

# Confronting Racism in Environmental Health Sciences: Moving the Science Forward for Eliminating Racial Inequities

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**BACKGROUND:** The twin pandemics of COVID-19 and systemic racism during 2020 have forced a conversation across many segments of our society, including the environmental health sciences (EHS) research community. We have seen the proliferation of statements of solidarity with the Black Lives Matter movement and commitments to fight racism and health inequities from academia, nonprofit organizations, governmental agencies, and private corporations. Actions must now arise from these promises. As public health and EHS scientists, we must examine the systems that produce and perpetuate inequities in exposure to environmental pollutants and associated health effects.

**OBJECTIVES:** We outline five recommendations the EHS research community can implement to confront racism and move our science forward for eliminating racial inequities in environmental health.

**DISCUSSION:** Race is best considered a political label that promotes inequality. Thus, we should be wary of equating race with biology. Further, EHS researchers should seriously consider racism as a plausible explanation of racial disparities in health and consider structural racism as a factor in environmental health risk/impact assessments, as well as multiple explanations for racial differences in environmental exposures and health outcomes. Last, the EHS research community should develop metrics to measure racism and a set of guidelines on the use and interpretation of race and ethnicity within the environmental sciences. Numerous guidelines exist in other disciplines that can serve as models. By taking action on each of these recommendations, we can make significant progress toward eliminating racial disparities. <https://doi.org/10.1289/EHP8186>

## Introduction

Statements of solidarity with the Black Lives Matter movement and against anti-Asian hate and commitments to fight racism and health inequities have proliferated since the summer of 2020. These statements and commitments have included calls from academia, nonprofit organizations, governmental agencies, and private corporations. We have been forced to reckon with the twin pandemics of COVID-19 and systemic racism. The environmental health sciences (EHS) community has joined this movement by pledging to enhance diversity within its ranks (McCarthy 2020), launching new initiatives on environmental health equity, and atoning for its own racist history and past relationship with the eugenics movement (Brune 2020). Significantly, these changes are voiced not only by individuals, but also by professional societies (Casey et al. 2020) and governmental agencies (Lenox 2020).

Of course, actions must arise from these promises. As public health and environmental health scientists, we must contribute by taking a longer, harder look at environmental racism—the systems that produce and perpetuate inequities in exposure to environmental pollutants and associated health effects. The disciplines that contribute to EHS—including epidemiology, biostatistics, exposure science, and toxicology—were developed in the context of racist laws, practices, and policies. Indeed, Francis Galton, the founder of the concepts of statistical correlation, also coined the phrase eugenics and advocated for avoiding racial admixture (Markel 2018). Let us at least accept this fundamental truth: EHS

institutions and scholarship have not avoided racism's influence. Further, EHS research has often ignored or excluded indigenous or traditional ecological knowledge that emphasizes interconnectivity between physical cultural and spiritual roles and responsibilities within a system (Arquette et al. 2002; Daniel 2019; Kelly 2020). What, then, is required of EHS so that this moment is not wasted and supports the social justice movement? As an initial step, we offer five recommendations for strengthening the science of racism and developing guidelines on the meaning and use of race and ethnicity in environmental health research.

### ***Recommendation #1. Recognize That Race is a Social/Political Construct, Not a Fixed Biological Trait. Investigate All Potential Causes of Racial Disparities in Environmental Health instead of Assuming They Are Due to Intrinsic Biological Differences***

Race is often conceptualized as a fixed biological characteristic in research, but changes in racial classifications over time clearly demonstrate that race is a social construct that reflects political exigencies, not biological differences. For example, Asians and Pacific Islanders were historically construed as one race. However, after 1997, Pacific Islanders lobbied to become classified as a distinct race, a practice that was codified in Directive 15 (Office of Management and Budget 1997), which mandates how federal agencies collect data on race and ethnicity. These categories continue to evolve. For example, ongoing debates (Robbin 2000; Khoshnevis 2019) consider whether people from the Middle East should be considered a separate race (they are currently classified as White). Moreover, Directive 15 considers people from Spanish-speaking countries to be an ethnic group rather than a racial group. Yet, this practice confounds many who consider LatinX peoples to be a race and fail to see the distinction between race and ethnicity. For this reason, many have also argued that LatinX persons should be a racial group (Allen et al. 2011; Telles 2018).

These racial labels are not merely about identity, but reflect and reinforce structural inequalities (Roberts 2012). For example, in *United States v. Bhagat Singh Thind* (1923), the Supreme Court in 1923 intervened to classify people from the country of India as Asian even though they were considered to be Caucasian by many anthropologists at that time. The reason for this reclassification

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was discriminatory because federal policies during that period allowed Caucasians, but not Asians, to seek naturalized citizenship (NRC 2001). As another example, in 1970, Louisiana passed a statute defining someone who is Black as having 1/32 Black ancestry, which means that someone who is 97% White should be classified as Black (Marcus 1983). Assuming that any differences between Black and White individuals are genetic in this context is clearly absurd. The law was originally passed in the 1700s to “keep the [White] landowner from having to share his land with his illegitimate children” who were conceived from rape or extramarital affairs with his Black slaves (Marcus 1983). The 1970 Louisiana law establishing the race formula was repealed in 1983 (Marcus 1983). These examples illustrate how race is a social construct that fundamentally reflects wealth, power, and privilege. For these reasons, commentators in other disciplines have argued against conceptualizing race as a biological construct, for example:

- “The use of biological concepts of race in human genetic research . . . is problematic at best and harmful at worst” (Yudell et al. 2016).
- “Attributing differences in biologic endpoints to race is not only imprecise, but also of no proven value in treating an individual patient” (Schwartz 2001).

We would not expect other social labels, such as political party affiliation, to represent an underlying biological trait. For example, if we found that Republicans and Democrats differed in risk for hypertension, we would not assume that these disparities resulted from differences in some cluster of alleles. Rather, we would investigate environmental and social mechanisms, such as environmental exposures, social class, culture, stress, health care access, and so forth. Yet, health differences across races are often assumed to be due to underlying biological differences. The U.S. Food and Drug Administration (FDA) approved the antihypertensive drug Bidil for Black patients, and no other races, based on an underlying assumption that biological differences exist between Blacks and Whites (Temple and Stockbridge 2007; Johnson 2019). It was believed that Blacks did not benefit as much as Whites from angiotensin converting enzyme (ACE) inhibitors and that alternative drugs were needed to provide better care. The role of genetics in explaining the difference remains an untested hypothesis. Hypertension, one of the major risk factors for congestive heart failure, is more common within the Black community (CDC 2010), and chronic social stress has been implicated as a possible contributor to the development of hypertension (Brody and Hunt 2006). Diet, exercise, and other environmental variables are also possible mediators (Brody and Hunt 2006). Later research suggested that the differential effect of ACE inhibitors by race was mostly due to higher sodium intake (Flack et al. 2000).

Assumptions about biological differences in drug effectiveness and metabolism are embedded, sometimes insidiously, within medical practice (Vyas et al. 2020) and have also appeared in toxicological research relevant to EHS. For example, higher levels of cotinine have previously been reported for Black smokers even though they report smoking fewer cigarettes compared with White smokers (Caraballo et al. 1998). Further, although Blacks usually smoke fewer cigarettes and start smoking cigarettes at an older age, they are more likely to die from smoking-related diseases than Whites (CDC 2020). Many investigators hypothesize that racial differences in the metabolism of tobacco toxins may explain differences in tobacco-related morbidity and mortality (Benowitz et al. 1999; Hukkanen et al. 2005). However, in a recent study aimed at evaluating the hypothesis that melanin (skin pigment) affects nicotine disposition kinetics in humans, researchers concluded there was no evidence of correlations between melanin and the pharmacokinetic parameters of nicotine or cotinine or tobacco dependence measures among a group of Black smokers (Liakoni et al. 2019).

Meanwhile, as well documented in records made public from numerous lawsuits, tobacco companies have targeted Black communities with mint-flavored menthol cigarettes for decades (Kaplan 2021). Mentholated cigarettes have been shown to have greater addictive potential than their nonmentholated counterparts, possibly influencing the metabolism of nicotine (Wickham 2020). The banning of menthol cigarettes has long been an elusive goal for public health regulators (Kaplan 2021). The tobacco industry has successfully delayed FDA action on menthol products (Delnevo et al. 2020). Thus, the difference between Black and White smokers appears to be due to the types of cigarettes marketed to Black communities rather than an intrinsic difference in metabolism.

Accordingly, the most dangerous interpretation of race is that of biological differences because such interpretations have been the basis for eugenics and harmful research (Braun 2006; Phelan et al. 2013; Byrd and Ray 2015). Investigators should consider multiple explanations simultaneously and do their best to rule out competing explanations. Importantly, we are not arguing that researchers should stop evaluating differences in exposures and outcomes according to race. Rather, we should first document whether racial differences exist and then investigate specific factors that might cause such differences. In short, researchers should define, measure, and investigate race as rigorously as they would any other exposure or outcome and acknowledge its limitations as a proxy measure of the underlying construct or mechanism(s) it is meant to represent (Nelson et al. 2018).

### ***Recommendation #2. Seriously Consider Racism as a Plausible Explanation of Racial Disparities in Health***

Advances in EHS have revolved around the deployment of observational, experimental, computational, and clinical approaches to more fully uncover the biological mechanisms hypothesized by the environmental public health paradigm (Sexton et al. 1992; U.S. EPA 2021). But as EHS researchers aim to discover and explain how factors—including chemical, physical, synthetic, and infectious agents, as well as social stressors—affect biological systems, it is not enough to just describe social disparities in exposures and health outcomes. We need to also investigate social mechanisms (Pellow 2000; Powell 2008) as plausible explanations of environmental exposures and illnesses. A social mechanism that is particularly relevant for the study of race disparities is racism and racial discrimination (Gee and Payne-Sturges 2004).

In the United States, racism is the social system that provides the basis of allocating power and privilege to Whites and disadvantages to racial/ethnic minorities (Jones 2000; Williams et al. 2019). Racism fundamentally alters one’s circumstances across the life course, such as where one lives and their educational and occupational opportunities (Gee and Ford 2011; Gee et al. 2019). Racism can confer stress, restrict opportunities, and contribute to adverse exposures (Morello-Frosch 2002; Lewis et al. 2015). Racism has occurred throughout history but, importantly, persists today (Ford and Airhihenbuwa 2010; Lewis and Van Dyke 2018). Because racism is such a powerful driver of social circumstances, it has been considered a fundamental cause of illness by numerous scientific bodies including the Institute of Medicine (Institute of Medicine Committee on Understanding and Eliminating Racial and Ethnic Disparities in Health Care 2003), the American Medical Association (AMA 2020), and the American Public Health Association (Benjamin 2020). As several meta-analyses have shown, when individuals experience racial discrimination, they are more likely to have a variety of health problems (Pascoe and Smart Richman 2009; Paradies et al. 2015).

Racial discrimination, the behavioral manifestation of racism, has been defined as having two components (NRC 2004). The first

is differential treatment based on race. This is how people often think of discrimination, that is, that racial minorities are treated poorly due to explicit racial animus. However, the second way of thinking of discrimination is based on the concept of disparate impact, which is treatment on the basis of inadequately justified factors other than race that harms a racial group. In other words, a practice can be discriminatory if it creates a racial disparity and if the practice does not have any compelling reason to exist. No explicit racial animus is necessary in the second definition. This idea was the basis for *Griggs v. Duke Power Co.* (1971), a suit levied against an employer who required employees to take aptitude tests. On the surface, such tests appeared race neutral because they were required of both Black and White employees. However, these tests had two qualities that made them discriminatory under the idea of disparate impact. The tests *a)* disadvantaged Black employees owing to their lower educational levels and, just as importantly, *b)* had no bearing on the job duties. Thus, the Supreme Court ruled that the tests were discriminatory against Black workers.

Rigorous science requires that we seriously consider racism and discrimination as plausible explanations for racial/ethnic inequities in environmental exposures and racial/ethnic differences in the impacts of such exposures (Mohai and Bryant 1992; Morello-Frosch et al. 2002; Morello-Frosch 2002; Gee and Payne-Sturges 2004). Such consideration includes studying how racism

- Accounts for the disproportionately higher rates of exposure among racial/ethnic minorities (Clark et al. 2017; Ash and Boyce 2018; Mikati et al. 2018; Tessum et al. 2019)
- Leads to preexisting health conditions (e.g., asthma) that render people more susceptible to environmental exposures (e.g., air pollution) (Guarnieri and Balmes 2014)
- Amplifies the effects of environmental exposures [e.g., effect modification between stress and lead poisoning on high blood pressure, effect modification by socioeconomic status (SES) of lead effects on intelligence quotient] (Bellinger et al. 1988; Hicken et al. 2013)
- Impairs one's ability to obtain effective medical care (Gonzales et al. 2014; Kugelmass 2016)
- Creates spillover effects that impair the well-being not simply of an individual but of their families and communities (e.g., when racism puts Black fathers in prison) (Priest et al. 2013; Lee et al. 2015; Williams et al. 2019)
- Impedes the ability to conduct rigorous scientific research (e.g., when researchers stereotype participants, when mistrust rooted in the Tuskegee Study diminishes participation in research) (Corbie-Smith et al. 2002; Ford and Airhihenbuwa 2010)
- Affects the reporting, interpretation, publication, and funding of racial disparities research (Tyler 2005; Ginther et al. 2011; Kubota 2020).

Thus, as EHS researchers, we need to start asking different questions (Payne-Sturges 2011) that can address the complex interactions between conditions, policies, and social, natural, and built environmental systems that result in unequal environmental health conditions or disproportionate impacts among (diverse) disadvantaged population groups, communities, neighborhoods, and individuals. For example, how does environmental inequality arise and why does it persist? What is the role of institutionalized racism and the economics of industrial development and production (i.e., industrial location, racialized division of labor, suburbanization, and economic restructuring)? Given the important role of toxicology in EHS, how can animal models be reformulated to be more directly relevant to the environmental context of human chemical exposures? Ultimately, what new strategies can be developed for alleviating systemic drivers of racial and socioeconomic disparities in environmentally mediated health outcomes and access to healthy environments?

In order to address these questions, we will also need to consider how best to build interdisciplinary research teams and to integrate methods and theories from systems and social sciences with EHS and corresponding training programs. The point is not to throw away the conventional research questions (e.g., what is the exposure–disease response relationship on average?), but to investigate new ones too, especially if we are concerned about disproportionate impacts and environmental health inequities.

### **Recommendation #3. Develop New Measures of Racism**

Within EHS research, discrimination has been operationalized in two main ways. First, discrimination has been inferred when a racial disparity remains after accounting for compelling covariates (e.g., socioeconomic conditions, land use ordinances, zoning policies). The assumption that the residual disparity represents the effects of racism relies on the assumption that key confounders have been accounted for and that racism is the true driver of the disparity (Bullard 1993). Second, racial residential segregation, which represents the cumulative impact of historic and contemporary racist practices that spatially separate races, is used as a measure of discrimination. Practices that contribute to residential segregation range from outright racial hostility (e.g., lynchings) to more subtle practices, such as redlining by banks or steering by real estate agents. Segregation has been linked to a variety of environmental exposures and poor outcomes (Morello-Frosch and Jesdale 2006; Mehra et al. 2017).

However, we need to think beyond these metrics. Research in other disciplines has documented racial inequities in police shootings, mass incarceration, educational tracking, media portrayals, citation practices, hospital case-management algorithms, emergency department waiting times, National Institutes of Health funding, and innumerable other segments of life (Krieger 1999; Gee and Ford 2011; Ginther et al. 2011; Bailey et al. 2017). In addition, some measures have been developed to focus on personal experiences of discrimination (Williams et al. 1997; Krieger et al. 2005; Landrine et al. 2006). This suggests that many aspects of environmental racism are yet to be documented, conceptualized, and measured.

As the example of the lead poisoning crisis in Flint, Michigan, showed us, there are numerous points along the continuum where inequality occurs, ranging from governmental policies, to the manipulation of data, to remediation and restoration (Michigan Civil Rights Commission 2017). Racism occurs partly due to explicit racial animus, but it also manifests as willful neglect and purposeful prioritization of advantaged communities. Although it has been recognized that the Flint crisis was due to structural racism (Michigan Civil Rights Commission 2017; Hammer 2019), there are yet no good metrics for detecting such discrimination.

Therefore, we call upon researchers to develop new measures of racism and racial inequities that may be particularly relevant to EHS. This may necessitate working in transdisciplinary teams that include scholars from fields such as sociology, history, and ethnic studies. This requires working with members of racial minority communities, who often are able to see the manifestations of racial bias long before the ideas diffuse into the academic literature (Israel et al. 2005, 2010). These measures then need to be incorporated into surveys such as the National Health and Nutrition Examination Survey or must permit linkages with such surveys and other data sets so that race and racism can be rigorously studied.

### **Recommendation #4. Consider Structural Racism as a Factor in Environmental Health Risk/Impact Assessment**

Risk assessment plays an important role in EHS because it shapes environmental health policy decisions at local and national levels. Although the majority of EHS researchers are not directly

involved in risk assessment, their work (including basic research on chemical properties; estimating fate, transport models, and pollutant exposure models; toxicity testing on animal models; and epidemiologic studies of human populations) feeds directly into risk assessment. However, unfortunately, evidence shows that the system of environmental health protection based on risk assessment does not work well for the people who need it the most (Israel 1994).

Since the mid-1970s, quantitative risk assessment—a method to identify and measure the risk that a particular environmental contaminant presents at a given exposure level—has been critical to many federal environmental regulatory and policy decisions. Risk assessment consisting of a four-step process (hazard identification, dose–response assessment, exposure assessment, and risk characterization) is a reductionist approach used mainly to assess and regulate individual chemicals. Risk assessment has guided the development of ostensibly race-neutral environmental policies. The limitations of chemical-by-chemical risk assessment to address real-world exposures have been acknowledged but seldom taken seriously (Israel 1994). Risk assessment typically omits multiple chemical exposures, cumulative and synergistic effects, and consequences of co-occurring nonchemical stressors and their potential downstream convergence that can lead to the enhancement of biological effects.

Yet the human environment includes multiple risk factors in addition to a multiplicity of chemicals acting concurrently or sequentially. This fact has direct relevance to both epidemiological and basic science studies, where the focus is predominantly on single chemical exposures and usually at the mean or median level. Given that chemical exposures and other environmental risk factors can operate on the same biological substrates, they open the door for multiple interactive effects with the potential to modify the toxicity of chemicals.

Currently, risk assessments conducted by the U.S. Environmental Protection Agency generally limit consideration of susceptible populations to the elderly, children, pregnant women, and perhaps people with comorbidities, without considering the broader social-environmental context. Epidemiologic studies ignore interactions between chemical and nonchemical exposures (Wing 1994) or suffer from an absence of methods allowing such assessments when sample sizes are modest. Animal models that inform risk assessments are significantly removed from human relevance in their assessment of the impacts of single chemical exposure effects in the absence of any such human relevant contexts; although stress is sometimes examined, the relevance of stress paradigms typically used in animal models (e.g., restraint stress, forced swim, social isolation) needs serious reconfiguration so as to relate to the types and magnitude of stressors associated with poverty, including lower income, SES, neighborhood poverty, and social and neighborhood resource deprivation, factors that are above and beyond those experienced in higher economic strata (Evans and Kim 2013; Perry et al. 2019). Similarly, epidemiologic studies need to query stress exposures relevant to the context of the populations being studied.

More relevant paradigms might be considered for both animal models and human epidemiologic studies. One possible avenue would be through stress paradigms contextually related to inequity aversion, that is, receipt of unequal reward for the same task, a phenomenon seen even in children as well as in other mammalian species. In human studies, such stress has also been shown to modify decision making, including enhancing the tendency to choose smaller and earlier rewards over larger delayed ones (a phenomenon known as delay discounting) (Haushofer and Fehr 2014). Because animal models are the basis for much of the research used for risk assessment and because disadvantaged human populations often experience the highest chemical

exposures, it is imperative to develop animal models of social disparity and acknowledge the potential for cumulative effects.

Further, the risk assessment framework, which is predicated on the environmental public health paradigm, does not examine the upstream economic and social forces that create disparities in exposure to environmental chemicals in the first place and contribute to enhanced toxicity. Because of this, environmental policies are likely based on underestimations of true health risks.

Moreover, the interpretation of risk varies considerably by demographic group. Many studies have documented a “White male effect” whereby White men are more likely to downplay risks associated with a variety of hazards (e.g., air pollution, climate change, cigarette smoking) compared with women and people of color (Finucane et al. 2000; Marshall et al. 2006; Sansani 2018). Therefore, if White men dominate decision making about risks that disproportionately affect people of color (Marshall 2006), risk assessment can help reinforce structural racism, exacerbate racial inequalities, and perpetuate race-related differences in environmental exposures and their effects. In this way, risk assessment can serve as a tool of White supremacy, which is, at its most fundamental level, about the exercise of power to privilege Whites and disenfranchise racial minorities (Jones 2000; Bailey et al. 2017; Gee et al. 2019; Walsdorf et al. 2020). With these limitations taken together, it comes as no surprise that we continue to have race-based differences in environmental exposures and health effects.

The EHS field needs to devise new ways to assess the cumulative health toll/burden of pollution by focusing on structural causes (racialized policies, practices, and decisions) of disparities, incorporating concerns of impacted communities, and promoting policies that not only address these structural causes but also move society toward a more regenerative environment, especially among communities that are already overburdened (O’Brien 2000; Cousins et al. 2019; Sengupta 2020). Health Impact Assessment (Yuen and Payne-Sturges 2013) and system dynamics (Homer and Hirsch 2006; Hovmand 2014) are promising approaches for overcoming key limitations of risk assessment in this regard. These approaches facilitate the explicit consideration of systems and their structures that create health inequities and the integration of quantitative and qualitative evidence from across multiple disciplines and sources of knowledge to inform development of more equitable public health policies.

### ***Recommendation #5. Develop Guidelines on the Use of Race and Ethnicity within EHS***

The previous recommendations were about furthering the development of the science of racism within the EHS context; this recommendation focuses on the use of race and ethnicity within EHS research. Unfortunately, race is notoriously poorly measured. One study of 995 medical articles found that race was defined in only 4.5% of the studies and the method for racial classification mentioned in only 10.3% (Bokor-Billmann et al. 2020). We would not accept such lax reporting for any environmental exposure, nor should we accept it when researching disparities. We should demand rigor in the study of race and ethnicity. Many disciplines have thus developed guidelines to clarify the meaning and use of race and ethnicity in research and publications, including the following:

- [APA Guidelines on Race and Ethnicity in Psychology \(APA Task Force on Race and Ethnicity Guidelines in Psychology 2019\)](#)
- [American Anthropological Association statement on race \(Executive Board of the American Anthropological Association 1998\)](#)

- *Race, Ethnicity, and Language Data: Standardization for Health Care Quality Improvement (Institute of Medicine Subcommittee on Standardized Collection of Race/Ethnicity Data for Healthcare Quality Improvement 2009)*
- “The impact of racism on child and adolescent health” (Trent et al. 2019)
- “On racism: a new standard for publishing on racial health inequities” (Boyd et al. 2020)

Environmental health scientists should follow suit and develop our own set of guidelines in collaboration with community members, policy makers, social scientists, and representatives from all of the other disciplines that contribute to EHS research. Professional societies, including the Society of Toxicology, the International Society for Environmental Epidemiology (ISEE), and the International Society of Exposure Science could also further this effort. For example, ISEE recently established an anti-racism task force whose goals include promoting consideration of structural racism as a mechanism for inequities in environmental health and encouraging more rigorous use and interpretation of race in environmental health research (D. Payne-Sturges and M. Hicken, personal communication). Such guidelines would call upon the researchers to

- Provide the scientific rationale for examining race as an exposure, confounder, or modifier
- Describe how race was measured and operationalized
- Integrate the role of racism and its various components (e.g., discrimination, prejudice) into research, and in doing so, to consider how racism operates at multiple levels (Bailey et al. 2017; Williams et al. 2019) and across the life course (Gee et al. 2012, 2019).

## Summary

As environmental health researchers, we are accustomed to making the invisible visible, be it the health impacts of tiny particles or epigenetic changes from exposures to chemicals. If we are serious about ending environmental racism, we must also direct our attention to making more visible the social mechanisms and systems that create racialized disparities in environmental health and how they influence the toxicity of chemical exposures. This means looking farther upstream and asking different research questions related to disproportionate environmental health impacts of practices such as redlining, predatory lending, and the siting of polluting industries, as well as so-called race-neutral policies and lax environmental enforcement. We should also work to increase collaboration with social scientists, be explicit about our reasons for using race in research, measure and classify race in a precise and rigorous way, and increase community-based participatory research. Our recommendations are not meant to be exhaustive but, rather, a starting point for future discussion and research.

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## References

Allen VC Jr, Lachance C, Rios-Ellis B, Kaphingst KA. 2011. Issues in the assessment of “race” among Latinos: implications for research and policy. *Hisp J Behav Sci* 33(4):411–424, PMID: 23239903, <https://doi.org/10.1177/0739986311422880>.  
 AMA (American Medical Association). 2020. New AMA policy recognizes racism as a public health threat. [https://www.ama-assn.org/press-center/press-](https://www.ama-assn.org/press-center/press-releases/new-ama-policy-recognizes-racism-public-health-threat)

[releases/new-ama-policy-recognizes-racism-public-health-threat](https://www.ama-assn.org/press-center/press-releases/new-ama-policy-recognizes-racism-public-health-threat) [accessed 14 April 2021].  
 APA Task Force on Race and Ethnicity Guidelines in Psychology. 2019. *APA Guidelines on Race and Ethnicity in Psychology: Promoting Responsiveness and Equity*. Washington, DC: American Psychological Association. <https://www.apa.org/about/policy/guidelines-race-ethnicity.pdf> [accessed 24 April 2021].  
 Arquette M, Cole M, Cook K, LaFrance B, Peters M, Ransom J, et al. 2002. Holistic risk-based environmental decision making: a Native perspective. *Environ Health Perspect* 110(suppl 2):259–264, PMID: 11929736, <https://doi.org/10.1289/ehp.02110s2259>.  
 Ash M, Boyce JK. 2018. Racial disparities in pollution exposure and employment at US industrial facilities. *Proc Natl Acad Sci U S A* 115(42):10636–10641, PMID: 30275295, <https://doi.org/10.1073/pnas.1721640115>.  
 Bailey ZD, Krieger N, Agénor M, Graves J, Linos N, Bassett MT. 2017. Structural racism and health inequities in the USA: evidence and interventions. *Lancet* 389(10077):1453–1463, PMID: 28402827, [https://doi.org/10.1016/S0140-6736\(17\)30569-X](https://doi.org/10.1016/S0140-6736(17)30569-X).  
 Bellinger D, Leviton A, Waternaux C, Needleman H, Rabinowitz M. 1988. Low-level lead exposure, social class, and infant development. *Neurotoxicol Teratol* 10(6):497–503, PMID: 3244341, [https://doi.org/10.1016/0892-0362\(88\)90084-0](https://doi.org/10.1016/0892-0362(88)90084-0).  
 Benjamin G. 2020. Racism is an ongoing public health crisis that needs our attention now. Statement from APHA Executive Director. 29 May 2020. <https://www.apha.org/News-and-Media/News-Releases/PHA-News-Releases/2020/Racism-is-a-public-health-crisis> [accessed 14 April 2021].  
 Benowitz NL, Perez-Stable EJ, Fong I, Modin G, Herrera B, Jacob P III. 1999. Ethnic differences in N-glucuronidation of nicotine and cotinine. *J Pharmacol Exp Ther* 291(3):1196–1203, PMID: 10565842.  
 Bokor-Billmann T, Langan EA, Billmann F. 2020. The reporting of race and/or ethnicity in the medical literature: a retrospective bibliometric analysis confirmed room for improvement. *J Clin Epidemiol* 119:1–6, PMID: 31715264, <https://doi.org/10.1016/j.jclinepi.2019.11.005>.  
 Boyd RW, Lindo EG, Weeks LD, McLemore MR. 2020. On racism: a new standard for publishing on racial health inequities. *Health Affairs Blog*. 2 July 2020. <https://doi.org/10.1377/hblog20200630.939347/full/> [accessed 24 April 2021].  
 Braun L. 2006. Reifying human difference: the debate on genetics, race, and health. *Int J Health Serv* 36(3):557–573, PMID: 16981631, <https://doi.org/10.2190/8JAF-D8ED-8WPD-J9WH>.  
 Brody H, Hunt LM. 2006. BiDiI: assessing a race-based pharmaceutical. *Ann Fam Med* 4(6):556–560, PMID: 17148635, <https://doi.org/10.1370/afm.582>.  
 Brune M. 2020. Pulling down our monuments. Executive Director’s Blog. 22 July 2020. [https://www.sierraclub.org/michael-brune/2020/07/john-muir-early-history-sierra-club?utm\\_source=sierraclub&utm\\_medium=email&utm\\_content=history](https://www.sierraclub.org/michael-brune/2020/07/john-muir-early-history-sierra-club?utm_source=sierraclub&utm_medium=email&utm_content=history) [accessed 11 August 2020].  
 Bullard RD, ed. 1993. *Confronting Environmental Racism: Voices from the Grassroots*. Boston, MA: South End Press.  
 Byrd WC, Ray VE. 2015. Ultimate attribution in the genetic era: White support for genetic explanations of racial difference and policies. *Ann Am Acad Polit Soc Sci* 661(1):212–235, <https://doi.org/10.1177/0002716215587887>.  
 Caraballo RS, Giovino GA, Pechacek TF, Mowery PD, Richter PA, Strauss WJ, et al. 1998. Racial and ethnic differences in serum cotinine levels of cigarette smokers: Third National Health and Nutrition Examination Survey, 1988–1991. *JAMA* 280(2):135–139, PMID: 9669785, <https://doi.org/10.1001/jama.280.2.135>.  
 Casey JA, Kiousmourtoglou MA, Nieuwenhuijsen MJ. 2020. ISEE statement on anti-black violence and racism. <https://www.iseepi.org/common/Uploaded%20files/2020%20Website%20Edits/ISEE%20Statement.pdf> [accessed 3 August 2020].  
 CDC (Centers for Disease Control and Prevention). 2010. *A Closer Look at African American Men and High Blood Pressure Control: a Review of Psychosocial Factors and Systems-Level Interventions*. [https://www.cdc.gov/bloodpressure/docs/African\\_American\\_Sourcebook.pdf](https://www.cdc.gov/bloodpressure/docs/African_American_Sourcebook.pdf) [accessed 24 April 2021].  
 CDC. 2020. African Americans and tobacco use. <https://www.cdc.gov/tobacco/disparities/african-americans/index.htm> [accessed 29 March 2021].  
 Clark LP, Millet DB, Marshall JD. 2017. Changes in transportation-related air pollution exposures by race-ethnicity and socioeconomic status: outdoor nitrogen dioxide in the United States in 2000 and 2010. *Environ Health Perspect* 125(9):097012, PMID: 28930515, <https://doi.org/10.1289/EHP959>.  
 Corbie-Smith G, Thomas SB, St George DMM. 2002. Distrust, race, and research. *Arch Intern Med* 162(21):2458–2463, PMID: 12437405, <https://doi.org/10.1001/archinte.162.21.2458>.  
 Cousins IT, Goldenman G, Herzke D, Lohmann R, Miller M, Ng CA, et al. 2019. The concept of essential use for determining when uses of PFASs can be phased out. *Environ Sci Process Impacts* 21(11):1803–1815, PMID: 31204421, <https://doi.org/10.1039/C9EM00163H>.  
 Daniel R. 2019. Understanding our environment requires an indigenous worldview. *Eos* 100, <https://doi.org/10.1029/2019EO137482>.

- Delnevo CD, Ganz O, Goodwin RD. 2020. Banning menthol cigarettes: a social justice issue long overdue. *Nicotine Tob Res* 22(10):1673–1675, PMID: 33030210, <https://doi.org/10.1093/ntr/ntaa152>.
- Evans GW, Kim P. 2013. Childhood poverty, chronic stress, self-regulation, and coping. *Child Dev Perspect* 7(1):43–48, <https://doi.org/10.1111/cdep.12013>.
- Executive Board of the American Anthropological Association. 1998. AAA statement on race. <https://www.americananthro.org/ConnectWithAAA/Content.aspx?ItemNumber=2583> [accessed 24 August 2029].
- Finucane ML, Slovic P, Mertz CK, Flynn J, Satterfield TA. 2000. Gender, race, and perceived risk: the ‘white male’ effect. *Health Risk Soc* 2(2):159–172, <https://doi.org/10.1080/713670162>.
- Flack JM, Mensah GA, Ferrario CM. 2000. Using angiotensin converting enzyme inhibitors in African-American hypertensives: a new approach to treating hypertension and preventing target-organ damage. *Curr Med Res Opin* 16(2):66–79, PMID: 10893650, <https://doi.org/10.1185/0300799009117011>.
- Ford CL, Airhihenbuwa CO. 2010. Critical race theory, race equity, and public health: toward antiracism praxis. *Am J Public Health* 100(suppl 1):S30–S35, PMID: 20147679, <https://doi.org/10.2105/AJPH.2009.171058>.
- Gee GC, Ford CL. 2011. Structural racism and health inequities: old issues, new directions. *Du Bois Rev* 8(1):115–132, PMID: 25632292, <https://doi.org/10.1017/S1742058X11000130>.
- Gee GC, Hing A, Mohammed S, Tabor DC, Williams DR. 2019. Racism and the life course: taking time seriously. *Am J Public Health* 109(suppl 1):S43–S47, PMID: 30699016, <https://doi.org/10.2105/AJPH.2018.304766>.
- Gee GC, Payne-Sturges DC. 2004. Environmental health disparities: a framework integrating psychosocial and environmental concepts. *Environ Health Perspect* 112(17):1645–1653, PMID: 15579407, <https://doi.org/10.1289/ehp.7074>.
- Gee GC, Walsemann KM, Brondolo E. 2012. A life course perspective on how racism may be related to health inequities. *Am J Public Health* 102(5):967–974, PMID: 22420802, <https://doi.org/10.2105/AJPH.2012.300666>.
- Ginther DK, Schaffer WT, Schnell J, Masimore B, Liu F, Haak LL, et al. 2011. Race, ethnicity, and NIH research awards. *Science* 333(6045):1015–1019, PMID: 21852498, <https://doi.org/10.1126/science.1196783>.
- Gonzales KL, Lambert WE, Fu R, Jacob M, Harding AK. 2014. Perceived racial discrimination in health care, completion of standard diabetes services, and diabetes control among a sample of American Indian women. *Diabetes Educ* 40(6):747–755, PMID: 25249597, <https://doi.org/10.1177/0145721714551422>.
- Guarnieri M, Balmes JR. 2014. Outdoor air pollution and asthma. *Lancet* 383(9928):1581–1592, PMID: 24792855, [https://doi.org/10.1016/S0140-6736\(14\)60617-6](https://doi.org/10.1016/S0140-6736(14)60617-6).
- Griggs v. Duke Power Co., No. 124. 401 U.S. 424 (Mar. 8, 1971). <https://supreme.justia.com/cases/federal/us/401/424/> [accessed 24 April 2021].
- Hammer PJ. 2019. The flint water crisis, the Karegnondi water authority and strategic-structural racism. *Crit Sociol* 45(1):103–119, <https://doi.org/10.1177/0896920517729193>.
- Haushofer J, Fehr E. 2014. On the psychology of poverty. *Science* 344(6186):862–867, PMID: 24855262, <https://doi.org/10.1126/science.1232491>.
- Hicken MT, Gee GC, Connell C, Snow RC, Morenoff J, Hu H. 2013. Black–white blood pressure disparities: depressive symptoms and differential vulnerability to blood lead. *Environ Health Perspect* 121(2):205–209, PMID: 23127977, <https://doi.org/10.1289/ehp.1104517>.
- Homer JB, Hirsch GB. 2006. System dynamics modeling for public health: background and opportunities. *Am J Public Health* 96(3):452–458, PMID: 16449591, <https://doi.org/10.2105/AJPH.2005.062059>.
- Hovmand PS. 2014. *Community Based System Dynamics*. New York, NY: Springer.
- Hukkanen J, Jacob P III, Benowitz NL. 2005. Metabolism and disposition kinetics of nicotine. *Pharmacol Rev* 57(1):79–115, PMID: 15734728, <https://doi.org/10.1124/pr.57.1.3>.
- Institute of Medicine Committee on Understanding and Eliminating Racial and Ethnic Disparities in Health Care. 2003. *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care*. Smedley BD, Stith AY, Nelson AR, eds. Washington, DC: National Academies Press.
- Institute of Medicine Subcommittee on Standardized Collection of Race/Ethnicity Data for Healthcare Quality Improvement. 2009. *Race, Ethnicity, and Language Data: Standardization for Health Care Quality Improvement*. Ulmer C, McFadden B, Nerenz DR, eds. Washington, DC: National Academies Press.
- Israel BD. 1994. An environmental justice critique of risk assessment. *NYU Environ Law J* 3(2):470–522.
- Israel BA, Coombe CM, Cheezum RR, Schulz AJ, McGranaghan RJ, Lichtenstein R, et al. 2010. Community-based participatory research: a capacity-building approach for policy advocacy aimed at eliminating health disparities. *Am J Public Health* 100(11):2094–2102, PMID: 20864728, <https://doi.org/10.2105/AJPH.2009.170506>.
- Israel BA, Parker EA, Rowe Z, Salvatore A, Minkler M, López J, et al. 2005. Community-based participatory research: lessons learned from the Centers for Children’s Environmental Health and Disease Prevention Research. *Environ Health Perspect* 113(10):1463–1471, PMID: 16203263, <https://doi.org/10.1289/ehp.7675>.
- Johnson KA. 2019. Research, race and profit. In: *Medical Stigmata: Race, Medicine, and the Pursuit of Theological Liberation*. Singapore: Palgrave Macmillan, 73–124.
- Jones CP. 2000. Levels of racism: a theoretic framework and a gardener’s tale. *Am J Public Health* 90(8):1212–1215, PMID: 10936998, <https://doi.org/10.2105/AJPH.90.8.1212>.
- Kaplan S. 2021. Menthol cigarettes kill many black people. a ban may finally be near. *New York Times*. 22 March 2021. <https://www.nytimes.com/2021/03/22/health/menthol-smoking-ban.html> [accessed 24 April 2021].
- Kelly D. 2020. Traditional ecological knowledge and western science: projections, problems, and potential. Indigenous New Hampshire. <https://indigenoussnh.com/2020/2001/2031/traditional-ecological-knowledge-and-western-science-projections-problems-and-potential/> [accessed 24 April 2021].
- Khoshnevis H. 2019. The inferior white: politics and practices of racialization of people from the Middle East in the US. *Ethnicities* 19(1):117–135, <https://doi.org/10.1177/1468796818798481>.
- Krieger N. 1999. Embodying inequality: a review of concepts, measures, and methods for studying health consequences of discrimination. *Int J Health Serv* 29(2):295–352, PMID: 10379455, <https://doi.org/10.2190/M11W-VVXE-KQM9-G97Q>.
- Krieger N, Smith K, Naishadham D, Hartman C, Barbeau EM. 2005. Experiences of discrimination: validity and reliability of a self-report measure for population health research on racism and health. *Soc Sci Med* 61(7):1576–1596, PMID: 16005789, <https://doi.org/10.1016/j.socscimed.2005.03.006>.
- Kubota R. 2020. Confronting epistemological racism, decolonizing scholarly knowledge: race and gender in applied linguistics. *Appl Linguist* 41(5):712–732, <https://doi.org/10.1093/applin/amz033>.
- Kugelmass H. 2016. “Sorry, I’m not accepting new patients”: an audit study of access to mental health care. *J Health Soc Behav* 57(2):168–183, PMID: 27251890, <https://doi.org/10.1177/0022146516647098>.
- Landrine H, Klonoff EA, Corral I, Fernandez S, Roesch S. 2006. Conceptualizing and measuring ethnic discrimination in health research. *J Behav Med* 29(1):79–94, PMID: 16470345, <https://doi.org/10.1007/s10865-005-9029-0>.
- Lee Y, Muennig P, Kawachi I, Hatzenbuehler ML. 2015. Effects of racial prejudice on the health of communities: a multilevel survival analysis. *Am J Public Health* 105(11):2349–2355, PMID: 26378850, <https://doi.org/10.2105/AJPH.2015.302776>.
- Lenox K. 2020. The NIEHS conversation on race, equity, and inclusion. *Environmental Factor*. August 2020. <https://factor.niehs.nih.gov/2020/8/feature/1-feature-race/index.htm> [accessed 10 August 2020].
- Lewis TT, Cogburn CD, Williams DR. 2015. Self-reported experiences of discrimination and health: scientific advances, ongoing controversies, and emerging issues. *Annu Rev Clin Psychol* 11:407–440, PMID: 25581238, <https://doi.org/10.1146/annurev-clinpsy-032814-112728>.
- Lewis TT, Van Dyke ME. 2018. Discrimination and the health of African Americans: the potential importance of intersectionalities. *Curr Dir Psychol Sci* 27(3):176–182, PMID: 30655654, <https://doi.org/10.1177/0963721418770442>.
- Liakoni E, St Helen G, Dempsey DA, Jacob P III, Tyndale RF, Benowitz NL. 2019. Relationship between skin melanin index and nicotine and nicotine pharmacokinetics in African American smokers. *Drug Alcohol Depend* 204:107474, PMID: 31521954, <https://doi.org/10.1016/j.drugalcdep.2019.04.039>.
- Marcus FF. 1983. Louisiana repeals black blood law. *New York Times*. Section A, Page 10. 6 July 1983. <https://www.nytimes.com/1983/07/06/us/louisiana-repeals-black-blood-law.html> [accessed 24 April 2021].
- Markel H. 2018. Column: the false, racist theory of eugenics once ruled science. Let’s never let that happen again. *PBS News Hour*. 16 February 2018. <https://www.pbs.org/newshour/nation/column-the-false-racist-theory-of-eugenics-once-ruled-science-lets-never-let-that-happen-again> [accessed 24 August 2020].
- Marshall BK, Picou JS, Formichella C, Nicholls K. 2006. Environmental risk perceptions and the white male effect: pollution concerns among deep-South coastal residents. *J Appl Sociol Sci* 23(2):31–49, <https://doi.org/10.1177/1936724062300203>.
- McCarthy G. 2020. NRDC stands up for racial justice. *Expert Blog*. 5 June 2020. <https://www.nrdc.org/experts/gina-mccarthy/nrdc-stands-racial-justice> [accessed 10 August 2020].
- Mehra R, Boyd LM, Ickovics JR. 2017. Racial residential segregation and adverse birth outcomes: a systematic review and meta-analysis. *Soc Sci Med* 191:237–250, PMID: 28942206, <https://doi.org/10.1016/j.socscimed.2017.09.018>.
- Michigan Civil Rights Commission. 2017. *The Flint Water Crisis: Systemic Racism Through the Lens of Flint: Report of the Michigan Civil Rights Commission*. Lansing, MI: Michigan Department of Civil Rights.
- Mikati I, Benson AF, Luben TJ, Sacks JD, Richmond-Bryant J. 2018. Disparities in distribution of particulate matter emission sources by race and poverty status. *Am J Public Health* 108(4):480–485, PMID: 29470121, <https://doi.org/10.2105/AJPH.2017.304297>.
- Mohai P, Bryant B. 1992. Environmental racism: reviewing the evidence. In: *Race and the Incidence of Environmental Hazards: A Time for Discourse*. B. Bryant, P. Mohai, eds. Boulder, CO: West View Press, 163–176.
- Morello-Frosch RA. 2002. Discrimination and the political economy of environmental inequality. *Environ Plann C Gov Policy* 20(4):477–496, <https://doi.org/10.1068/c03r>.
- Morello-Frosch R, Jesdale BM. 2006. Separate and unequal: residential segregation and estimated cancer risks associated with ambient air toxics in U.S. metropolitan

- areas. *Environ Health Perspect* 114(3):386–393, PMID: [16507462](https://doi.org/10.1289/ehp.8500), <https://doi.org/10.1289/ehp.8500>.
- Morello-Frosch R, Pastor M Jr, Sadd J. 2002. Integrating environmental justice and the precautionary principle in research and policy making: the case of ambient air toxics exposures and health risks among schoolchildren in Los Angeles. *Ann Am Acad Polit Soc Sci* 584(1):47–68, <https://doi.org/10.1177/000271620258400104>.
- Nelson SC, Yu JH, Wagner JK, Harrell TM, Royal CD, Bamshad MJ. 2018. A content analysis of the views of genetics professionals on race, ancestry, and genetics. *AJOB Empir Bioeth* 9(4):222–234, PMID: [30608210](https://doi.org/10.1080/23294515.2018.1544177), <https://doi.org/10.1080/23294515.2018.1544177>.
- NRC (National Research Council). 2001. *America Becoming: Racial Trends and Their Consequences: Volume I*. Washington, DC: National Academies Press.
- NRC. 2004. *Measuring Racial Discrimination*. Blank RM, Dabdy M, Citro CF, eds. Washington, DC: National Academies Press.
- O'Brien M. 2000. When harm is not necessary: risk assessment as diversion. In: *Reclaiming the Environmental Debate: The Politics of Health in a Toxic Culture*. Hofrichter R, ed. Cambridge, MA: MIT Press, 113–134.
- Office of Management and Budget. 1997. Revisions to the standards for the classification of federal data on race and ethnicity. Docket No. 97-28653. *Fed Reg* 62(210):58782–58790. <https://www.govinfo.gov/content/pkg/FR-1997-10-30/pdf/97-28653.pdf> [accessed 24 April 2021].
- Paradies Y, Ben J, Denson N, Elias A, Priest N, Pieterse A, et al. 2015. Racism as a determinant of health: a systematic review and meta-analysis. *PLoS One* 10(9): e0138511, PMID: [26398658](https://doi.org/10.1371/journal.pone.0138511), <https://doi.org/10.1371/journal.pone.0138511>.
- Pascoe EA, Smart Richman L. 2009. Perceived discrimination and health: a meta-analytic review. *Psychol Bull* 135(4):531–554, PMID: [19586161](https://doi.org/10.1037/a0016059), <https://doi.org/10.1037/a0016059>.
- Payne-Sturges D. 2011. Humanizing science at the US Environmental Protection Agency. *Am J Public Health* 101(suppl 1):S8–S12, PMID: [22028453](https://doi.org/10.2105/AJPH.2011.300369), <https://doi.org/10.2105/AJPH.2011.300369>.
- Pellow DN. 2000. Environmental inequality formation: toward a theory of environmental injustice. *Am Behav Sci* 43(4):581–601, <https://doi.org/10.1177/0002764200043004004>.
- Perry RE, Finegood ED, Braren SH, DeJoseph ML, Putrino DF, Wilson DA, et al. 2019. Developing a neurobehavioral animal model of poverty: drawing cross-species connections between environments of scarcity-adversity, parenting quality, and infant outcome. *Dev Psychopathol* 31(2):399–418, PMID: [29606185](https://doi.org/10.1017/S095457941800007X), <https://doi.org/10.1017/S095457941800007X>.
- Phelan JC, Link BG, Feldman NM. 2013. The genomic revolution and beliefs about essential racial differences: a backdoor to eugenics? *Am Sociol Rev* 78(2):167–191, PMID: [24855321](https://doi.org/10.1177/0003122413476034), <https://doi.org/10.1177/0003122413476034>.
- Powell JA. 2008. Structural racism: building upon the insights of John Calmore. *N C Law Rev* 86:791–816. <https://scholarship.law.unc.edu/nclr/vol86/iss3/8> [accessed 24 April 2021].
- Priest N, Paradies Y, Trenery B, Truong M, Karlsen S, Kelly Y. 2013. A systematic review of studies examining the relationship between reported racism and health and wellbeing for children and young people. *Soc Sci Med* 95:115–127, PMID: [23312306](https://doi.org/10.1016/j.socscimed.2012.11.031), <https://doi.org/10.1016/j.socscimed.2012.11.031>.
- Robbin A. 2000. Classifying racial and ethnic group data in the United States: the politics of negotiation and accommodation. *J Gov Inf* 27(2):129–156, [https://doi.org/10.1016/S1352-0237\(00\)00131-3](https://doi.org/10.1016/S1352-0237(00)00131-3).
- Roberts D. 2012. *Fatal Invention: How Science, Politics, and Big Business Create Race in the Twenty-First Century*. New York, NY: New Press.
- Sansani S. 2018. Ethnicity and risk: a field test of the white-male effect. *Appl Econ Lett* 25(2):74–77, <https://doi.org/10.1080/13504851.2017.1296540>.
- Schwartz RS. 2001. Racial profiling in medical research. *N Engl J Med* 344:1392–1393, <https://doi.org/10.1056/NEJM200105033441810>.
- Sengupta S. 2020. Black environmentalists talk about climate and anti-racism. *New York Times*. 3 June 2020. <https://www.nytimes.com/2020/06/03/climate/black-environmentalists-talk-about-climate-and-anti-racism.html> [accessed 21 April 2021].
- Sexton K, Selevan SG, Wagener DK, Lybarger JA. 1992. Estimating human exposures to environmental pollutants: availability and utility of existing databases. *Arch Environ Health* 47(6):398–407, PMID: [1485803](https://doi.org/10.1080/00039896.1992.9938381), <https://doi.org/10.1080/00039896.1992.9938381>.
- Telles E. 2018. Latinos, race, and the U.S. Census. *Ann Am Acad Polit Soc Sci* 677(1):153–164, <https://doi.org/10.1177/0002716218766463>.
- Temple R, Stockbridge NL. 2007. BiDiI for heart failure in black patients: the U.S. Food and Drug Administration perspective. *Ann Intern Med* 146(1):57–62, PMID: [17200223](https://doi.org/10.7326/0003-4819-146-1-200701020-00010), <https://doi.org/10.7326/0003-4819-146-1-200701020-00010>.
- Tessum CW, Apte JS, Goodkind AL, Muller NZ, Mullins KA, Paoletta DA, et al. 2019. Inequity in consumption of goods and services adds to racial–ethnic disparities in air pollution exposure. *Proc Natl Acad Sci U S A*, PMID: [30858319](https://doi.org/10.1073/pnas.1818859116), <https://doi.org/10.1073/pnas.1818859116>.
- Trent M, Dooley DG, Dougé J, Section on Adolescent Health, Council On Community Pediatrics, Committee on Adolescence. 2019. The impact of racism on child and adolescent health. *Pediatrics* 144(2):e20191765, PMID: [31358665](https://doi.org/10.1542/peds.2019-1765), <https://doi.org/10.1542/peds.2019-1765>.
- Tyer P. 2005. Combating editorial racism in psychiatric publications. *Br J Psychiatry* 186(1):1–3, PMID: [15630115](https://doi.org/10.1192/bjp.186.1.1), <https://doi.org/10.1192/bjp.186.1.1>.
- United States v. Bhagat Singh Thind, No. 261. U.S. 204, 43 S.Ct. 338, 67 L.Ed. 616 (S. Ct. Washington, DC. Feb. 19, 1923). <https://supreme.justia.com/cases/federal/us/261/204/> [accessed 24 April 2021].
- U.S. EPA (U.S. Environmental Protection Agency). 2021. Report on the environment: human exposure and health. <https://www.epa.gov/report-environment/human-exposure-and-health#note1> [accessed 24 April 2021].
- Vyas DA, Eisenstein LG, Jones DS. 2020. Hidden in plain sight—reconsidering the use of race correction in clinical algorithms. *N Engl J Med* 383(9):874–882, PMID: [32853499](https://doi.org/10.1056/NEJMms2004740), <https://doi.org/10.1056/NEJMms2004740>.
- Walsdorf AA, Jordan LS, McGeorge CR, Caughy MO. 2020. White supremacy and the web of family science: implications of the missing spider. *J Fam Theory Rev* 12(1):64–79, <https://doi.org/10.1111/jftr.12364>.
- Wickham RJ. 2020. The biological impact of menthol on tobacco dependence. *Nicotine Tob Res* 22(10):1676–1684, PMID: [31867627](https://doi.org/10.1093/ntr/ntz239), <https://doi.org/10.1093/ntr/ntz239>.
- Williams DR, Lawrence JA, Davis BA. 2019. Racism and health: evidence and needed research. *Annu Rev Public Health* 40:105–125, PMID: [30601726](https://doi.org/10.1146/annurev-publhealth-040218-043750), <https://doi.org/10.1146/annurev-publhealth-040218-043750>.
- Williams DR, Yan Y, Jackson JS, Anderson NB. 1997. Racial differences in physical and mental health: socio-economic status, stress and discrimination. *J Health Psychol* 2(3):335–351, PMID: [22013026](https://doi.org/10.1177/135910539700200305), <https://doi.org/10.1177/135910539700200305>.
- Wing S. 1994. The limits of epidemiology. *Med Global Survival* 1(2):74–86.
- Yudell M, Roberts D, DeSalle R, Tishkoff S. 2016. Science and society. Taking race out of human genetics. *Science* 351(6273):564–565, PMID: [26912690](https://doi.org/10.1126/science.aac4951), <https://doi.org/10.1126/science.aac4951>.
- Yuen TK, Payne-Sturges DC. 2013. Using health impact assessment to integrate environmental justice into federal environmental regulatory analysis. *New Solut* 23(3):439–466, PMID: [24551949](https://doi.org/10.2190/NS.23.3.b), <https://doi.org/10.2190/NS.23.3.b>.