AL among Black women is underreported.

Scholars propose that institutional experiences of racial discrimination (vs. routine mistreatment) may be a key risk factor for developing chronic health conditions among Blacks.[2,5,38,41,50,78,199] Institutional racial discrimination operates within societal organizations (e.g. universities, the workplace) to shape access to health-promoting resources and opportunities whereas day-to-day experiences are more mundane interpersonal experiences that generally occur in public.[200] Both experiences can vary in frequency (acute vs. chronic). For Black women, racial and gender inequalities interact to make avoiding high-risk exposures exceedingly more difficult over the lifecourse regardless of socioeconomic position.[25,30,95,109,127] This may help explain, in part, mixed findings between racial discrimination and various health outcomes.[36,46,139,141,142,145,147,305-310] For instance, workplace discrimination was associated with 30% higher breast cancer risk in the Black Women's Health Study whereas everyday exposure was weakly associated.[46] Should lifetime experiences within major social institutions be found to elicit deleterious physiological responses leading to elevated AL, interventions addressing institutional racism may be more effective in combatting a variety of health disparities faced by Black women and other socially marginalized groups.

Research shows that self-perceived health status is predictive of chronic disease risk and mortality[208-210] but report discrepancies between self-perceived health status and more objective health indicators. For example, evidence suggests that discrepancies between self-perceived health status and underlying AL levels can widen disparities in disease prevention, detection, and treatment.[122,216-218] Those at higher subclinical disease risk, such as having elevated cholesterol

or blood pressure, may not be aware of it. Self-perceived good health contributes to lower health care utilization, like annual check-ups.[311,312] Moreover, discrepancies between perceived and actual health are higher for Blacks (vs. Whites).[212,313] This disconnect has considerable implications for the timely clinical detection of AL in Black women, the highest at-risk group. Furthermore, associations between self-reported health and racial discrimination are mixed: everyday exposures more consistently predict poor self-reported health than institutional experiences.[49,60,138,211-215] Together these factors suggest a need to assess whether specific racial discrimination exposures are more predictive of health, and predict similar AL *and* self-perceived health status amid Black women.

No studies, to date, have compared associations between everyday versus institution-specific racial discrimination with AL and self-perceived health. To address this gap, our objectives were to examine associations of (1) everyday racial discrimination with both AL and self-reported health and of (2) institution-specific racial discrimination with AL and self-reported health. We hypothesized that (1) everyday racial discrimination would be associated with worse health and that (2) institution-specific racial discrimination would be associated with worse health, and that associations would be stronger than everyday experiences due to the theoretical excess burden related to the embodiment of institutional discrimination.[108,302-304]

MATERIALS AND METHODS

Study sample, recruitment, and participation

Data are from the African American Women's Heart & Health Study (AAWHHS), a cross-sectional study examining the association between social-environmental stress and mental and physical health among a sample of 208 midlife Black (i.e. African American) women. AAWHHS methods for study sample recruitment and participation have been described in more detail elsewhere.[202] Briefly, a community sample was recruited from five San Francisco Bay Area counties using purposive sampling with multiple recruitment strategies to maximize variability across key variables of interest (e.g. racial discrimination, socioeconomic indicators). Participants completed an interviewer-administered questionnaire, computer-assisted self-interview, physical examination, and fasting venous blood draw. Study approval was provided by the Committee for the Protection of Human Subjects at the University of California, Berkeley.

Exposure variables

Everyday Discrimination Scale (EDS). We used a modified version of the EDS scale asking respondents how often they experienced day-to-day unfair treatment based on their race, ethnicity or skin color in 10 subtle yet routine life situations (e.g. receiving poorer service) (α=0.95).[126] Responses were scored on a six-point Likert scale ranging from 1="Never" to 6="Almost every day", and were then added across items to generate a summary score (10-60) with higher scores reflecting greater frequency of everyday experiences. Though racial discrimination has been measured continuously to assess health associations,[38,213,314] previous evidence suggests a potential curvilinear relationship.[145,202] Therefore the EDS variable was measured both continuously and categorically (5-level qualitative-based) to reflect gradual increases in annual exposure; none ($\leq$20), low=few times/year (21-30), moderate=few times/month (31-40), high=at least once a week (41-50), and very high=~everyday (51-60).[202]

Experiences of Discrimination Scale (EOD). Respondents were asked whether they have "ever been treated unfairly, judged differently than others, prevented from doing something, been hassled, or made to feel inferior because of their race, ethnicity or skin color" across eight institutional domains (e.g. at work) (α=0.92).[315] One survey item from the original EOD scale ("getting services in a store or restaurant") was removed to avoid overlap with the same EDS item. Responses were scored on a five-point Likert scale ranging from 1="Never" to 5="6 or more times" over one's lifetime. Summary scores across the 8 EOD items ranged from 8 to 40 with higher scores reflecting greater frequency of institution-specific exposure. Like the EDS, summary scores were assessed continuously and as a 5-category qualitative-based variable representing conceptual increases of lifetime discriminatory experiences; never (=8), once (9-16), 2-3x (17-24), 4-5x (25-32), and ≥6x (33-40).[202] To establish commensurability with the EDS, the EOD categories were then labeled as none, low, moderate, high, and very high.

Outcome variables

Allostatic load. AL was comprised of 15 biomarkers indicating functioning across four physiologic systems (Chart 1). Following Seeman et al. and others,[30,108,122,202,206,316-321] we used 75th-percentile distribution-based cut-points for biomarkers without established clinical risk criterion. All other biomarkers were coded according to established cut-points, consistent with the conceptual definition of AL as an indicator of subclinical risk. Each biomarker was coded dichotomously (0=low risk, 1=high risk), then a summary score was created ranging from 0 to 15 with higher scores reflecting higher AL.

Chart 1. Allostatic Load Biomarker Cut-points

Biomarker	***Guideline Used***	***AL Cutpoints***
Metabolic System		
HDL (mg/dL)	ATPIII	<50
LDL (mg/dL)	ATPIII	≥100
Waist (in)	ATPIII	>35
Glucose (mg/dL)	ATPIII	≥100 *or* <70
HbA1c (mmol/mol)	ADA	≥5.7
Total Cholesterol (mg/dL)	ATPIII	≥160
Triglycerides (mg/dL)	ATPIII	≥150
BMI (kg/m^2)	ATPIII	≥25 *or* <18.5
Cardiovascular System[d]		
Systolic BP (mm Hg)	AHA (JNC 7)	≥120
Diastolic BP (mm Hg)	AHA (JNC 7)	≥80
Neuroendocrine System		
[a]*Epinephrine (pg/mL)*	n/a	>77.70
[a]*Norepinephrine (pg/mL)*	n/a	>686.30
[a]*Cortisol (µg/dL)*	n/a	>12.69
Inflammatory System		
[a]*Il-6 (pg/mL)*	n/a	>7.85
hsCRP (mg/L)	AHA	>3

[a]75th percentile cutpoints used for biomarkers that do not have clinical guidelines; subclinical cutpoints used for rest.

Self-reported health. Respondents were asked how they would rate their overall physical health at the present time. Responses were scored on a five-point Likert scale ranging from 1="Excellent" to 5="Poor" with higher scores representing worse health. Consistent with prior studies,[22,138,208,322-325] self-reported health was assessed dichotomously (0="Excellent/Very good/Good", 1="Fair/Poor").[326]

Covariates

We assessed established empirical and theoretical confounders of the exposure—outcome association; age, education, employment, poverty, and marital/partnership status. Other covariates included [1]medication use (cardiovascular and diabetes). Because research suggests that health behaviors and access to health-promoting resources may be on the pathway between racial discrimination and AL,[5,30,86,119,317,327-332] health insurance and behaviors were identified as mediators and thus were not included in the analysis to avoid over-controlling (see Appendix 3.A.). Except for age (measured in years), all other covariates were dichotomized at established risk levels (0=low, 1=high) to maximize power. These included 1=≤ high school diploma, 1=not employed, 1=≤ 100% federal household poverty threshold, 1=not married/domestically-partnered, and 1=current medication use. In addition, a composite socioeconomic position (SEP) measure was generated using the four dichotomous SEP variables. SEP summary scores ranged from 0 to 4 with higher values representing worse SEP.

Statistical analysis

STATA SE 13.1 was used for all statistical analyses. Data were missing at random ($P>0.10$) which was ≤ 5%. Thus, we used multiple imputation ($m=20$) to account for missingness.[333] In the final models, one observation had more than one missing variable within the linear combination of predictors and within the AL response variable resulting in computational problems, and was therefore dropped before imputation. Biomarkers were log-transformed prior to imputation to satisfy assumptions of normality, as needed. Statistical differences between exposure and outcome variables were assessed using bivariate analysis methods (e.g. *t*-test), as applicable. Linear regression was used to estimate EDS and EOD associations with AL whereas logistic regression was used to estimate self-reported health associated with each exposure, adjusted for covariates significant at $P<0.10$. Similar to prior work,[145,202] moderate discrimination was selected as the reference group of categorical regression models given that episodic stress exposure is self-regulatory and considered health-protective.[203,207,334] We conducted model diagnostic tests, as appropriate (e.g. heteroscedasticity). We assessed relative efficiency post-imputation to ensure the simulated data did not inflate residual variance.[333,335] Sensitivity and bias analyses were performed on regression models.[336,337] We found no evidence of linear associations for AL or for self-reported health with either discrimination scale, as anticipated; hence, our final models are reported using the qualitative-based EDS and EOD variables described above. Parameters for power calculations are reported in the final regression table.[289]

[1] Information regarding the specific type of cardiovascular and diabetes medications taken by participants was not collected. Without knowing the specific medication and which biomarker(s) are targeted, we cannot account for it in our 15-biomarker AL measure (e.g. antihypertensives lower blood pressure; statins lower cholesterol). To preserve internal validity and account for medication use, we adjusted for medication use. We evaluated potential confounding by indication using stratified and bias analyses, alas cell sizes were too small. However, stepwise regression showed medication use was significant in final models ($P<0.05$) and that adjusting for it did not introduce bias or diminish the precision of the estimates.

RESULTS

Sample Characteristics

Table 1 presents the sample distribution of sociodemographic characteristics.

Table 1. Study Sample Characteristics (*N=207*)

Covariates	*n*	*%*	*Racial Discrimination Exposures*	*n*	*%*
Age mean (±SD)	41.72 (5.90)				
SEP mean (±SD) (range 0-4)	1.67 (0.96)		**Everyday Discrimination Scale (EDS)**		
Educational Attainment			*None (EDS score: less than/equal 20)*	59	28.50
> High School Diploma	138	66.67	*Low (EDS score: 21-30)*	65	31.40
≤ High School Diploma	69	33.33	*Moderate (EDS score: 31-40)*	38	18.36
Employment Status			*High (EDS score: 41-50)*	26	12.56
Employed	114	55.07	*Very High (EDS score: 51-60)*	19	9.18
Not Employed	93	44.93	**Experiences of Discrimination (EOD)**		
Poverty Status			*None (EOD score: 8)*	22	10.63
> 100% Federal Poverty	168	81.16	*Low (EOD score: 9-16)*	71	34.30
≤ 100% Federal Poverty	39	18.84	*Moderate (EOD score: 17-24)*	63	30.43
Marital/Partnership Status			*High (EOD score: 25-32)*	29	14.01
Married/Domestic Partnership	61	29.47	*Very High (EOD score: 33-40)*	22	10.63
Not Married/Domestic Partnership	146	70.53			
Cardiovascular Medication			***Health Outcomes***		
Not Currently Taking	164	79.23	**Allostatic Load** (range 0-15)		
Currently Taking	43	20.77	mean (±SD)	5.96 (2.24)	
Diabetes Medication			**Self-reported Overall Physical Health**		
Not Currently Taking	195	94.20	*Excellent/Very good/Good*	156	75.36
Currently Taking	12	5.80	*Fair/Poor*	51	24.64

SD=standard deviation; SEP=socioeconomic position

Everyday experiences of discrimination (EDS). Half of the sample reported low to moderate levels of everyday discrimination (i.e. 1-3x/year) (Table 1). Approximately 1 in 5 (21%) reported high to very high levels (i.e. at least 1x/week to ~everyday). Figure 1 shows the distribution of reported occurrences by each scale item. The majority reported racial discrimination in 6 out of 10 "everyday" situations. The frequency distribution of each EDS item response is presented in Appendix 3.B.

Figure 1. Percent Reporting EDS More Than Once Per Year by Item (*N=207*)

Experiences of institution-specific discrimination (EOD). Approximately 2 in 3 women (64%) reported experiencing low to moderate levels of institutional racial discrimination (i.e. 1-3x in ≥1 domain) (Table 1). Figure 2 presents the frequency of reported experiences within each domain. A quarter reported high to very high levels (i.e. ≥4-6x within ≥1 domain), and over half reported at least one racial discrimination experience in 7 out of 8 domains. The frequency distribution of each EOD item response is presented in Appendix 3.C.

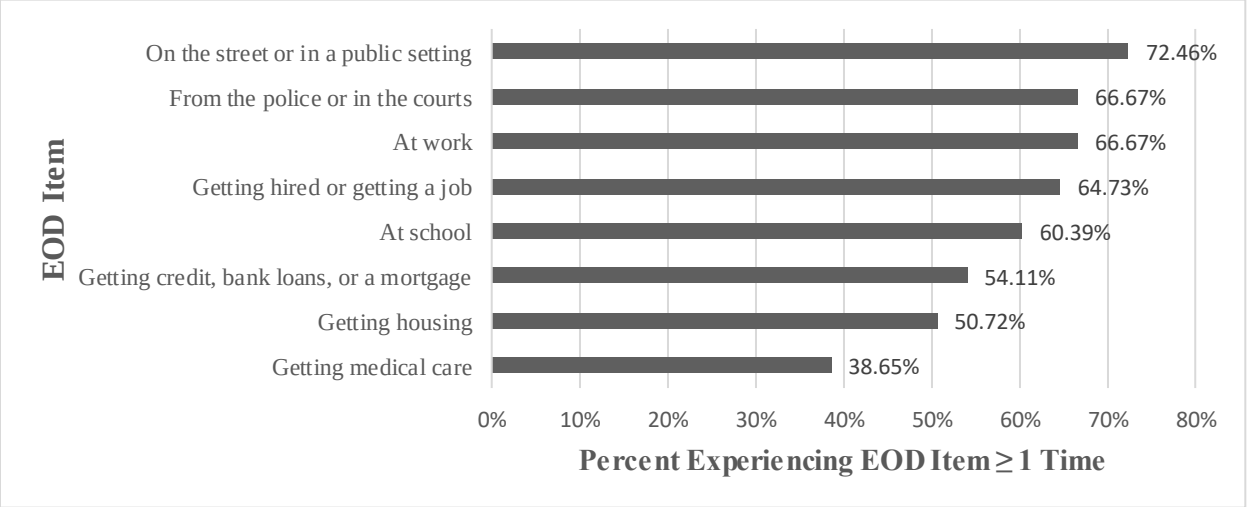

Figure 2. Percent Reporting EOD One or More Times by Item (*N=207*)

Allostatic load. Mean AL score was 5.96±2.24 (range 0-15) (Table 1).

Self-reported Health. Precisely 3 in 4 women reported good to excellent health (75%) (Table 1).

Significance of exposure and outcome differences

Bivariate analyses compared exposure-to-exposure, outcome-to-outcome, and exposure-to-outcome differences (see Appendix 3.D). Significant differences were found between EDS and EOD exposure measures (X^2=151; P<0.01). Mean AL did not vary by self-reported health status (t=-0.51; P=0.69). Estimates showed lower mean AL among "very high" (vs. "moderate") EOD levels (F=2.56; P=0.04) and no variation for EDS (F=1.21; P=0.31). No differences were found between either EDS or EOD measure with self-reported health (X^2=4.05; P=0.40 & X^2=2.08; 0.72 respectively).

Multivariable linear regression models

Figures 3 & 4 show the adjusted estimates for AL and self-reported health, respectively, for each EOD and EDS level. Compared to those reporting moderate discrimination (reference), there was a negative association between EOD and AL for those reporting very high discrimination (β=-1.31; 95% Confidence Interval=-2.41, -0.20) (Table 2). No significant association was found for EDS and AL. Self-reported health was not associated with EDS or EOD.

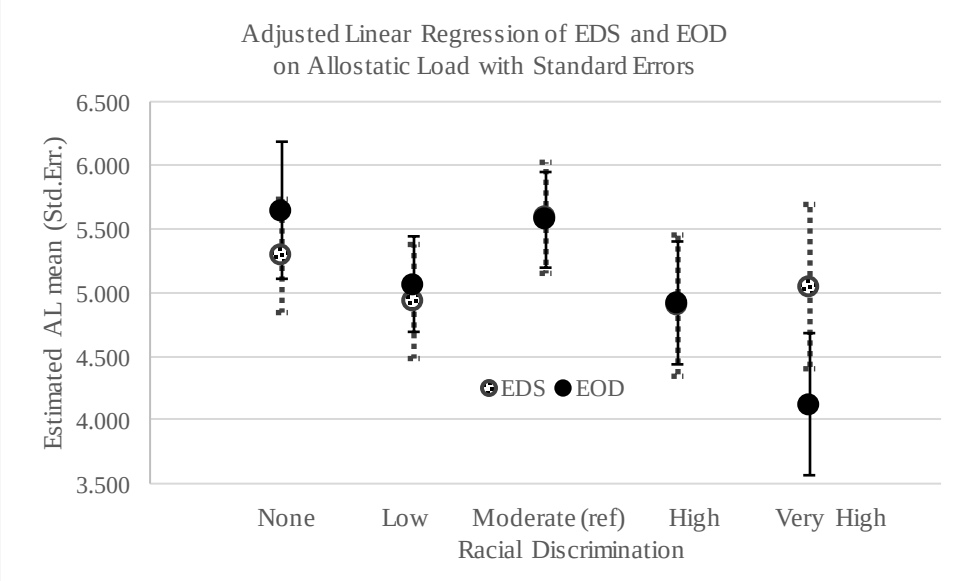

Figure 3. Linear regression of allostatic load by EDS and EOD measures adjusted for age, socioeconomic position, and medication use.

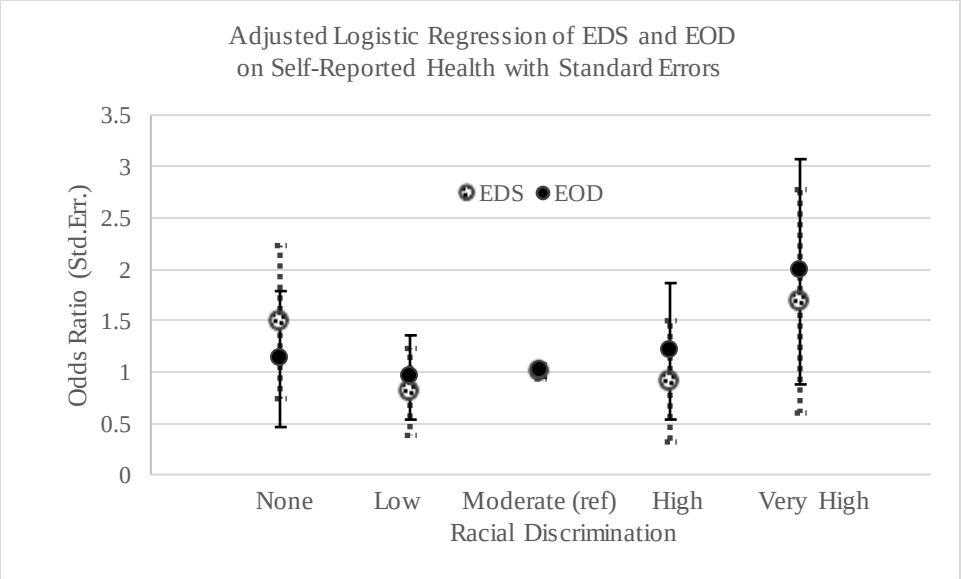

Figure 4. Logistic regression of self-reported health by EDS and by EOD measures adjusted for age, socioeconomic position, and medication use.

Table 2. Linear Regression of Allostatic Load and Logistic Regression of Self-Reported Health by EDS and by EOD (*N=207*)

Discrimination	**Allostatic Load**				**Self-reported Physical Health**			
	EDS		**EOD**		**EDS**		**EOD**	
	β[a]	95% CI	β[b]	95% CI	OR[c]	95% CI	OR[d]	95% CI
None	-0.166	(-1.044, 0.713)	0.216	(-0.847, 1.279)	1.483	(0.554, 3.973)	1.124	(0.354, 3.565)
Low	-0.524	(-1.408, 0.360)	-0.364	(-1.104, 0.377)	0.804	(0.286, 2.256)	0.945	(0.403, 2.213)
Moderate (ref)	ŧ5.454	—	ŧ5.431	—	1.000	—	1.000	—
High	-0.556	(-1.651, 0.539)	-0.512	(-1.464, 0.441)	0.907	(0.253, 3.248)	1.200	(0.405, 3.552)
Very High	-0.407	(-1.682, 0.869)	***-1.307**	**(-2.411, -0.203)**	1.686	(0.476, 5.969)	1.974	(0.664, 5.865)

*EDS=Everyday Discrimination Scale; EOD=Experiences of Discrimination Scale; β=beta coefficient; OR=odds ratio; CI=confidence interval; Models adjusted for age, socioeconomic position, and medication use; ŧ=estimated mean allostatic load; *P<0.05; [a](Power)=1-β=0.99 (R^2=0.16, α=0.05); [b]1-β=0.99 (R^2=0.18, α=0.05); [c]1-β=0.80 (R^2=0.07, α=0.10); [d]1-β=0.80 (R^2=0.06, α=0.10)*

DISCUSSION

Summary of Findings

In this study, we examined whether self-reported experiences of everyday versus institution-specific racial discrimination showed differing associations with AL and with self-reported health in a community sample of midlife Black women. There were four main findings: As hypothesized, we found (1) differential associations between everyday versus institution-specific discrimination and health and (2) divergent associations between institution-specific racial discrimination and AL versus self-reported health. However, contrary to our hypothesis, we found (3) that racial discrimination did not predict self-reported health and (4) a negative association between chronic (vs. moderate) exposure to institutional racial discrimination and AL. Women reporting "very high" levels of EOD had lower levels of AL whereas EDS showed no association. These findings suggest that factors associated with reporting a high burden of

institutional racial discrimination may contribute to lower subclinical disease risk for Black women, and that the underlying biological manifestation of chronic exposure within major institutions may diverge from associations with health perception.

EOD and AL

Similar to our initial study,[202] AL was lower among those reporting chronic institution-specific racial discrimination. Likewise, prior studies have shown inverse associations between adverse life experiences and biological stress reactivity.[338-340] Carpenter et al. (2007) demonstrated that childhood maltreatment predicted decreased adrenocorticotropin hormone and cortisol reactivity in adults.[339] Lovallo and colleagues (2012) found an inverse dose-dependent effect of adverse life events on cortisol levels and heart rate.[338] We cannot make inferences about stress reactivity patterns due to the cross-sectional nature of our study. However, our finding provides support for the notion that reporting chronic racial discrimination may promote a blunted stress-response for Black women.

The paradoxical relationship between reporting high levels of racial discrimination and a reduced stress-response has been previously reported.[38,141,145,202] Krieger and Sidney (1996) showed that working-class Blacks reporting the highest frequency of EOD had lower risk of elevated systolic blood pressure, and the effect was stronger for women.[145] This buffered response related to racial discrimination has also emerged for cardiovascular disease risk among Whites reporting an implicit bias connecting themselves to being a target of racial discrimination.[38] Scholars suggest that positive perceptions of within-group racial identity, as well as attributing negative experiences to systemic racism versus self-blame, may be health-protective.[58,341-346]

Conversely, stress theory posits a biopsychosocial mechanism by which one's appraisal of a recurrent threat, perceived resources, and working memory of previous exposures can result in a reduced (i.e. maladaptive) stress-response.[203,334,347-349] Inadequate reactivity to stressors can be health-damaging long-term via hyperactivity of supplementary mediators.[203] Indeed, in comparing the distributions of at-risk biomarkers within our sample, women taking cardiometabolic medications were at higher risk than non-medication users (Appendix 3.E). This interpretation proposes a deleterious biopsychosocial pathway. Since Black women show the highest predicted AL compared to other racial/gender groups, an attenuated value could erroneously appear normal or 'healthy', masking the harmful changes in regulatory systems.[108,203,334] Further within-racial group longitudinal studies may help disentangle healthy versus unhealthy stress-response mechanisms associated with racial discrimination.

EDS and AL

Contrary to previous work, we did not find an association between everyday discrimination and AL, which could be explained by our EDS scale explicitly attributing the unfair treatment to one's race/ethnicity.[350] Four recent publications found positive associations between everyday discrimination and AL using similar versions of the EDS.[30,317,351,352] However, these studies measured general unfair treatment as opposed to experiences of discrimination attributed to race/ethnicity. A meta-analysis including 30 years of studies examining chronic psychosocial factors and acute physiologic responses found that stress reactivity is contingent on the specific nature of the psychosocial exposure.[353] Research shows that most Blacks attribute their discrimination experiences to race/ethnicity (vs. other social identities),[38,351,354,355] report racial

discrimination as a predominant psychosocial stressor,[123,145,352,354,356] and report more chronic experiences (vs. Whites).[38,355] Thus, our result may be partly representing the unique embodiment of routine race-based discrimination for Black women as opposed to more general discriminatory exposures. Additionally, commonplace stressors become highly predictable and less stressful resulting in a diminished stress-response (e.g. military parachute-training).[357] This may help explain why daily racial discrimination showed no association with AL in our study versus studies measuring less predictable unfair treatment, such as getting housing.

EOD, EDS & Self-Reported Health

Our divergent finding from the literature of a null racial discrimination—self-reported health association for both EOD and EDS could be explained by our restricted sample of middle-aged Black women. Racial discrimination levels likely did not vary enough between self-reported health categories to detect adjusted associations. Prior studies have demonstrated positive EDS associations with self-reported health comparing Blacks to Whites, comparing men to women, and based on estimates adjusted for age and gender.[49,126,241] Findings related to institution-specific racial discrimination are more disparate: EOD has predicted worse self-reported health among US Black CARDIA study participants[138] yet showed no association among US-born nor foreign-born Blacks in Boston.[213] Subtle differences in study sample composition likely contribute to such varied results. Our finding adds to this literature by demonstrating no within-group differences among Bay Area Black women reporting any exposure to everyday or institutional racial discrimination. More importantly, findings suggest that racism-related self-perceived health may differ from actual disease risk, which, if further validated, could contribute substantially to our understanding of racial health disparities.

LIMITATIONS AND STRENGTHS

There are several methodological considerations for this research. First, our cross-sectional design limits causal inference yet provides important evidence that may help inform future work in this area. We recruited a non-probability sample intended to maximize variability in the exposure. Findings are not generalizable. However, our sample's distribution of covariates was largely comparable to midlife Black women living in the same counties in the 2013 American Community Survey.[358] Next, our utilization of two well-validated, reliable discrimination scales for exposure assessment strengthened the study's internal validity while also allowing for comparability of our results with other studies. The EDS and EOD measures were highly but not perfectly correlated (r=0.74)[288] showing that, conceptually, they are capturing different experiences and are not interchangeable (see Appendices 3.D & 3.F). Moreover, collapsing summary scores of discrimination responses into 5 categories across multiple life domains risks misclassifying those with highly frequent experiences in just one or two domains (e.g. being called names "almost everyday") as low risk when such exposure frequency could be considered chronic. Nevertheless, constructing discrimination categories was supported by our sensitivity analysis comparing continuous and quintile-based exposure variables, which provided evidence that there were no linear or meaningful distribution-based associations (see Appendices 3.G-I). Patterns of qualitative-based versus distribution-based EDS and EOD measures showed no agreement (0% & 13% respectively; see Appendix 3.J), suggesting that qualitative categories may better represent conceptual increases in exposure. Further, exposure and outcome misclassification due to poor recall is a fundamental limitation to any observational design using self-report. Last, we greatly reduced potential misclassification of physical health by using biomarkers for AL assessment.

CONCLUSION

This study provides preliminary evidence that institutional racial discrimination may contribute to physiologic stress-regulation for midlife Black women regardless of self-perceived health status. These findings introduce the potential utility of allostatic load as a clinical tool to assess Black women's underlying health risk. Further, policy and program interventions addressing institutional racism may help mitigate chronic disease disparities. Additional research is needed to elucidate mediators and moderators that buffer the physiologic consequences of racial discrimination, particularly within major social institutions with a focus on Black women taking medication to manage high cardiometabolic risk.

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CO-AUTHORS AND AFFILIATIONS

Elizabeth K Michaels[a], Alexis Nicole Reeves[a], Uche Okoye[a], Melisa M Price[a], Rebecca E Hasson[b], David H Chae[c], Amani M Allen[a]

[a]Division of Epidemiology, School of Public Health, University of California, Berkeley, 2121 Berkeley Way #5302, Berkeley, CA, 94720-7360, USA

[b]University of Michigan, 1402 Washington Heights, Ann Arbor, MI, 48109-2029, USA

[c]Auburn University, 210 Spidle Hall, Auburn, AL, 36849, USA

Conclusion and Future Research

Structural racism is widely considered a fundamental cause of US racial health disparities. A large body of public health research examining the link between racism and health has applied a stress paradigm to understand how racial discrimination is embodied; however, the effects of structural racism are not adequately captured under frameworks that require exposures to be "perceived". Structural racism can cause racial differences in health that an at-risk population may not consciously observe, for instance through US law enforcement policies that contribute to Black-White disparities in police homicide rates as demonstrated in this dissertation. Social and institutional policies and practices have the potential to make wide-ranging impacts that can worsen or improve population health outcomes for Blacks and racial minorities more broadly. Study designs utilizing policy-level indicators of structural racism are urgently needed.

Targeting underlying structural-level racist policies, practices, and norms that perpetuate and exacerbate Black-White disparities in morbidity, mortality, and life expectancy is a considerable challenge for epidemiologic researchers. Because structural racism can cause racial differences in health that unfairly advantage Whites and disadvantage Blacks over the life course and across generations, there are infinite mechanisms by which Black-White gaps can be generated and reinforced. Researchers are therefore tasked to find innovative ways to better operationalize aspects of structural racism, conceptualize complex mechanisms (e.g. intergenerational effects, ecosocial theory), develop standardized approaches, advance new statistical modeling strategies, and identify likely forms of racism that may reinforce one another.

This research identified several novel institutional policies and practices that may mitigate racial disparities. Avoidable Black killings may be reduced if police agencies (a) evaluate officer threat appraisal of Blacks, especially those who are older or may have mental illness, (b) use external organizations to conduct departmental research, and (c) hire more officer supervisors and full-time personnel. Too, social institutions promoting policies and norms aimed at addressing racial bias and discrimination may help prevent stress-related chronic disease risk among Blacks.

Future research should focus on the improvement in measurement of structural racism, specifically on the development of standardized measures across various types of exposures (e.g. anti-racist policies, intergenerational drag), and its translation into practice. Epidemiologic study designs should include different spatial and time scales (e.g. historical period, birth cohort, geographic location, critical period) to better understand the impact of racism over the life course. Moreover, applying advanced epidemiologic methodology to statistical analysis would improve our ability to make valid causal inference using strategies such as case-only design, simulation modeling, time and place assessments (e.g. difference-in-difference), and complex modeling of intergenerational effects across multigenerational inequalities.

Epidemiologic evidence shows that racial disparities persist despite our best efforts. Eradicating the negative health consequences of structural-level racial inequality requires a fundamental cause and ecosocial approach using a life course perspective that has generational implications. Therefore, more empirical studies and peer-reviewed literature investigating the long-term mechanistic health effects of social and institutional policy and practices are needed to not only reduce disparities by race/ethnicity and health, but to improve population health as a whole.

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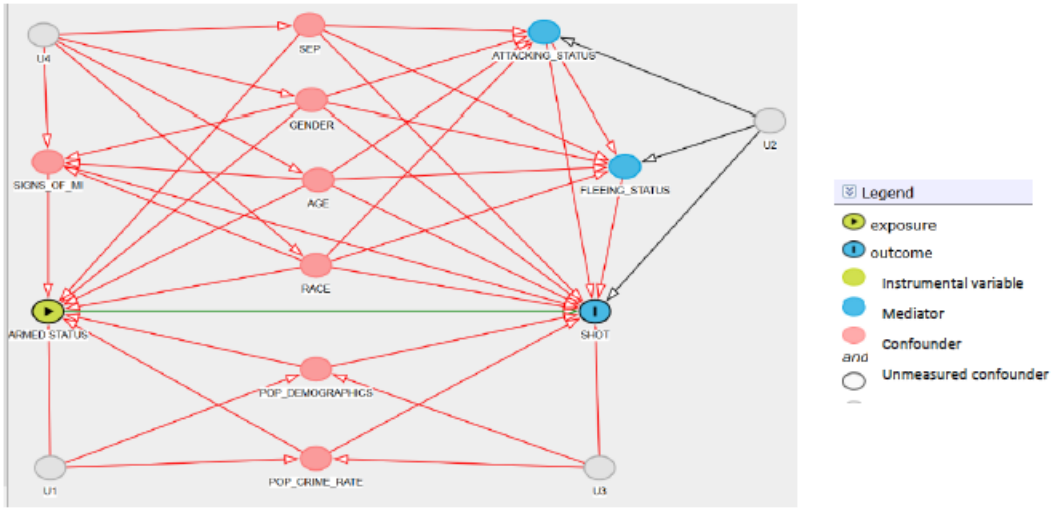
Appendices

Appendix 1.A. Directed acyclic graph for working knowledge of being armed and shot by US law enforcement during 2015-2018

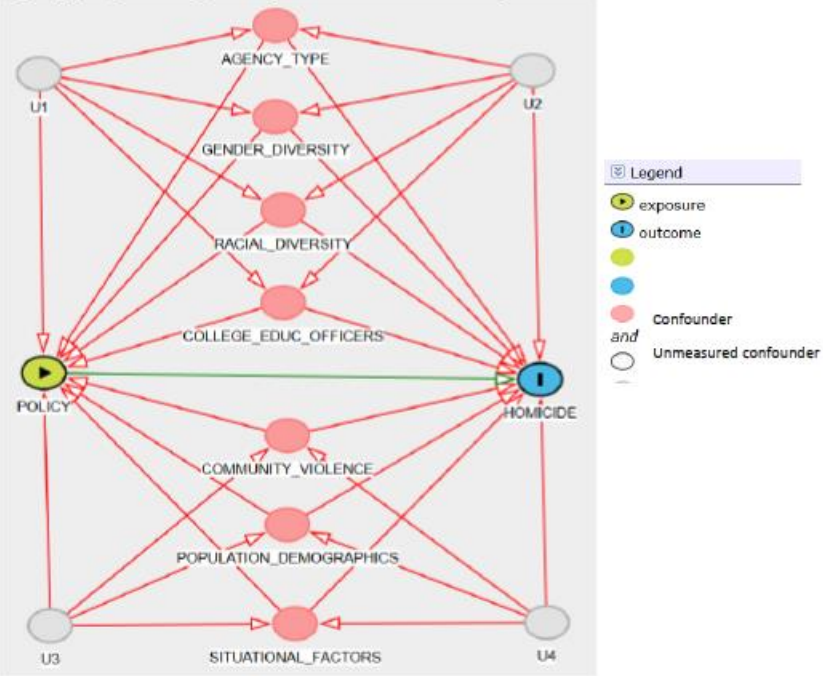


Appendix 1.B. Unadjusted relative odds of being Black among unarmed men shot by US law enforcement 2015-18 in WaPo, and estimates stratified by covariates (*N=2,442*)

Black X Unarmed	**OR**	**LB 95% CI**	**UB 95% CI**	**MH X^2**
Unadjusted	1.89	1.38	2.59	--
Age				0.04
≤24	1.23	0.65	2.00	
25-44	1.39	0.92	2.10	
≥45	4.17	1.64	10.33	
Mental Illness Signs				0.02
No	1.56	1.09	2.24	
Yes	3.68	1.81	7.39	
US Region/% Black				0.01
Midwest	2.56	0.62	12.27	
Northeast	3.19	1.53	6.50	
South	2.43	1.53	3.86	
West	0.60	0.27	1.24	

OR=odds ratio; CI=confident interval; LB=lower bound; UB=upper bound; MH X^2=Mantel-Haenszel chi-square test of homogeneity within strata

Appendix 2.A. Directed acyclic graph for working knowledge of law enforcement agency policy and being killed by US law enforcement during 2015-2016

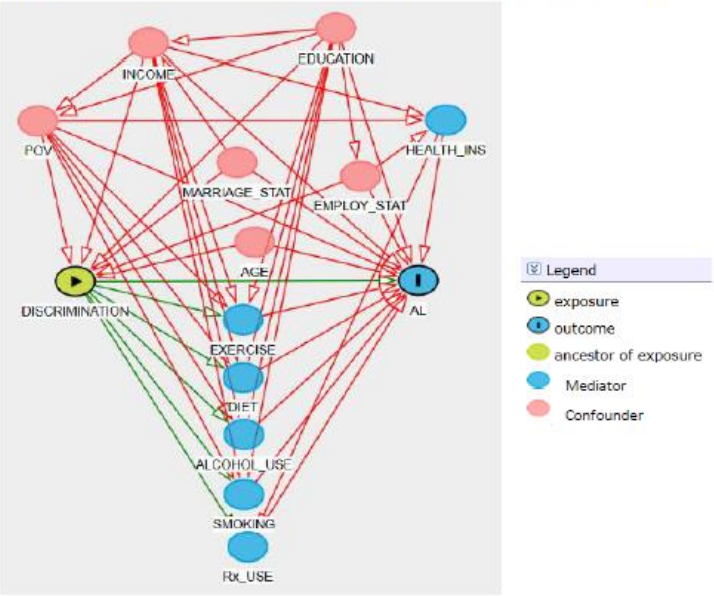


Appendix 2.B. Bivariate Analyses of US Law Enforcement Agency Policies (exposure) and The Counted Homicides during 2015-16 (outcome) with Covariates

	Agency type	US region	Percent BA/BS Degree	Percent female personnel	Percent full-time White personnel	Median age	Percent US native	Percent HS Diploma	Percent BA/BS Degree	Gini index	Median income (K)	Percent below poverty	Percent married	Percent owner occupied housing units	Violent crime rate (per 100K)
Bureaucratic control	P-value	P-value	P-value or *r*	P-value or *r*	P-value or *r*	P-value or *r*	P-value or *r*	P-value or *r*	P-value or *r*	P-value or *r*	P-value or *r*	P-value or *r*	P-value or *r*	P-value or *r*	P-value or *r*
Intermediate supervisors (#)	0.000	0.478	*r=-0.06*	*r=0.14*	*r=-0.09*	*r=-0.02*	*r=-0.13*	*r=-0.02*	*r=0.10*	*r=0.06*	*r=0.03*	*r=0.03*	*r=-0.10*	*r=-0.16*	*r=0.11*
First-line supervisors (#)	0.000	0.300	*r=-0.05*	*r=0.12*	*r=-0.09*	*r=-0.03*	*r=-0.17*	*r=-0.03*	*r=0.12*	*r=0.09*	*r=0.06*	*r=0.01*	*r=-0.09*	*r=-0.17*	*r=0.11*
Collective bargaining offered	0.000	0.000	0.900	0.139	0.550	0.339	0.000	0.232	0.890	0.772	0.120	0.629	0.293	0.009	0.060
Active collective bargaining	0.000	0.000	0.688	0.488	0.820	0.104	0.000	0.844	0.513	0.245	0.037	0.698	0.048	0.002	0.080
Any college education required	0.010	0.710	0.945	0.007	0.778	0.061	0.015	0.069	0.000	0.974	0.001	0.086	0.630	0.074	0.330
Minimum educational requirement	0.006	0.770	0.473	0.022	0.046	0.100	0.061	0.139	0.000	0.995	0.009	0.083	0.400	0.060	0.560
>=8 Hrs community policing training	0.020	0.794	0.411	0.152	0.684	0.450	0.843	0.620	0.690	0.481	0.530	0.678	0.462	0.242	0.596
Community evaluation used	0.021	0.524	0.709	0.000	0.854	0.812	0.008	0.181	0.000	0.751	0.030	0.104	0.092	0.009	0.151
Any statistical analysis	0.000	0.802	0.569	0.003	0.637	0.030	0.000	0.943	0.077	0.625	0.148	0.792	0.007	0.001	0.000
External statistical analysis *(n=431)*	0.085	0.192	0.922	0.009	0.190	0.135	0.949	0.988	0.202	0.965	0.805	0.352	0.003	0.278	0.007
Full-time personnel (%)	0.262	0.576	*r=-0.13*	*r=0.02*	*r=-0.07*	*r=-0.10*	*r=-0.12*	*r=0.02*	*r=0.12*	*r=0.02*	*r=0.06*	*r=-0.01*	*r=-0.08*	*r=-0.09*	*r=0.16*
Incentives	0.124	0.000	*r=-0.07*	*r=0.08*	*r=-0.17*	*r=-0.09*	*r=-0.37*	*r=-0.14*	*r=0.11*	*r=0.06*	*r=0.20*	*r=-0.07*	*r=-0.06*	*r=-0.20*	*r=0.12*
Mission statement	0.004	0.525	0.843	0.187	0.032	0.163	0.005	0.539	0.032	0.834	0.069	0.220	0.386	0.004	0.017
Less-lethal weapon authorized	0.603	0.000	*r=-0.05*	*r=0.05*	*r=0.12*	*r=-0.04*	*r=-0.16*	*r=0.05*	*r=0.12*	*r=-0.04*	*r=0.15*	*r=-0.13*	*r=0.04*	*r=-0.05*	*r=-0.05*
Additional training for new hires	0.148	0.387	0.430	0.790	0.358	0.706	0.508	0.121	0.033	0.621	0.231	0.219	0.695	0.202	0.973
Video use	0.423	0.069	*r=0.06*	*r=0.07*	*r=0.11*	*r=0.04*	*r=0.23*	*r=0.09*	*r=-0.02*	*r=-0.01*	*r=-0.11*	*r=0.02*	*r=-0.02*	*r=0.07*	*r=-0.03*
Agencies w/Homicides (N=480)	0.000	0.161	*r=0.10*	*r=0.13*	*r=-0.15*	*r=-0.11*	*r=-0.18*	*r=-0.11*	*r=0.08*	*r=0.09*	*r=0.02*	*r=0.05*	*r=-0.13*	*r=-0.22*	*r=0.20*
Agencies w/White Homicides (n=323)	0.000	0.110	*r=-0.12*	*r=-0.02*	*r=-0.03*	*r=-0.04*	*r=-0.08*	*r=-0.06*	*r=0.04*	*r=0.04*	*r=-0.01*	*r=0.04*	*r=0.09*	*r=-0.13*	*r=0.11*
Agencies w/Black Homicides (n=181)	0.136	0.607	*r=0.04*	*r=0.26*	*r=-0.19*	*r=-0.15*	*r=0.11*	*r=-0.07*	*r=0.13*	*r=0.08*	*r=0.01*	*r=0.05*	*r=-0.18*	*r=-0.23*	*r=0.27*

r=Pearson correlation coefficient (continuous-continuous variables); ANOVA F-test (continuous-categorical variables); Chi-square test (categorical-categorical variables)

Appendix 3.A. Directed acyclic graph for working knowledge of racial discrimination and allostatic load



Appendix3.B. Frequency (%) of Racial Discrimination (EDS Scale) among AAWHHS Participants (*N=207*)

Everyday Discrimination Domain	Never	<1/year	Few x/year	Few x/month	≥1/week	Almost everyday	≥1/year
You are treated with less courtesy than other people	24 (11.82)	25 (12.08)	66 (31.88)	39 (18.84)	27 (13.30)	26 (12.56)	158 (76.33)
You are treated with less respect than other people	35 (16.91)	30 (14.49)	57 (27.54)	32 (15.46)	25 (12.08)	28 (13.53)	142 (68.60)
You receive poorer service than other people at restaurants or stores	28 (13.53)	43 (20.77)	57 (27.54)	37 (17.87)	19 (9.18)	23 (11.11)	136 (65.70)
People act as if they think you are not smart	49 (23.67)	35 (16.91)	48 (23.19)	21 (10.14)	28 (13.53)	26 (12.56)	123 (59.42)
People act as if they are afraid of you	69 (33.33)	33 (15.94)	32 (15.46)	26 (12.56)	22 (10.63)	25 (12.08)	105 (50.73)
People act as if you are dishonest	64 (30.92)	43 (20.77)	38 (18.36)	20 (9.66)	14 (6.76)	28 (13.53)	100 (48.31)
People act as if they're better than you are	26 (12.56)	24 (11.59)	45 (21.74)	40 (19.32)	25 (12.08)	47 (22.71)	157 (75.85)
You are called names or insulted	95 (45.89)	41 (19.81)	34 (16.43)	12 (5.80)	12 (5.80)	13 (6.28)	71 (34.30)
You are threatened or harassed	118 (57.00)	33 (15.94)	23 (11.11)	10 (4.83)	9 (4.35)	14 (6.76)	56 (27.05)
You are followed around in stores	46 (22.22)	37 (17.87)	61 (29.47)	18 (8.70)	17 (8.21)	28 (13.53)	124 (59.90)

AAWHHS=African American Women's Heart & Health Study

Appendix3.C. Frequency (%) of Racial Discrimination (EOD Scale) among AAWHHS Participants (*N=207*)

Experience of Discrimination Domain	Never	Once	2-3 times	4-5 times	≥6 times	≥1 experiences
At school	82 (39.61)	23 (11.11)	55 (26.57)	17 (8.21)	30 (14.49)	125 (60.39)
Getting hired or getting a job	73 (35.27)	33 (15.94)	52 (25.12)	22 (10.63)	27 (13.04)	134 (64.73)
At work	69 (33.33)	34 (16.43)	56 (27.05)	22 (10.63)	26 (12.56)	138 (66.67)
Getting housing	102 (49.28)	23 (11.11)	40 (19.32)	14 (6.76)	28 (13.53)	105 (50.72)
Getting medical care	127 (61.35)	15 (7.25)	30 (14.49)	13 (6.28)	22 (10.63)	80 (38.65)
Getting credit, bank loans, or a mortgage	95 (45.89)	15 (7.25)	47 (22.71)	13 (6.28)	37 (17.87)	112 (54.11)
On the street or in a public setting	57 (27.54)	32 (15.46)	70 (33.82)	17 (8.21)	31 (14.98)	150 (72.46)
From the police or in the courts	69 (33.33)	45 (21.74)	44 (21.26)	22 (10.63)	27 (13.04)	138 (66.67)

AAWHHS=African American Women's Heart & Health Study

Appendix 3.D. Bivariate Analyses for Exposure-to-Exposure, Outcome-to-Outcome, and Exposure-to-Outcome Differences and Correlations among AAWHHS Participants (*N=207*)

Variable	**Allostatic Load**			**Self-reported Health**			Pearson's *r*	
Discrimination	β	95% CI	P-value	Good *n (%)*	Not Good *n (%)*	P-value	**AL**	**EDS**
EDS			0.307			0.400	-0.0127	—
None	-0.126	(-1.048, 0.796)		41 (26)	18 (35)			
Low	-0.839	(-1.738, 0.060)		52 (33)	13 (25)			
Moderate (ref)	—			30 (19)	8 (16)			
High	-0.585	(-1.725, 0.556)		21 (14)	5 (10)			
Very High	-0.595	(-1.841, 0.650)		12 (8)	7 (14)			
EOD			0.040			0.721	-0.0950	0.7430
None	0.729	(-0.362, 1.819)		16 (10)	6 (12)			
Low	-0.517	(-1.279, 0.244)		55 (35)	16 (31)			
Moderate (ref)	—			49 (31)	14 (27)			
High	-0.260	(-1.249, 0.728)		22 (14)	7 (14)			
Very High	-1.226	(-2.316, -0.135)		14 (9)	8 (16)			
Self-reported Health	*(μ)*		0.694					
Good *(n=156)*	5.917	(5.566, 6.268)		—	—	—	—	—
Not Good *(n=51)*	6.098	(5.481, 6.715)		—	—	—	—	—

AAWHHS=African American Women's Heart & Health Study; *EDS=Everyday Discrimination Scale; EOD=Experiences of Discrimination Scale; AL=allostatic load; SRH=self-reported health;* β=beta coefficient; μ=mean*; CI=confidence interval*

Appendix 3.E. Sample Distribution of At-risk Biomarkers by Medication (Med) Use among AAWHHS Participants (*N=207*)

At-Risk	Full *(N=207)*	No Meds *(N=157)*	Meds *(N=50)*	
System	***n (%)***			***P-value***
CV				
DBP	104 (50)	58 (37)	46 (92)	0.001
SBP	112 (54)	66 (42)	46 (92)	0.001
Inflammatory				
IL6	57 (28)	46 (29)	11 (22)	0.314
CRP	103 (50)	72 (46)	31 (62)	0.047
Neuroendocrine				
Cortisol	54 (26)	35 (22)	19 (38)	0.028
Epi	51 (25)	40 (25)	11 (22)	0.619
Norepi	51 (25)	36 (23)	16 (32)	0.165
Metabolic				
HDL	87 (42)	61 (39)	19 (38)	0.508
LDL	84 (41)	62 (40)	22 (44)	0.572
Tri	15 (7)	8 (5)	5 (10)	0.388
Cholesterol	138 (67)	106 (68)	33 (66)	0.842
BMI	179 (86)	135 (86)	43 (86)	0.911
Waist	151 (73)	109 (70)	41 (82)	0.098
Glucose	40 (19)	23 (15)	17 (34)	0.003
A1c	40 (19)	27 (17)	15 (30)	0.028

AAWHHS=African American Women's Heart & Health Study; CV=cardiovascular

Appendix 3.F. Chi-square Test of Homogeneity for Qualitative-based Reports of EDS and EOD among AAWHHS Participants *(N=207)*

Discrimination	**EOD**					
EDS	*None*	*Low*	*Moderate*	*High*	*Very High*	Total
None	19	31	8	1	0	59
Low	2	31	23	8	1	65
Moderate	0	6	19	8	5	38
High	1	2	9	10	4	26
Very High	0	1	4	2	12	19
Total	22	71	63	29	22	207

AAWHHS=African American Women's Heart & Health Study; EDS=Everyday Discrimination Scale; EOD=Experiences of Discrimination Scale; Pearson chi2(16)=151.5538; P=0.000

Appendix 3.G. Sensitivity Analysis: Linear Regression of Allostatic Load and Logistic Regression of Self-Reported Health by Linear EDS and EOD among AAWHHS Participants (*N=207*)

Variable	**Allostatic Load**				**Self-reported Health**			
	EDS		**EOD**		**EDS**		**EOD**	
	β	(95% CI)	β	(95% CI)	OR	(95% CI)	OR	5% CI)
Discrimination	-0.003	(-0.026, 0.019)	-0.018	(-0.053, 0.016)	0.998	(0.974, 1.022)	1.018	(0.981, 1.056)
Age	**0.078	(0.026, 0.130)	**0.082	(0.029, 0.134)	0.953	(0.899, 1.001)	0.949	(0.895, 1.006)
≤ High School Diploma	**1.085	(0.417, 1.753)	**1.029	(0.352, 1.706)	1.496	(0.741, 3.019)	1.606	(0.784, 3.292)
Not Employed	-0.407	(-1.033, 0.220)	-0.372	(-0.999, 0.255)	1.393	(0.692, 2.805)	1.328	(0.657, 2.684)
≤ 100% Federal Poverty	0.443	(-0.328, 1.214)	0.478	(-0.294, 1.249)	1.889	(0.871, 4.098)	1.834	(0.841, 4.000)
Not Married/Partnered	0.216	(-0.446, 0.877)	0.210	(-0.445, 0.866)	0.923	(0.445, 1.914)	0.912	(0.442, 1.899)
Taking CV Meds	*0.931	(0.158, 1.704)	*0.939	(0.168, 1.711)	*2.679	(1.205, 5.954)	*2.684	(1.205, 5.975)
Taking DM Meds	**1.799	(0.516, 3.083)	**1.763	(0.480, 3.045)	0.828	(0.190, 3.611)	0.883	(0.204, 3.824)

*AAWHHS=African American Women's Heart & Health Study; EDS=Everyday Discrimination Scale; EOD=Experiences of Discrimination Scale; CV=Cardiovascular; DM=Diabetes Mellitus; β=beta coefficient; OR=odds ratio; CI=confidence interval; *p<0.05; **p<0.01; Referent group: Moderate; High-risk covariates reported*

Appendix 3.H. Distribution-based Reports of Racial Discrimination among AAWHHS Participants (*N=207*)

Racial Discrimination	***n***	***%***
Everyday Discrimination Scale		
None (Q1)	45	21.74
Low (Q2)	40	19.32
Moderate (reference) (Q3)	42	20.29
High (Q4)	42	20.29
Very High (Q5)	38	18.36
Experiences of Discrimination Scale		
None (Q1)	49	23.67
Low (Q2)	44	21.26
Moderate (reference) (Q3)	41	19.81
High (Q4)	34	16.43
Very High (Q5)	39	18.84

AAWHHS=African American Women's Heart & Health Study

Appendix 3.I. Sensitivity Analysis: Linear Regression of Allostatic Load and Logistic Regression of Self-Reported Health by Distribution-based EDS and EOD among AAWHHS Participants (*N=207*)

Variable	Allostatic Load				Self-reported Health			
	EDS		EOD		EDS		EOD	
Discrimination	β	(95% CI)	β	(95% CI)	OR	(95% CI)	OR	(95% CI)
None (Q1)	0.342	(-0.623, 1.306)	-0.374	(-1.249, 0.500)	2.367	(0.805, 6.954)	0.932	(0.331, 2.622)
Low (Q2)	0.241	(-0.727, 1.210)	-0.007	(-0.956, 0.943)	1.577	(0484, 5.135)	0.877	(0.296, 2.596)
Moderate (Ref. Q3)	†4.972	—	†5.463	—	1.000	—	1.000	—
High (Q4)	0.730	(-0.244, 1.705)	0.007	(-0.944, 0.958)	1.505	(0.486, 4.658)	1.286	(0.424, 3.898)
Very High (Q5)	-0.110	(-1.094, 0.873)	-0.703	(-1.671, 0.265)	2.079	(0.678, 6.371)	1.088	(0.362, 3.277)
Age	**0.074	(0.021, 0.127)	**0.081	(0.028, 0.135)	0.950	(0.896, 1.008)	0.950	(0.896, 1.008)
≤ High School Diploma	**1.090	(0.402, 1.778)	**1.023	(0.340, 1.705)	1.285	(0.616, 2.680)	1.569	(0.761, 3.233)
Not Employed	-0.440	(-1.070, 0.190)	-0.333	(-0.969, 0.303)	1.510	(0.735, 3.102)	1.340	(0.657, 2.734)
≤ 100% Federal Poverty	0.447	(-0.322, 1.217)	0.556	(-0.224, 1.336)	1.900	(0.872, 4.141)	1.896	(0.862, 4.172)
Not Married/Partnered	0.255	(-0.408, 0.918)	0.178	(-0.482, 0.835)	0.876	(0.416, 1.844)	0.911	(0.438, 1.892)
Taking CV Meds	*0.934	(0.155, 1.713)	*0.918	(0.145, 1.692)	*2.741	(1.211, 6.206)	*2.640	(1.181, 5.900)
Taking DM Meds	**1.849	(0.566, 3.132)	**1.768	(0.478, 3.058)	0.833	(0.188, 3.689)	0.881	(0.201, 3.869)

*AAWHHS=African American Women's Heart & Health Study; EDS=Everyday Discrimination Scale; EOD=Experiences of Discrimination Scale; CV=Cardiovascular; DM=Diabetes Mellitus; β=beta coefficient; OR=odds ratio; CI=confidence interval; †=estimated mean allostatic load; *p<0.05; **p<0.01; Referent group: Moderate; High-risk covariates reported*

Appendix 3.J. Kappa Tests for Qualitative-based and Distribution-based Reports of EDS and EOD among AAWHHS Participants (*N=207*)

Discrimination	% Agreement	Kappa	P-value
EDS	0.00	-0.17	1.00
EOD	12.56	-0.08	1.00

AAWHHS=African American Women's Heart & Health Study; *EDS=Everyday Discrimination Scale; EOD=Experiences of Discrimination Scale*