



Journal of Health Disparities Research and Practice

Volume 11, Issue 2, Summer 2018, pp. 190-206

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Measuring Inequity: A Systematic Review of Methods Used to Quantify Structural Racism

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ABSTRACT

Objective: To summarize the ways in which researchers have quantified measures of structural racism for the purposes of empirical, quantitative investigation of its associations with physical and mental health outcomes.

Methods: Systematic review of literature published January 1, 2007-December 31, 2017. We searched PubMed and EMBASE databases for studies conducted in the last ten years including at least one of the following search terms in the title or abstract: “structural racism”, “systemic racism”, “institutional racism”, “institutionalized racism”. Excluded studies were not original research, not US based, did not quantify an explicitly named indicator of structural racism, or were qualitative designs. Data from full text articles were abstracted and synthesized.

Results: Twenty articles met the final inclusion criteria. Articles included measures of structural racism within the following domains, in order of frequency: residential neighborhood/housing, perceived racism in social institutions, socioeconomic status, criminal justice, immigration and border enforcement, political participation, and workplace environment. Many measures included were chosen by authors due to availability of public data which was analyzed in the context of differential experiences attributed to structural racism, while others relied on participant survey responses. Impacts of structural racism on health were evaluated by matching observed health disparities to racialized differences in exposure to spectra of structural racism.

Conclusions: A burgeoning body of work suggest ways to operationalize and measure structural racism in US society for the purposes of exploring its impacts on individual and population health inequities.

Keywords: Structural racism; racism; structural determinants of health; health outcomes

Journal of Health Disparities Research and Practice Volume 11, Issue 2, Summer 2018

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INTRODUCTION

Vast racial inequities in health have endured in the United States since the country's founding.(Feagin & Bennefield, 2014; Krieger & Bassett, 1986) The privileges associated with whiteness and white racial dominance in the US are evident in the unequal distributions of a broad range of health-promoting resources and opportunities, neighborhood and social conditions, and generational accumulation of wealth.(Malat, Mayorga-Gallo, & Williams, 2017) The result is an advantage favoring whites over non-whites by most measures of population health.(Malat et al., 2017) Decades of medical and public health research have documented their magnitude and persistence,(Heckler, 1985; Statistics, 2016) but the fundamental reasons underlying racial inequities in health and, relatedly, how to eliminate their occurrence remain elusive.

Nearly 20 years ago, Dr. Camara Phyllis Jones published the *Gardener's Tale*.(Jones, 2000) a now widely-known allegory for understanding how racism operates on multiple levels to negatively impact the health of people of color and perpetuate racial inequities. Dr. Jones' allegory uses gardening as a way to demonstrate the observed impacts of racism—flowers grown in rich soil with proper care will flourish, while genetically identical flowers grown in poor or leached soil will wither. Work such as this and others(Jones, 2002; Krieger, 1999, 2012; Williams & Mohammed, 2013) have helped to advance theoretic frameworks and generate new hypotheses for understanding structural racism as the totality of ways in which societies foster racial discrimination via mutually reinforcing inequitable systems (e.g. housing, education, employment, earnings, benefits, credit, media, health care, criminal justice, etc.) that in turn reinforce discriminatory beliefs, values, and distribution of resources reflected in history, culture, and interconnected institutions.(Bailey et al., 2017)

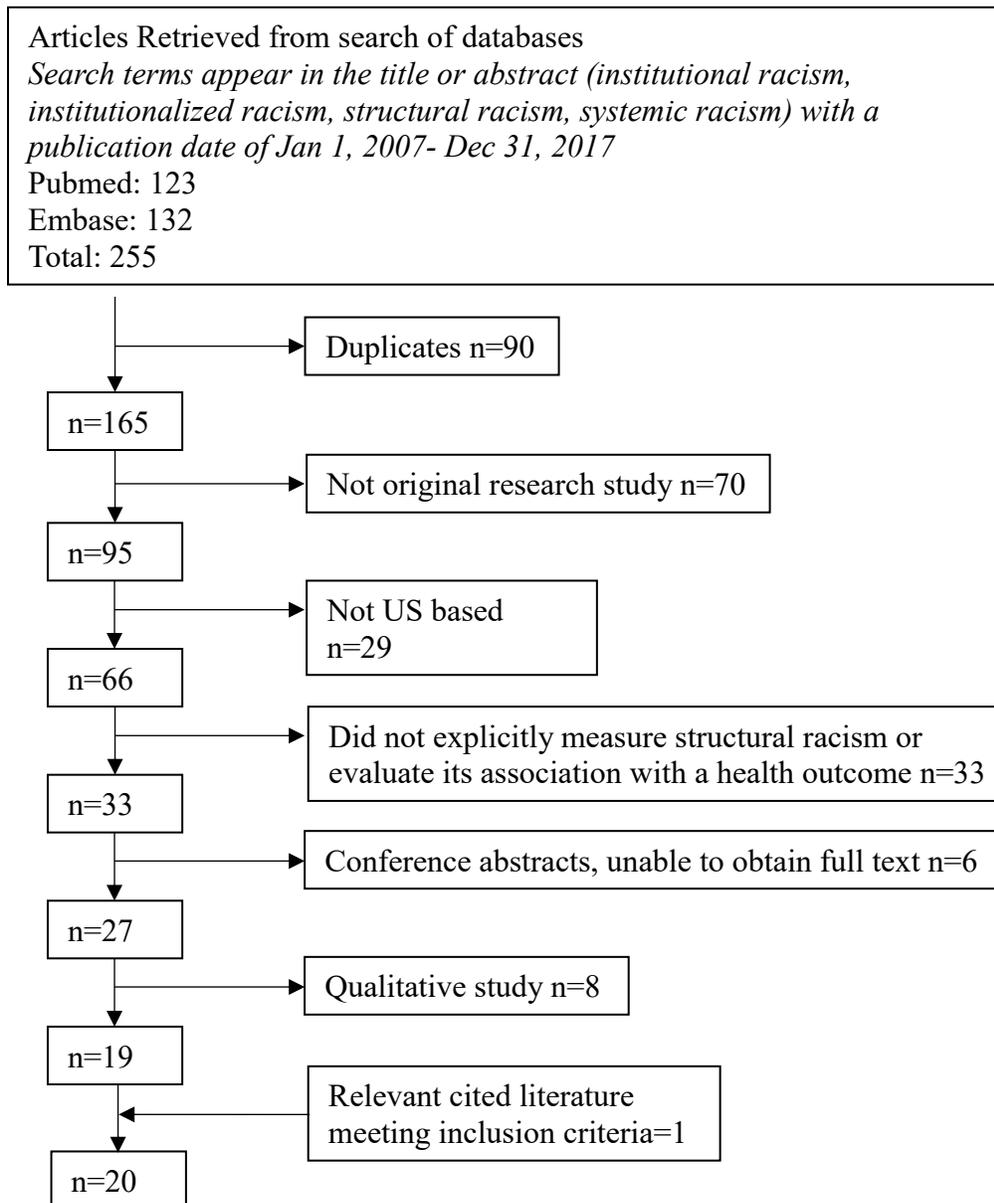
Yet to date, the literature on racism's effects on health has been dominated by individual-level perceptions of discrimination or unfair treatment in interactions with other (usually white) individuals, exposures commonly measured by self-report using validated survey instruments.(Krieger, Smith, Naishadham, Hartman, & Barbeau, 2005; McNeilly et al., 1996)

Lag in research on structural racism as a root cause of health inequities may be due, in part, to difficulties in measuring or quantifying the degree to which it exists within a community or society. Empirical evidence of the relationship between structural racism and population health inequity requires a quantifiable measurement of the phenomenon for the purposes of causal modeling. Such a measurement may depend on spatiotemporal scale, historical context, and/or the domain in which it is occurring,(Krieger, 2014) and thus there may not be a universal, single best or “gold standard” operationalization of structural racism. However, valid, replicable and theoretically sound measures of structural racism are urgently needed in order to build evidence of its harms to population health and to identify pathways for intervention to advance racial health equity. The aim of this review was to identify the various ways in which researchers have begun quantifying exposure to structural racism for the purpose of evaluating its association with health outcomes.

METHODS

Our review methods followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Figure 1).

Figure 1. Article identification flowchart



Data Sources and Searches

We conducted systematic literature searches of the PubMed and Embase databases for articles dated January 1, 2007 – December 31, 2017. While there may be important distinctions in definitions of structural racism and institutional racism, (Bailey et al., 2017) many academics and non-academics use the terms interchangeably. Therefore, for the purpose of this review, we searched for the following terms in each database: *structural racism*, *systemic racism*, *institutional racism*, *institutionalized racism*. We searched for these phrases with adjacent terms in both the title and the abstract of the databases. Date of last search was 05/04/2018. To complement these searches, we reviewed relevant cited articles within the primarily identified articles to determine eligibility.

Study Selection

Original research studies analyzing associations between *explicitly named* and quantified measures of structural racism and health outcomes were the target of this review. We included studies that used quantitative measurements of structural racism for the purposes of testing its effects on a physical or mental health outcome. We excluded publications with the following characteristics:

1. Those that were not original research studies, including systematic reviews, commentaries, and those that described or proposed theoretic frameworks or conceptual models for the study of structural racism but with no empirical data.
2. Those conducted in countries outside of the US, given the historically-established and contemporary perpetuation of racial hierarchy unique to this society.
3. Those that did not quantify an indicator of structural racism or evaluate its association with a health outcome (articles that discussed structural racism broadly as a possible cause underlying their primary findings, for example).
4. Published conference abstracts without full text available, therefore lacking sufficient detail on measurements.
5. Qualitative studies. While these studies provide useful insight for ways to conceptualize and operationalize structural racism, they were excluded for the purpose of this review of quantitative measures.

We used EndNote (Thompson Reuters, New York, NY), a citation management software system, to organize and manage our citation database for the review. EndNote enabled us to de-duplicate the individual searches and document the dates on which each article was identified. Following exclusion criteria, articles were qualitatively reviewed in full to ensure eligibility for inclusion, and those that did not fit the purpose of the study were removed and categorized into the inclusion flowchart.

Data Abstraction and Analysis

Data from the final set of included articles (n=20) were compiled in an excel spreadsheet, with categories as follows: study year, authors, title, study location, racial comparisons, domain or system (e.g. criminal justice, residential neighborhood, workplace, etc.), variables used in structural racism measure, variable data source, operationalization of variables, primary outcome of interest, and other relevant notes. We quantified the number of studies by type and domain. We include descriptive reports of the structural racism measures reported by each publication retained for inclusion.

RESULTS

Measures of Structural Racism

Of the 237 abstracts identified, 20 met the final inclusion criteria (Figure 1). (Albert et al., 2010; Gee, 2008; Greer, Brondolo, & Brown, 2014; Greer & Spalding, 2017; Jacoby, Dong, Beard, Wiebe, & Morrison, 2017; Krivo, Peterson, & Kuhl, 2009; Lukachko, Hatzenbuehler, & Keyes, 2014; McCluney, Schmitz, Hicken, & Sonnega, 2017; Mendez, Hogan, & Culhane, 2011; Mendez, Hogan, & Culhane, 2013, 2014; Patler & Laster Pirtle, 2017; Sabo et al., 2014; Scott et al., 2014; Seaton, 2010; Vines & Baird, 2009; M. Wallace, Crear-Perry, Richardson, Tarver, & Theall, 2017; M. E. Wallace, Mendola, Liu, & Grantz, 2015; Zhou, Bemanian, & Beyer, 2017) Among these, structural racism was quantified within the contexts (domains) of residential housing patterns (n=8), (Chambers, Erausquin, Tanner, Nichols, & Brown-Jeffy, 2017; Gee, 2008; Jacoby et al., 2017; Krivo et al., 2009; Mendez et al., 2011; Mendez et al., 2013, 2014; Zhou et al., 2017) perceptions of structural racism in social institutions broadly (n=6), (Albert et al., 2010; Greer et al., 2014; Greer & Spalding, 2017; Scott et al., 2014; Seaton, 2010; Vines & Baird, 2009) socioeconomic status (n=3), (Lukachko et al., 2014; M. Wallace et al., 2017; M. E. Wallace et al., 2015) criminal justice (n=4), (Chambers et al., 2017; Lukachko et al., 2014; M. Wallace et al., 2017; M. E. Wallace et al., 2015) immigration and border enforcement (n=2), (Patler & Laster Pirtle, 2017; Sabo et al., 2014) political participation (n=2) (Chambers et al., 2017; Lukachko et al., 2014), and workplace (n=1) (McCluney et al., 2017) (Table 1). The two publications utilizing immigration and border enforcement policies as indicators of structural racism focused on their health impacts among Latino individuals. (Patler & Laster Pirtle, 2017; Sabo et al., 2014) One publication focused on home mortgage discrimination among Chinese Americans relative to whites. (Gee, 2008) The remaining publications utilized structural racism measures of black-white racial group comparisons and their impacts on black health outcomes or black-white health inequities.

Table 1 includes the measure of structural racism utilized by each article. Structural racism in residential housing patterns were most commonly evaluated, including indices of racial residential segregation and redlining – the practice of mortgage lending discrimination based on racial neighborhood composition and purposeful financial disinvestment in non-white neighborhoods (“red zones”). Jacoby et al. (Jacoby et al., 2017) utilized the 1937 Home Owner’s Loan Corporation redlining map of Philadelphia to classify 2010 Census tracts by the color-coded scheme of credit-worthiness (red zones vs blue, green, or yellow zones), representing historical place-based racial discrimination. In three related publications, Mendez et al. (Mendez et al., 2011; Mendez et al., 2013, 2014) estimated a contemporary census-tract level redlining index from Home Mortgage Disclosure Act (HMDA) data, representing the black-white disparity in odds of mortgage loan denial. Gee’s (Gee, 2008) version of the redlining index similarly utilized HMDA data to estimate tract-level odds of mortgage loan denial among Asians compared to whites. Using the same data source, Zhou et al. (Zhou et al., 2017) applied slightly different methodologies to estimate two indices, which they refer to as racial bias in mortgage lending (black-white odds of denial of a mortgage application) and residential redlining (odds of denial of the mortgage application in particular neighborhoods compared to others). Krivo et al. (Krivo et al., 2009) explored the index of dissimilarity – a quantifiable measure of racial residential segregation (Bureau, 2002) – and a neighborhood socioeconomic disadvantage index as indicators of structural racism.

Table 1. Description of included studies

First author	Domain(s)	Racial comparisons	Measure of structural racism
Albert(Albert et al., 2010)	Perceived racism in social institutions	black-white	Summary score of responses to three questions: if respondent ever treated unfairly (1) on the job (hiring, promotion, and firing); (2) in housing (renting, buying, and mortgage); and (3) by the police (stopped, searched, and threatened) because of their race.
Chambers (Chambers et al., 2017)	Political participation, criminal justice, residential segregation	Black-White	Compared traditional measures to novel measures of structural racism: Traditional: Dissimilarity index, delta index, isolation index Novel: Felony incarcerations, Racial composition of county board of supervisors
Gee(Gee, 2008)	Residential neighborhood/housing	Chinese Americans -white	Redlining index of mortgage discrimination
Greer(Greer et al., 2014)	Perceived racism in social institutions	black-white	Institutional racism subscale of the Index of Race-Related Stress-Brief Version (IRRS-B)
Greer(Greer & Spalding, 2017)	Perceived racism in social institutions	black-white	Institutional racism subscale of the Index of Race-Related Stress-Brief Version (IRRS-B)
Jacoby(Jacoby et al., 2017)	Residential neighborhood/housing	black-white	2010 Census tract color category based on the 1937 Home Owner's Loan Corporation redlining map
Krivo(Krivo et al., 2009)	Residential neighborhood/housing	black-white	Census tract socioeconomic disadvantage index and index of dissimilarity
Lukachko(Lukachko et al., 2014)	Political participation, socioeconomic status, criminal justice	black-white	Relative proportions of Blacks to Whites in each state who were >age 18 and registered to vote, who actually voted, and who were elected to the state legislature in the civilian labor force; who were >age 16 and were employed, who were in executive or managerial positions, and who were in professional specialties; who were >25 and had attained a bachelor's level degree or higher; who were incarcerated (jails and prisons), felony disenfranchised, or serving a death sentence.
McCluney(McCluney et al., 2017)	Workplace environment	black-white	Subjective (self-reported) and objective ratings of psychosocial workplace environment: opportunities for

			advancement, work recognized, autonomy, decision freedom, training support, supportive management
Mendez(Mendez et al., 2011)	Residential neighborhood/housing	black-white	Redlining index (black-white disparity in odds of mortgage loan denial by Census tract)
Mendez(Mendez et al., 2013)	Residential neighborhood/housing	black-white	Redlining index
Mendez(Mendez et al., 2014)	Residential neighborhood/housing	black-white	Redlining index
Patler(Patler & Laster Pirtle, 2017)	Immigration and border enforcement	Latino immigrant youth	Deferred Action for Childhood Arrivals (DACA) status
Sabo(Scott et al., 2014)	Immigration and border enforcement	US citizen and permanent residents of Mexican descent	Prevalence and type of perceived ethno racial profiling, frequency and location of sightings of immigration officials, and direct encounters with immigration officials, including immigration related detention
Scott(Scott et al., 2014)	Perceived racism in social institutions	black-white	Adapted scale by Diaz et al. to assess men's experience of racism and homophobia in the past year.
Seaton(Seaton, 2010)	Perceived racism in social institutions	black-white	Institutional racism subscale of the Index of Race-Related Stress (IRRS)
Vines(Vines & Baird, 2009)	Perceived racism in social institutions	black-white	Telephone-Administered Perceived Racism Scale (TPRS) items involving institutionalized forms of racism.
Wallace(M. E. Wallace et al., 2015)	Socioeconomic status, criminal justice	black-white	Relative proportions of blacks to whites in each state who were >age 16 and employed; who were >age 25 and had attained a bachelor's or higher degree; who were prison incarcerated.
Wallace(M. Wallace et al., 2017)	Socioeconomic status, criminal justice	black-white	Relative proportions of blacks to whites in each state who were >age 16 and employed, employed in professional occupations; who were >age 25 and had attained a bachelor's or higher degree; black to white ratios of median household income, prison incarceration and juvenile custody rates.
Zhou(Zhou et al., 2017)	Residential neighborhood/housing	black-white	Racial bias in mortgage lending index and residential redlining index

Chambers et al.(Chambers et al., 2017) focused on county-specific data and differentiated between “traditional” (residential segregation) and two “novel” domains of structural racism (political participation and judicial treatment). Residential segregation was assessed via indices of concentration (delta index), evenness (dissimilarity index) and exposure (isolation index),

while novel indicators were evaluated via ratio of Blacks/Whites incarcerated for a felony and ratio of Blacks/Whites elected to the county board of supervisors. Strength of association between each indicator and the health outcome was then tested, comparing traditional to novel indicators.

Six studies utilized self-reported responses to quantify individuals' lived experience of structural racism.(Albert et al., 2010; Greer et al., 2014; Greer & Spalding, 2017; Scott et al., 2014; Seaton, 2010; Vines & Baird, 2009) Three utilized items from the institutional racism subscale of the Index of Race-Related Stress brief or full version, which includes responses ranging from 0 (*this has never happened to me*) to 4 (*event happened and I was extremely upset*) with items such as “*you were refused an apartment or other housing*”.(Greer et al., 2014; Greer & Spalding, 2017; Seaton, 2010) Three additional studies used self-reported questionnaire responses.(Albert et al., 2010; Scott et al., 2014; Vines & Baird, 2009)

Lukachko et al.(Lukachko et al., 2014) quantified structural racism across political participation, socioeconomic status, and criminal justice domains by comparing the relative proportions of blacks to whites in each state who were registered to vote, who actually voted, and who were elected to the state legislature in the civilian labor force, who were employed, who were in executive or managerial positions, and who were in professional specialties, who had attained a bachelor's level degree or higher, who were incarcerated (jails and prisons), felony disenfranchised, and on death row. Wallace et al utilized a selection of the above indicators in subsequent studies,(M. Wallace et al., 2017; M. E. Wallace et al., 2015) and included black-white ratios of juvenile custody rates as an additional indicator of structural racism in the criminal justice domain.(M. Wallace et al., 2017)

Patler et al.(Patler & Laster Pirtle, 2017) explored exclusionary immigration policies as a form of structural racism, operationalized by classifying individuals based on Deferred Action for Childhood Arrivals (DACA) status while Sabo et al.(Sabo et al., 2014) measured structural racism on the US-Mexico border as the prevalence of ethno-racial profiling and mistreatment. Finally, McCluney et al.(McCluney et al., 2017) operationalized structural racism within the workplace by comparing black and white respondents subjective (self-reported) and objective (Occupation Information Network data) ratings of opportunities for advancement, having work recognized, autonomy, decision freedom, training support, and supportive management.

With the exception of the self-reported perceived exposures to structural racism and DACA status, all other measures were derived from secondary and publicly available data. Table 2 includes the data source and methodology used in deriving the structural racism measure for those estimated from secondary data sources.

Table 2. Data sources and methods used in quantifying structural racism

Structural racism measure	Data source(s)	Methodology in estimation
Historical redline color category	1937 Home Owner's Loan Corporation, 2010 Census block shapefile	Imported the historical map image as a raster layer into ArcMap v.10.3, then aligned this layer with Census 2010 blocks. Blocks were assigned to one of five categories (green, blue, yellow, red, or not zoned) in which their center point (internal centroid) was located.

Redlining indices	Home Mortgage Disclosure Act (HMDA) data available through the Federal Financial Institutions Examination Council's HMDA Loan Application Register.	Mendez et al.(Mendez et al., 2011; Mendez et al., 2013, 2014): Multilevel logistic model to account for clustering of individual loans within census tracts, fit with a random intercept and random slope for race to estimate black-white difference in log odds of loan denial controlling for loan amount, income, and gender of the applicant. Gee(Gee, 2008): Estimated an odds ratio for each tract including the applicant's race and the ratio of load request to applicant income. Redlined areas operationalized as tracts where Asian home mortgage loan applications were disfavored by 40% in comparison to white applicants (OR>1.4). Zhou et al.(Zhou et al., 2017): Integration of logistic regression models with the adaptive spatial filtering (ASF) approach.
Index of Dissimilarity	US Census Bureau	$D = 0.5 * \sum_{i=1}^n x_i / X - y_i / Y $ where x_i is the proportion of area i (census tract) that is black, X is the proportion of the larger geographic unit (county) that is black, y_i is the proportion of tract i that is white, Y is the proportion of the county that is white. D is the proportion of African Americans that would have to change their place of residence to achieve an even distribution of Whites and African Americans in the region(Chambers et al., 2017)
Isolation Index	American Community Survey, U.S Census Bureau	$xPx^* = \sum_{i=1}^n [(x_i / X) (x_i / t_i)]$ where x_i is the total African Americans in a census tract, t_i is the total population (African Americans + Whites) in a census tract, X is total African Americans in a county. xPx^* represents the probability that an African American will reside in the same sub-area within a county as another African American. Scores range from 0 (complete integration) to 1 (complete segregation).(Chambers et al., 2017)
Delta Index	American Community Survey, U.S. Census Bureau	$Del = \frac{1}{2} \sum_{i=1}^n [(x_i / X) - (a_i / A)]$ where x_i is the total African Americans in a census tract, X is the total African Americans in a county, a_i is the total land area in a census tract and A is the total land area in a county. Del represents the proportion of African Americans that would have to change their place of residence to achieve uniform density across a county. Scores range from 0 (complete integration) to 1 (complete segregation).(Chambers et al., 2017)

Neighborhood deprivation index	US Census Bureau	Average z-scores of the extent of joblessness, professional or managerial occupations (reverse coded), high school graduates (reverse coded), female-headed families, secondary sector workers (those in the six occupations with the lowest average incomes), and poverty.
Relative proportions of blacks to whites	US Census Bureau, US Department of Labor and Statistics, US Department of Justice, Bureau of Justice Statistics.	Ratio of black to white population values for each indicator. Ratio values less than 1 indicate blacks underrepresented, values greater than 1 indicate blacks overrepresented.
Psychosocial workplace environment	Department of Labor Occupational Information Network (O*NET), Health and Retirement Study (HRS)	Six measures of workplace environment scored between 1 and 5 summed and normalized to take values between 0 and 1, estimated separately among white and black workers.

Health Outcomes

Links between experience of structural racism and specific health outcomes were obtained in a variety of ways. Table 3 summarizes the health outcomes examined in association with measures of structural racism. The majority used objective measurements of health outcomes (i.e. premature birth, blood pressure, colorectal cancer survival)(Mendez et al., 2014; Greer et al., 2014; Zhou et al., 2017) compared between a group of people that experienced structural racism versus the results of these same health outcomes in persons that did not experience the measured racism. Mendez et al., who analyzed redlining and effects on birth outcomes, provided one rationalization of the direct relationship between racism and health, saying,

There are four key mechanisms describing the associations between segregation and health disparities...the four key mechanisms are: (1) redlining and segregation influences individual socioeconomic status, which influences birth outcomes; (2) redlining and segregation modifies social capital for a geographic region (i.e. city) and racial/ethnic groups within the region; (3) redlining and segregation produces and reinforces unhealthy neighborhood environments; and (4) redlining and segregation modifies individual behaviors related to pregnancy and birth as well as influences stress pathways.(Mendez et al., 2014)

Other authors analyzed results from participant responses to survey questions describing structural racism “you were refused an apartment or other housing,” and compared health outcomes between participants with “high” scores (indicating high exposure to structural racism) and “low” scores.(Greer et al., 2014) By using objective data and pooled results from administered questionnaires, and by controlling for other individual variables, the authors each were able to evaluate specific health outcomes and how they differed by exposure to a differing variable—structural racism.

Table 3. Health outcomes evaluated by domain of structural racism.

Domain	Health outcomes
Residential neighborhood/housing	Violent crime, stress, preterm birth, colorectal cancer survival, poor health status, gestational age, birth weight
Perceived racism in social institutions	Mortality, anxiety, stress, adherence to hypertensive treatment, delayed HIV testing, psychological well-being
Immigration and border enforcement	Psychological well-being
Political participation, socioeconomic status, criminal justice	Myocardial infarction, infant mortality, small-for-gestational age birth, gestational age, birth weight
Workplace environment	Self-rated health, episodic memory function, mean arterial pressure

DISCUSSION

Growing awareness of structural racism within (and outside of) public health discourse has led to calls for public health researchers, governmental public health practitioners, medical providers, and policy makers to explicitly identify structural racism as a root cause of racial health inequity. (Bailey et al., 2017; Jee-Lyn Garcia & Sharif, 2015; Jones, 2002) Yet, empirical research has been slow to quantify structural racism and demonstrate its impact on population health, evident in the number of articles excluded from the study due to lack of direct, explicit measurement. Difficulties in operationalizing measures of structural racism may arise from its nature as a complex and insidious de facto feature of our society. The need for more works analyzing the impacts of structural racism is twofold: one, to better understand and explore how structural racism continues to impact the lives of thirty-nine percent of our population (United States Census Bureau, 2016) and also to grant credible support to the inclusion of the terms “structural racism,” “institutional racism,” etc. as driving factors of health disparities. (Bradby, 2010) As Bradby explains,

since it is rarely defined in detail, the term institutional racism is increasingly employed as a description of inequality that has no clear cause...without credible models of its operation institutional racism will lose analytic purchase and come to be seen as irrelevant. (Bradby, 2010)

In an effort to promote more work on the study of structural racism, we identified 20 publications from the past decade that attempted to measure the degree to which structural racism in various societal domains is associated with the health and well-being of individuals and communities. These included measures across many, but not all, of the domains, systems and institutions in which it exists (e.g. housing, education, employment, earnings, benefits, credit, media, health care, criminal justice, societal beliefs and values, among others.) (Bailey et al., 2017)

Of the seven domains identified in our search, only two (residential housing patterns and perceptions of structural racism operating in social institutions) had more than five individual studies in which their effects were analyzed. The remaining five domains could benefit from a deeper analysis. Many have also been studied in the context of discrimination, interpersonal or community racism, but not in the unique light of structural racism. Echoing the call of researchers before us, (Bailey et al., 2017) we would encourage authors to further tackle the continuing impacts

of social security laws, environmental and occupational health inequities, media and marketing, investment in neighborhoods and the subsequent impact on health care availability and quality, the impacts of “urban renewal” projects, education, voter suppression, and more nuanced aspects of the criminal justice system aside from number of arrests and percent incarcerated.(Bailey et al., 2017) Within each of these domains, there are multiple levels and options for study: for example, within the domain of education, work could be done to measure impacts of structural racism as racial segregation between schools as well as within individual schools (i.e. percent composition of race at different schools and preferential tracking of students to different academic paths and courses),(Gee et al., 2011) or racial bias in disciplinary practices and policies.

Many of the measures identified in this review used straightforward, uncomplicated methods applied to publicly available data, facilitating replicability and ease of use. Our search of the literature showed that the vast majority of work done to measure structural racism has looked at racial residential segregation and redlining, using data publicly available from the Home Mortgage Disclosure Act (HMDA) or census data. Far less studied were the other domains, especially structural racism operating in the workplace, which was measured in only one study. Workplace environment was measured using surveys and objective data on multiple aspects of the workplace; researchers looking to address a different aspect of structural racism in the workplace could investigate how minority workers are differentially funneled into jobs with fewer benefits and more dangers or further analyze bias in hiring.(Bailey et al., 2017) Immigration and border enforcement, analyzed in our review with DACA status (Patler & Laster, 2017) and encounters with immigration officials,(Scott et al., 2014) could also be analyzed via exclusionary immigration policies.(Gee et al., 2011) The criminal justice system, analyzed in our review as percent incarcerated and percent serving a death sentence, (Lukachko et al., 2014) could benefit from a review of racialized sentencing policies(Bailey et al., 2017) and post-incarceration trajectories and outcomes by race, or racialized police violence. Additionally, the use of publically available data facilitates the study of single snapshots of time; future research will benefit from longitudinal observations of the cumulative impacts of racism.(Chambers et al., 2017) These are only a few examples of areas lacking research. Finally, it is evident that no domain of structural racism operates in isolation; (Gee et al., 2011) the interplay of multiple domains must be analyzed to obtain a complete understanding of the impacts.

Qualitative studies present another way in which the impacts of structural racism on health can be assessed. Because our purpose was to identify ways in which researchers have begun quantifying structural racism, we excluded qualitative studies. However, these studies are crucially important to our understanding of the ways in which structural racism is perceived and experienced, and provide useful insight for future efforts to measure the phenomenon. (Cene et al., 2011; Freeman et al., 2017; Lykes & Scheib, 2016; McAllister, Thomas, Wilson, & Green, 2009; Nuru-Jeter et al., 2009; Rauscher & Wilson, 2017; Salm Ward, Mazul, Ngui, Bridgewater, & Harley, 2013) Existing research addressing the qualitative impacts of structural racism has analyzed structural racism within the health care domain experienced by Black and Hispanic persons living with HIV, (Freeman et al.,2017) by immigration status and risk for clinically diagnosed psychosis,(Anglin et al., 2013) and through the effects of public policies and racialized differences in school readiness. (McAllister et al., 2009) Much data can be gleaned from qualitative studies, and they can be combined with quantitative measures (McCluney et al., 2017) to provide a deeper understanding of the damage caused by structural racism.

The broad range of physical and mental health outcomes evaluated by the studies included in this review suggests the diverse ways structural racism's effects may manifest in both individual and community profiles. Health outcomes ranged from womb to tomb, documenting disparities in birth outcomes and pregnancy course along with overall mortality measures. The health impacts witnessed were both mental and physical—stress, anxiety, and psychological well-being were mental health measures used, while colorectal cancer survival, myocardial infarction, mean arterial blood pressure, and episodic memory function were physical outcomes. Behavioral changes due to experience of structural racism, such as violent crime, adherence to hypertensive treatment, and delayed HIV testing were also documented. The health impacts of structural racism are evident in almost all aspects of health—the effects of discrimination do not discriminate within the body.

Limitations

Limitations to this review exist. This systematic literature review focused on articles that used structural racism or a similar term in the title and abstract. It is possible that articles that did not use the term in the title or abstract but quantitatively measure structural racism in their study were missed. However, all articles that mentioned “structural” and “racism” anywhere in the article were reviewed, whether adjacent or not; because of this thorough review, it is unlikely that articles analyzing the effects of structural racism and health were missed. We did not compare the magnitude of associations reported in the included studies, nor rate the quality or rigor of the analytic approach for potential biases in measures of structural racism's effects. Thus, we are unable to isolate which among the measures of racism identified may have the largest health impact. However, the study comparing traditional to novel measures of structural racism found a more vigorous and causal relationship between the traditional indicators and health outcomes than with the novel indicators.(Chambers et al., 2017) A continued exploration of magnitude of impact of each domain of structural racism may help guide selection of future research domains.

As we did not include reviews in our analysis, studies comparing results from secondary data-derived sources to self-reported experiences of structural racism were not included. In addition, our review may have overlooked studies that referred to terms such as racial discrimination or systemic discrimination, but did not include “racism” or any of the four search terms.

Research on structural racism in other contexts may provide additional inspiration for measuring its breadth (a number of Australia and New Zealand-based studies were initially identified, for example). However, we limited this review to US based studies given the unique historical and contemporary context of racial oppression in this country.

CONCLUSION

While previous systematic reviews have explored the burgeoning public health literature on structural racism, (Bailey et al., 2017; Krieger, 1999) our aim was to identify ways in which researchers have begun to operationalize measures of structural racism for the purposes of quantitative assessment of its deleterious health impacts. Researchers from across public health and clinical subfields should be encouraged to continue these efforts, to expand and innovate ways to quantify structural racism for the study of its association with, and as a driver of, their outcomes of interest, thereby integrating antiracist discourse across the public health agenda. Our review documented 20 primary studies, which did just this. Further repeating and refining of these

measures, along with developing new ones and diving deeper into each individual domain are critical steps towards advancing research on structural racism and guiding efforts to eliminate it.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the Frost Foundation and the Health Resources and Services Administration (HRSA/MCHB; T03MC07649, Theall).

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Journal of Health Disparities Research and Practice Volume 11, Issue 2, Summer 2018

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