

Broadening the Environmental Lens to Include Social and Structural Determinants of Women’s Health Disparities

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BACKGROUND: Due to the physical, metabolic, and hormonal changes before, during, and after pregnancy, women—defined here as people assigned female at birth—are particularly susceptible to environmental insults. Racism, a driving force of social determinants of health, exacerbates this susceptibility by affecting exposure to both chemical and nonchemical stressors to create women’s health disparities.

OBJECTIVES: To better understand and address social and structural determinants of women’s health disparities, the National Institute of Environmental Health Sciences (NIEHS) hosted a workshop focused on the environmental impacts on women’s health disparities and reproductive health in April 2022. This commentary summarizes foundational research and unique insights shared by workshop participants, who emphasized the need to broaden the definition of the environment to include upstream social and structural determinants of health. We also summarize current challenges and recommendations, as discussed by workshop participants, to address women’s environmental and reproductive health disparities.

DISCUSSION: The challenges related to women’s health equity, as identified by workshop attendees, included developing research approaches to better capture the social and structural environment in both human and animal studies, integrating environmental health principles into clinical care, and implementing more inclusive publishing and funding approaches. Workshop participants discussed recommendations in each of these areas that encourage interdisciplinary collaboration among researchers, clinicians, funders, publishers, and community members. <https://doi.org/10.1289/EHP12996>

Introduction

The mission of the National Institute of Environmental Health Sciences (NIEHS) is to discover how the environment affects people in order to promote healthier lives.¹ Key to fulfilling that mission is addressing the unequal burden of environmental hazards experienced by many communities of color and uncovering how racism and social determinants of health combined with the burden of chemical and other exposures further exacerbate health disparities. The NIEHS Environmental Health Disparities and Environmental Justice Faculty advances the Institute’s priorities in these areas by helping to define facets of environmental racism and promote environmental health equity.²

As part of the initiatives to address environmental racism, environmental health disparities, and issues related to environmental justice, NIEHS hosted two virtual workshops to explore how racism affects health. The first, held in December 2021, focused broadly on environmental health disparities and environmental justice.³ The second, held in April 2022, focused on maternal and fetal health outcomes, diseases specific to women, and the role of racism in driving disparate exposure to chemical and nonchemical stressors—such as air pollution, noise, psychosocial stress, and social factors.⁴

In the months leading up to the April 2022 workshop, NIEHS staff met with grantees, community partners, presenters, and panelists in planning meetings to discuss the agenda for the respective workshop sessions. During the workshop, invited experts, including NIEHS staff and grantees, clinicians, external researchers, and community organization leaders discussed how to incorporate multiple systemic factors that contribute to women’s health disparities into environmental health research and clinical care.⁵

The purpose of this commentary is to synthesize workshop presentations and discussions, based on foundational research and unique insights from participants, with an emphasis on current challenges and recommendations to address women’s environmental and reproductive health disparities. As such, the statements and opinions expressed in this commentary reflect the points made during the workshop, while also referencing supporting evidence and context as appropriate.

By highlighting the need to broaden the definition of “environment” to include upstream social and structural determinants of health, our goal is to offer perspectives and a framework that will inform strategies to promote women’s reproductive health and environmental justice. Although most of the examples presented were based on studies involving cisgender women of reproductive age, workshop participants stressed that exposure and health disparities are relevant to sexual and gender minorities throughout life. Throughout the commentary, the term “women” refers broadly to people assigned female at birth, though the authors acknowledge that transgender and nonbinary individuals assigned female at birth do not experience their gender as women.

Women’s Health Disparities and Reproductive Health

Workshop participants explained how women’s bodies undergo dramatic physical, metabolic, and hormonal changes during puberty, pregnancy, and menopause that may increase their susceptibility to environmental insults. These physiological changes

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before, during, and after pregnancy may increase risk for adverse health outcomes from exposure to chemical and nonchemical stressors.^{6–8}

Chemical exposures during pregnancy when the fetus is still developing, such as exposure to air pollution, can result in adverse birth outcomes, including preterm birth and low birth weight⁹ and set the stage for those children to have poor health later in life. Nonchemical stressors, such as racial inequity and structural racism, have also been linked to adverse outcomes, including higher infant mortality.¹⁰

Health disparities affect more than individuals—they can be passed on to future generations through biological processes.^{11,12} For example, multiple epigenetic factors related to preterm birth were shared between black mothers and their children, suggesting an intergenerational link for risk of preterm birth and subsequent adverse health outcomes.¹³ These intergenerational health risks may amplify the harmful effects of chemical and nonchemical stressors, further perpetuating health disparities in future generations.

Participants shared how disparities in access to and quality of health care also influence women's health. For example, compared to white women, black women were more likely to have a hysterectomy for uterine fibroids and undergo abdominal hysterectomy compared to more minimally invasive options.^{14,15} Experiences of racism in the health care system can cause women to delay seeking medical care for fibroids and affect the quality of diagnosis and treatment they receive.¹⁶ Furthermore, despite similarities in infertility rates among women with various racial, ethnic, educational, insurance, and socioeconomic characteristics, there are differences in who seeks infertility care.¹⁷ Uninsured women, those with lower incomes, and non-US citizens were less likely to receive infertility care, highlighting disparities in access to women's health care.¹⁷

These stressors contribute to significant disparities in women's reproductive health, including:

- Age at menarche: Compared to black participants, Hispanic girls were more likely to have menarche earlier, while white and Asian girls were more likely to have menarche later.¹⁸ Earlier age of menarche is associated with higher breast cancer risk later in life.¹⁹
- Uterine fibroids: Black women experience higher risk of uterine fibroids, earlier age of fibroid onset, and more severe symptoms than white women.^{15,20,21}
- Hypertensive disorders in pregnancy: Non-Hispanic black women and American Indian and Alaska Native women have the highest prevalence of hypertensive disorders in pregnancy, a leading cause of pregnancy-related deaths and a risk factor for poor cardiovascular outcomes in women later in life.^{22,23}
- Pregnancy-related death: Non-Hispanic black women in the US are nearly three times more likely to die from pregnancy-related complications than non-Hispanic white women.^{24–26}
- Preterm birth: Black, Native Hawaiian and Pacific Islander, and American Indian and Alaska Native women are more likely than white women to have a preterm birth.^{27,28}

Workshop participants discussed how these health disparities are driven by complex intersecting factors including social determinants of health, structural racism, environmental exposures, and psychosocial stress (Figure 1). Speakers emphasized that identifying and implementing multifaceted solutions is necessary to achieve reproductive health justice for all women and will require collaboration among researchers, clinicians, communities, and institutions.

Racism, Not Race, Drives Health Disparities

Participants explained how health disparities have traditionally been attributed to race, which is often treated as a biological characteristic in data analyses.²⁹ However, race is a social construct used to group people based on phenotype into hierarchies that

determine power and privilege.^{29,30} Because of this, participants discussed how structural racism as opposed to race acts as a central driver of health disparities among racial groups in the US and elsewhere.

Structural racism refers to the societal promotion and preservation of discrimination across multiple “mutually reinforcing systems,” including policy, housing, education, employment, transportation, criminal justice, health care, income, and wealth and results in the systematic denial of resources and opportunities based on discriminatory beliefs and actions.^{30,31} Structural racism shapes experiences with discrimination³² and the risk of exposure to chemical and nonchemical stressors,²⁹ which creates health disadvantages for women of color and affects pregnancy outcomes^{8,31} and health throughout the life course.

Attributing health disparities to race without considering the social environment leads researchers to target explanations and interventions based on individuals' behaviors, participants explained. This can imply that people who are structurally disadvantaged are responsible for their poor health.³³ This overlooks the causal factors driving disparities, thereby missing opportunities to achieve health equity.^{32,34}

Speakers noted that recently more attention has been given to place-based social determinants of health, including poverty, income inequality, inadequate housing, lower educational attainment, higher rates of incarceration, food insecurity, residential segregation, unreliable transportation, and lower access to health care, which can translate to additional health disparities.^{33,35,36} For example, social vulnerability has been strongly tied to increased risk of preterm birth, even when race was removed from statistical models.³⁷ While income inequality contributed to increased risk for preterm birth even when adjusting for maternal race/ethnicity, it exerted the strongest negative effects among non-Hispanic black women who experienced compounded social stressors.³⁸ Furthermore, neighborhood-level mass incarceration, high police exposure, and high eviction rates were linked to increased risk of preterm birth among black women.^{39–41} Similarly, when structural racism and higher income inequality co-occurred, the risk of poor pregnancy outcomes nearly doubled.^{39–41}

Participants illustrated how living in a racist society places chronic stress on communities of color through repeated experiences of social adversity and racial discrimination. For example, black adults who experienced racial discrimination, such as micro-aggressions, had an immediate increase in the stress biomarker cortisol.⁴² The cumulative burden of chronic stress and adverse life events is referred to as allostatic load.⁴³ When social and environmental challenges reach the point of allostatic overload, defined as environmental challenges that exceed an individual's ability to cope, people experience worse health outcomes.^{43,44}

In addition to bearing higher burdens of social stressors and racial discrimination, communities of color face higher exposures to environmental hazards.^{36,45,46} Such disparities in exposure are well documented,^{47,48} including pollution emitting industries, which are more likely to be located near low-income communities of color.^{49,50} Likewise, 29% of all minorities in the US and 26% of all households below the poverty level live within 3 miles of a Superfund site.⁵¹

Workshop discussions highlighted how discriminatory policies of the past, such as redlining—an exclusionary mortgage appraisal practice from the 1930s—continue to drive current differences in air pollution exposure^{49,52} and health disparities, such as worse birth outcomes.⁵³ Upstream factors can also result in reduced access to resources that can benefit and improve health, such as access to health care,⁵⁴ healthy foods,⁵⁵ and green space.⁵⁶

Similarly, racist beauty norms affect chemical exposures through the use of personal care products by women of color,

such as skin lightening creams and hair straighteners, which contain endocrine-disrupting chemicals,⁵⁷ and have been linked to ovarian,⁵⁸ uterine,⁵⁹ and breast cancers.^{58–60} Compared to white women, and independent of socioeconomic status,⁵⁷ women of color have higher serum or urinary concentrations of such chemicals, which have been linked to uterine fibroids.⁶¹

Participants grappled with the complexity of how the combination of structural factors, chemical and nonchemical exposures, and factors within a person's body—including their genes and gene expression, epigenetics, hormones, microbiome, and physiology—affect women's health. Collectively, these factors make up their exposome: the totality of an individual's exposures across the life course and how those exposures affect biology.^{62,63} These environmental and social stressors have synergistic and cumulative effects on the health of individuals.^{36,63}

Considering the broader context of historical and discriminatory structural factors that shape the distribution of social and environmental determinants of health will allow researchers and decision makers to better identify and implement effective strategies to address them, participants suggested (Figure 1).³³

Discussion

The April 2022 workshop focused on reproductive health outcomes and diseases specific to women and the role of racism in driving disparate exposure to chemical and nonchemical stressors. As noted in the introduction, the purpose of this commentary is to synthesize workshop discussions with an emphasis on current challenges and recommendations to address women's environmental and reproductive health disparities. Although most of the examples presented here are based on studies involving cisgender women of reproductive age, workshop participants stressed that issues of exposure and health disparities also apply to sexual and gender minorities throughout life. Furthermore, this commentary focuses on US populations and implications for US-based researchers, but social determinants of health, including racial and gender discrimination, are global issues.⁶⁴ Speakers noted the importance of racism being recognized as a driver of disparities in health on a global scale.

Throughout the workshop, several cross-cutting themes emerged as opportunities to promote women's health equity and justice. The first theme is to move away from merely documenting exposure and health disparities to identifying and implementing effective interventions. This shift requires gaining a deeper understanding of the complex structural causes of disparities. The second theme is to move away from the traditional focus on individual behavior change to improve health to addressing the upstream factors of structural racism that drive women's environmental health and reproductive health disparities, which will require policy and systems-level change. The third theme is placing greater emphasis on meaningful community engagement in which affected individuals have opportunities to voice concerns, participate in research, and share power in decision-making.

These themes represent significant shifts in the status quo. The remainder of this commentary pairs key challenges that were discussed related to the themes along with one or more recommendations. As appropriate, examples where researchers have been successful in overcoming one or more aspects of an identified challenge are included; however, these recommendations and examples of progress made toward solutions are not meant to be exhaustive or prescriptive. Rather, they are included to illustrate how bringing together diverse perspectives and thinking outside the box can begin to address such broad and complex barriers to women's health equity.

Finally, the challenges and their recommendations are organized by different partner groups—researchers, clinicians, and

research funders and publishers (Table 1). However, multidisciplinary collaboration within and across these groups and with communities is critical to addressing these challenges and advancing women's health equity.

Workshop speakers and organizers appreciate that achieving these recommendations will be challenging; however, those challenges do not reduce their importance, and those tasked with protecting health should rely on currently available information to make progress toward advancing women's health equity despite these barriers.

Researchers: Challenges and Solutions

Researchers are well trained in the scientific method, an iterative process of refining, altering, expanding, or rejecting hypotheses based on new information. By developing innovative approaches to better capture the structural and social aspects of our environment that affect health, participants stressed how researchers are uniquely positioned to identify innovative solutions to pressing problems.

Challenge: racism as a driver vs. confounder. Historically, health research considered race as an individual genetic trait or a population-level confounder, instead of racism as a driver of outcomes. Even now, few population studies of reproductive health outcomes specifically name structural racism as a driver of disparities⁶⁵ or integrate upstream quantitative or qualitative measures of structural racism, representing a missed opportunity to identify underlying mechanisms and potential solutions.^{66,67}

Workshop recommendation. By incorporating and operationalizing quantitative measures of structural racism into existing environmental index and disparity mapping tools,^{47,48} as well as epidemiology studies, researchers can better understand how upstream factors contribute to women's environmental and reproductive health disparities and reveal a path toward intervention.^{66,67}

In a narrative review, Alson et al.⁶⁶ identified multiple quantitative measures of structural racism within four domains that may affect reproductive health outcomes—civil rights laws and legal racial discrimination, residential segregation and housing discrimination, police violence, and mass incarceration. Additional quantitative measures may include the index of concentration at the extremes,⁶⁸ the area-deprivation index,⁶⁹ and the redlining index.⁷⁰

Other strategies may include linking existing datasets using shared variables, such as census tracts, combining quantitative and qualitative data in mixed-methods analyses, and using multi-level and multidimensional models,⁶⁷ for example, using scales, indices, and indicators that reflect the multidimensional and reinforcing nature of structural racism, such as combining rates of incarceration, racist policies, unemployment, educational attainment, and others.^{10,71}

Challenge: incorporating nonchemical stressors as a critical component of the exposome. The exposome is a promising concept for integrating and understanding the interacting drivers of health disparities.⁷² However, despite advancements in exposome models, measuring nonchemical stressors remains a challenge, and the concept has yet to be systematically operationalized in such a way that addresses health disparities.^{73–75}

Workshop recommendation. As researchers work to analyze all of the environmental drivers of health and disease comprehensively and systematically, they need to identify exposome models that incorporate mediating factors, including the natural, built, social, and policy environments. Such exposome approaches can help scientists and decision makers better understand and address the issues driving women's health disparities by considering the local social and environmental exposure context. The public health exposome model⁷⁴ and those that incorporate community perspectives,⁷⁶ for example, can help researchers better understand the mechanisms driving health disparities. Furthermore, by developing

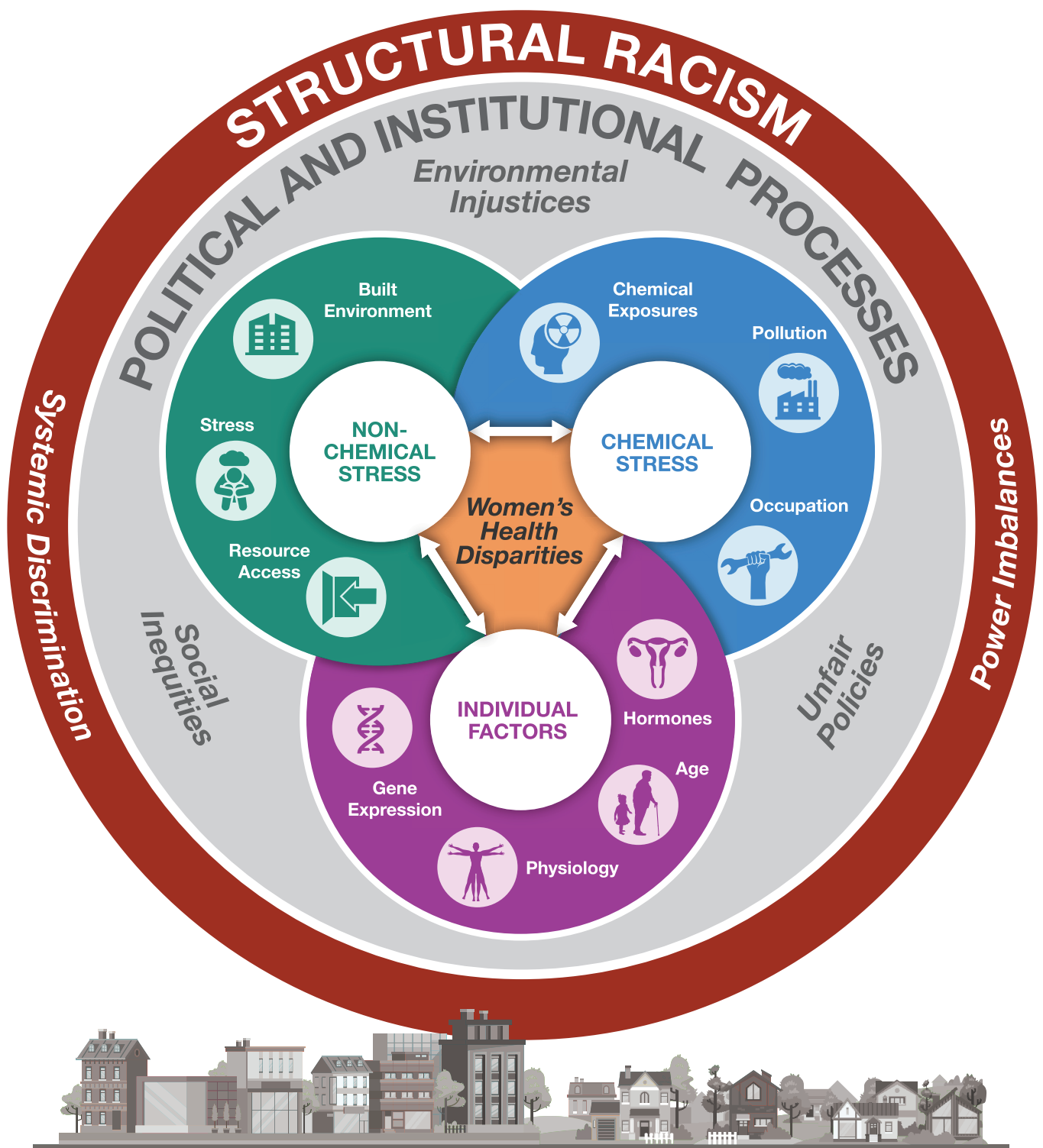


Figure 1. Conceptual model illustrating how structural racism affects multiple processes and factors related to women’s health disparities. Identifying and developing approaches to address these disparities requires meaningful community engagement and involvement at every level.

hypotheses about how social variables may affect health outcomes, exposome researchers can better select which social variables to include in their analyses.⁷⁵

Researchers must also recognize that multiple forms of discrimination and inequality can exist for an individual. Intersectionality is a framework that recognizes how multiple social identities such as race, gender, sexual orientation, socioeconomic status, and disability

intersect to determine an individual’s unique experiences of discrimination and oppression.^{77,78} Integrating intersectionality into the exposome provides a more complete understanding of how racism, sexism, and other social stressors interact with environmental factors to influence health outcomes. An intersectionality approach to the exposome can support development of more effective policies and interventions to reduce health disparities.⁷³

Table 1. Challenges and recommendations to achieving women’s environmental and reproductive health equity, as discussed by workshop participants. Overcoming these challenges requires collaboration across groups and authentic partnerships with communities.

Partner group	Challenge	Recommendation
Researchers	Racism as a driver vs. confounder	Incorporate quantitative measures of structural racism into environmental index and disparity mapping tools and in epidemiological studies.
Researchers	Incorporating nonchemical stressors as a critical component of the exposome	Identify exposome models that incorporate natural, built, social, and policy environments.
Researchers	Lack of diversity in cohorts for studies of environmental causes of diseases	Partner with trusted organizations and community members, align communication efforts with culture and language, and reimburse study participants’ transportation in order to recruit populations underrepresented in research.
Researchers	Lack of complexity of <i>in vivo</i> and <i>in vitro</i> models	Design animal studies that mimic genetic diversity in the human population, enhance genetic diversity of cell sources, utilize stress challenges that incorporate experience of inequality, and examine how chemical and nonchemical stressors interact to affect health.
Researchers	Promoting meaningful community engagement and partnerships to achieve health equity	Use a conceptual model to promote equitable and ethical community engagement and empowerment in research.
Clinicians	Incorporating environmental health history and exposures in patient care	Integrate environmental health in clinical education through inclusion in curricula and continuing education. Use existing resources to assess environmental health history as part of patient care.
Clinicians	Identifying and eliminating interpersonal discrimination in health care settings	Change clinical curricula to include the effects of racism, standardize how race and ethnicity are described in clinical practice, and create opportunities for current and future practitioners to learn about antiracism.
Clinicians	Implementing patient-centered care (PCC) in disproportionately impacted communities	Expand the use of PCC in women’s health.
Research funders and publishers	Publishing qualitative health disparities research in high-impact journals	Build journal editorial review boards that are diverse in demographics and disciplines.
Research funders and publishers	Lack of diversity in biomedical research workforce	Support initiatives and target funding opportunities to recruit and retain groups underrepresented in the biomedical sciences.

Both of these approaches require robust multidisciplinary partnerships across the environmental health sciences, including toxicology, epidemiology, biomedical sciences, natural and earth sciences, engineering, urban planning, social and behavioral sciences, policy sciences, as well as contributions from clinicians, statisticians, data scientists, and more. Such collaborations should be embedded within the exposome framework from start to finish—from study planning, data collection, and analysis through dissemination and implementation.

Challenge: lack of diversity in cohorts in studying environmental causes of disease. Those experiencing greater chemical and nonchemical stressors due to racism and income level are less likely to be included in studies examining the environmental causes of disease compared to their counterparts.^{79,80} This lack of demographic diversity in cohorts limits the generalizability of study results, thus exacerbating health disparities by excluding a large and growing segment of the US population from the benefits of scientific discovery that can improve health.^{79,80}

Workshop recommendation. Investigators should focus cohort recruitment efforts so that study participants reflect the diversity in the community being studied. Increased diversity in research-focused aspects of lived experiences increases knowledge of how interventions may work in varied contexts.⁸¹ Additionally, cohort diversity may be part of helping to build trust between a diverse public and researchers.⁸²

Approaches to achieve adequate participation of underrepresented populations in research can include partnering with trusted organizations, health care providers, and leaders in the community to promote and facilitate recruitment; aligning communication efforts with community culture and primary language; and providing reimbursement and transportation to study participants for their time and resources expended to take part in the study.⁷⁹

Research funding agencies can also encourage investigators to conduct inclusive research by launching funding opportunities and initiatives that aim to increase minority participation. For example, the NIH *All of Us* research program aims to enroll at least one million participants, which reflect the diversity of the US, to advance precision medicine and improve health.⁸³

Researchers should also expand cohort recruitment efforts to include sexual and gender minorities, as these populations similarly experience discrimination that may affect health outcomes. These recruitment efforts should include outreach to sexual and gender minorities across race and class, who are often excluded from gynecologic research.⁷³ For example, in an effort to better understand patients’ intersectional health experiences, investigators of the Fibroids Observational Research on Genes and the Environment study are recruiting transgender men at different intersections of race and class.⁷³

Furthermore, improved measures of sex, gender identity, and sexual orientation will allow researchers to better understand the upstream factors that impact health and disease in these populations. A 2022 report from the National Academies of Science, Engineering, and Medicine offered guidance to researchers for collecting data and selecting appropriate measures to assess sex, gender identity, and sexual orientation.⁸⁴

Challenge: lack of complexity of *in vivo* and *in vitro* models. Many cell- and animal-based toxicological studies do not reflect the complexity of genetic diversity and exposures in humans, limiting translation of results to human populations. Furthermore, these models lack the complexity of human lived experiences, including racism and the structural, political, and institutional processes it affects, as well as the downstream social, external, and individual factors (see Figure 1).

Workshop recommendation. In cell-based research, scientists should enhance the genetic diversity of cell sources by including cells from multiple ethnic origins in their studies of chemical and nonchemical stressors. Researchers should also design animal studies to align more closely with the human condition, including capturing genetic diversity and examining co-occurring risk factors—such as chemical exposures, nutritionally modified diets, underlying health conditions, and psychosocial stress—that interact and potentially have synergistic effects. Such approaches will better model the intersecting factors involved in environmental health disparities.

To more accurately mimic genetic diversity in the human population, researchers are encouraged to use the Collaborative Cross and Diversity Outbred mouse models.^{85,86} These models may demonstrate how responses to environmental exposures vary among individuals compared to genetically identical, inbred mouse strains.

Participants stressed that researchers should also utilize stress challenges that are more realistic and relevant to the human experience of inequality compared to commonly used challenges, like immobilization, forced swim, or social isolation. For example, inequity aversion, where completing the same task results in unequal reward, may better model social disparity and stress experienced by humans.²⁹

Similarly, it is important to design experiments that shed light on how chemical exposures, including to low levels over a long period of time, and nonchemical stressors can interact to affect health. For example, because the highest levels of lead exposure in the US tend to be in low socioeconomic status populations, and the higher allostatic load of those populations contributes to disease incidence, researchers have begun to disentangle the complex ways in which lead exposure and stress interact with each other additively and synergistically, even creating new effects unobserved with either variable alone.⁸⁷

Together, these approaches can help researchers and regulators better model and understand the complexity of cumulative exposures on health, participants explained.

Challenge: promotion of meaningful community engagement and partnerships to achieve health equity. Communities most impacted by structural racism and health disparities have historically not been included in all phases of the research process or in decisions to create or restructure the programs and policies that are designed to benefit them. Further, some historical and unethical studies have severely damaged trust and contributed to intergenerational trauma in these groups.^{81,88–90}

This has created barriers to conducting research that is most relevant to community needs and to developing effective interventions, policies, and programs to reduce women's health disparities. While involving community members and collaborating with them has become more standard practice, it can still be difficult to form authentic partnerships and build trust in communities disproportionately impacted by structural racism to achieve the desired outcomes.

Workshop recommendation. Communities should be involved in interventions at different scales, from the individual to the structural (see Figure 1). Conceptual models can help researchers plan, implement, assess, and sustain meaningful community engagement, particularly those models grounded in a community-based participatory research approach and that focus explicitly on achieving health equity, empowering communities, and systems change.^{91–94}

Common elements among models that promote equitable and ethical community engagement in research and in policy and intervention development to reduce health disparities, include the following:

- **Building trust:** Community engagement should be grounded in trust among all partners. This requires researchers to show up authentically, be honest and transparent about intentions and limitations, and engage in active listening.⁹¹ Gaining community trust is a long-term commitment, one that may require years of showing up before embarking on research endeavors and sustaining relationships after a grant cycle ends.⁹⁵
- **Engaging community:** The community should have the option to be involved in all stages of research, from conception of the research question to publication of results. Common research questions and goals should be developed in collaboration with communities to address their concerns. This demonstrates shared power and allows communities to see themselves reflected in research. Developing a community advisory board can be an effective method to ensure community engagement and shared leadership throughout the project.^{96,97} Researchers should also be mindful in scheduling meetings at times that are convenient for participants with different working schedules and, if needed, provide reimbursement, childcare, and food at those meetings.
- **Engaging youth:** Engaging youth in research can motivate them to pursue careers in science, build their self-esteem and leadership skills, and become environmental justice leaders in their communities. Engaging youth also benefits researchers, as young people bring creativity, new ideas, and energy to research endeavors.^{98–101}
- **Returning research results:** Returning research results to study participants and the broader community is critical to help people understand and reduce their exposures. Researchers should ensure materials and messages are culturally appropriate for the community. Tools, such as the Digital Exposure Report-Back Interface (DERBI), can help researchers present and discuss results with participants, while providing individuals with useful information on how to reduce their own exposures, thereby facilitating solutions-oriented research.^{102–104}
- **Sustainability:** Providing technical assistance after a grant cycle ends is key to sustaining relationships. Community Engagement Cores, a required component of many NIEHS-funded research centers, can help scientists continually show up in communities. Research supported through multiple funding mechanisms can help sustain long-term partnerships and is more likely to achieve structural change.¹⁰⁵

Clinicians: Challenges and Solutions

Clinicians, including doctors, nurses, advanced practice providers, clinic managers, and allied health professionals, form care teams that diagnose and treat illnesses that are directly or indirectly related to patients' environmental exposures.¹⁰⁶ Clinicians rely on scientific advances to inform and refine their care plans. Participants argued that improving clinicians' environmental health knowledge is key to diagnosing, treating, and preventing environmentally related diseases and achieving women's health justice.

Challenge: incorporation of environmental health history and exposures in patient care. Workshop participants noted that building a holistic view of the barriers patients experience in reducing environmental exposures is a challenge for time-constrained clinicians who may lack environmental health knowledge. For example, patients may be experiencing downstream effects of structural racism, including challenges with economic mobility and difficulty finding safe and healthy housing, transportation, and recreation opportunities that promote health. By not identifying the challenges patients have outside of the health care system, clinicians might overlook intervention opportunities, such as connecting patients to social services and reducing their environmental exposures.

Workshop recommendation. Health care providers can support patients facing higher environmental disease burdens by having routine conversation about their built environment and environmental exposures. There are different methods for working with patients to assess and mitigate harmful exposures from *in utero* to childhood, adolescence, and other life stages.¹⁰⁷ Although many obstetricians self-reported that conducting an environmental health history would help identify patients' exposures, only 1 in 15 respondents reported receiving training on collecting environmental health histories.¹⁰⁸ The inclusion of environmental health into the medical school curriculum is key to ensuring the next generation of physicians is prepared to diagnose, treat, and prevent environmentally related diseases in patients.¹⁰⁹ Clinicians can take advantage of resources that offer guidance on documenting environmental exposures, testing, and clinical follow up for specific scenarios, such as for per- and polyfluoroalkyl substances (PFAS).¹¹⁰ Participating in continuing education opportunities can also help prepare clinicians to discuss the environmental causes of disease with patients and better assess their risk.

Pediatricians also have an opportunity to reduce patients' exposures to toxic chemicals and have been working to integrate environmental health in their practice. The US Environmental Protection Agency supports a national network of Pediatric Environmental Health Specialty Units (PEHSUs), which provide information on the prevention, diagnosis, management, and treatment of environmentally related health issues for the pediatric population.¹⁰⁷ For example, one PEHSU worked with environmental pediatricians and partners to create Prescriptions for Prevention, which provide expecting parents and families with children information about how to reduce harmful exposures.¹¹¹ PEHSU resources provide information on a range of environmental exposures such as arsenic, lead, PFAS, formaldehyde, and carbon monoxide.

Challenge: identification and elimination of interpersonal discrimination in health care settings. Discrimination in health care settings, especially in women's reproductive health, affects diagnoses and treatment. Implicit interpersonal discrimination,¹¹² along with structural racism, drives disparities in mortality and morbidity during childbirth,¹¹³ and other women's health outcomes.¹¹⁴

Workshop recommendation. Eliminating interpersonal discrimination in health care settings requires systemic changes to current medical school curricula,³² nursing curricula,¹¹⁵ curricula for other providers, and continuing education courses. Improving or requiring clinical training on the effects of racism and implicit bias in clinical practice is necessary to reduce health disparities.^{30,32,115} The literature on improving health professionals' interactions with a diverse patient population provides many strategies, including recommendations to:

- Dedicate more instructional hours to social epidemiologists, medical anthropologists, and others that research racism and health in the education curriculum.³⁰
- Standardize how race and ethnicity are described in clinical practice and change how race is used to assess patients.^{32,116}
- Improve clinical practice by partnering with community health workers and developing training programs that increase language and cultural competency.¹¹⁷
- Foster early education opportunities that will lead to greater diversity in the medical work-force, so patients can see doctors with whom they identify.¹¹⁸
- Create opportunities for current practitioners to learn about antiracism and health disparities through continuing education courses.¹¹⁹

Challenge: implementing patient-centered care in disproportionately impacted communities. There are many challenges with implementing patient-centered care (PCC) in communities with unmet needs—such as reduced health care access, social

isolation, and management of multiple chronic illnesses¹²⁰—that also face environmental exposures. A PCC approach incorporates patient preferences, needs, and values in clinical decision-making¹²¹ and encourages patients to be empowered and active partners in the patient-provider relationship.¹²² Women were documented as less likely than men to experience PCC, and PCC experiences differed by race.^{121–123}

Workshop recommendation. Clinicians should expand the use of PCC, which increases patient trust, quality of care, and health outcomes¹²⁴ and can help reduce women's health disparities. An innovative application of PCC principles is group prenatal care, which has been implemented in over 100 practices across the US since 1995.¹²⁵ Group prenatal care brings together several providers, multiple pregnant people, and their caregivers. A randomized control trial found that women in group prenatal care were significantly less likely to have preterm births compared to women who received standard care¹²⁵ and group prenatal care improved pregnancy outcomes for black women.¹²⁶ Group care also increased clinician-patient time and patient and clinician satisfaction.¹²⁶

For example, the Elevating Voices, Addressing Depression, Toxic Stress and Equity (EleVATE) in Group Prenatal Care is a model that embeds an evidence-based mental health intervention into a racial equity framework and includes federally qualified community health centers, obstetric and mental health clinicians, and community organizations. The intervention reaches a predominantly low-income, under- and uninsured black population.¹²⁶ The application of EleVATE group prenatal care increased the likelihood of diagnosing mental health needs and connecting people to mental health services.¹²⁶ This approach represents a paradigm shift as it changes providers' views of patients and their barriers to care through education about structural racism rather than focusing on individual behavior without accounting for structural barriers.¹²⁶

Research Funders and Publishers: Challenges and Solutions

Institutions that fund research can guide scientific advancement by supporting projects that align with their vision for the future of the scientific landscape. Likewise, through the publishing process, scientific journals play a role in defining what is considered meritorious research within a scientific field. As such, participants noted that research funders and publishers have a responsibility to support, promote, and disseminate research that provides insight into the upstream factors driving women's health disparities.

Challenge: difficulty in publishing qualitative health disparities research in high-impact journals. Qualitative research is rarely published in high-impact health journals,¹²⁷ making it difficult to disseminate information that provides context to the factors driving health disparities and to identify appropriate interventions.

Workshop Recommendation. Journals should intentionally build editorial review boards that are diverse in terms of race, ethnicity, sex, gender, and scientific discipline. This diversity can create an environment where reviewers' academic and personal experiences allow them to appreciate and advocate for the context that qualitative data provides in illuminating the impact of upstream factors on women's health disparities.

For example, editorial boards should include individuals with expertise in fields outside the biomedical sciences, including sociology, anthropology, history, political science, psychology, environmental justice, and communication research. This academic diversity allows editors to recognize the merit of qualitative methods in health disparities research, increasing the likelihood of qualitative research being published.

Furthermore, participants from groups historically underrepresented in the editorial process bring unique knowledge,

perspectives, and insight into the role of racism and discrimination in health disparities. This diversity can also benefit scientists' careers, allowing journals to play a role in creating a diverse scientific workforce.¹²⁸

Challenge: lack of biomedical research workforce diversity. A lack of diversity in the biomedical research workforce¹²⁹ can limit researchers' perspectives and understanding of how racism and discrimination affect women's health. Historically black colleges and universities (HBCUs) and other minority-serving institutions play a critical role in preparing minority students for scientific research careers.¹²⁹ However, participants noted that due to chronic underfunding, there is an inequity in the capacity of HBCU investigators to be competitive in the biomedical research enterprise.

Workshop recommendation. A more inclusive biomedical research workforce can broaden perspectives on the role of racism and discrimination in health disparities. Creating more opportunities to bring these critical perspectives to the table can also facilitate recruitment and retention of demographically diverse study populations, as researchers from underrepresented groups may have a better understanding of the participants' culture, perspectives, lived experiences, and barriers to research participation, such as mistrust.^{130,131}

Research funding agencies should support efforts to increase participation of groups that are underrepresented in the biomedical sciences, including Asian American, Native Hawaiian and Pacific Islander; Hispanic or Latinx; black or African American; American Indian or Alaska Natives; sexual and gender minorities; and people with disabilities. These initiatives should include targeted funding opportunities to train investigators and build the research infrastructure necessary to facilitate significant scientific contributions from investigators at HBCUs and other minority-serving institutions and those conducting community-engaged research.^{132,133}

Examples of approaches to increase diversity in the biomedical research enterprise include identifying barriers and opportunities to building a diverse and inclusive scientific workforce; hosting listening sessions; and providing education, training, and funding opportunities for students and faculty from underrepresented groups.

The National Institutes of Health (NIH) launched the UNITE initiative to address structural racism and increase diversity in the biomedical sciences in February 2021.¹³⁴ Through broad and systematic evaluation, UNITE is identifying elements that perpetuate structural racism and inequitable representation within the NIH and the extramural research community and developing strategies and funding initiatives to generate significant, sustainable change.

A series of listening sessions hosted by NIEHS highlighted obstacles HBCU researchers face in the grant application process and helped the institute establish the partnerships necessary to address those challenges.¹³⁵ Sponsored by the NIEHS Office of Science Education and Diversity, the HBCU-Connect initiative expands scientific career opportunities through research mentoring, training, and funding for faculty and students at HBCUs.¹³⁶ The NIEHS Scholars Connect Program increases diversity in environmental health sciences by providing hands-on, mentored research experiences to undergraduate students interested in the biomedical sciences, with a focus on HBCU or underrepresented minority trainees.¹³⁷

Conclusion

This second workshop in a series from NIEHS continued the interdisciplinary conversation about racism and environmental health with a focus on disparities experienced by women. Workshop participants, including government officials, grant recipients, and community organization leaders identified several

key recommendations to promote women's environmental and reproductive health justice:

- Incorporate quantitative and qualitative measures of structural racism into epidemiology studies.
- Include structural and social determinants of health into exposome research.
- Increase demographic diversity in environmental epidemiology studies.
- Design toxicology studies to better reflect the complexity and diversity of human genetics and co-occurring risk factors.
- Include communities in all phases of the research process.
- Consider environmental and social determinants of health in patient care.
- Acknowledge the impacts of structural racism on quality of clinical care and train health care providers to equitably care for diverse patient populations.
- Create diverse editorial review boards that appreciate and advocate for qualitative studies.
- Increase participation of underrepresented groups in the biomedical sciences and research capacity at HBCUs and other minority-serving institutions.

Putting these recommendations into practice will require broadening the definition of the environment to include the full context and complexity of lived experiences that contribute to cumulative risk. Additionally, the scope of environmental health research must also broaden to reveal the underlying structural causes for exposures and health disparities so that effective solutions can be identified. Importantly, this paradigm shift should also occur within the international community, as racial and gender discrimination are global issues.

Moving forward, bringing together diverse collaborators and disciplines across the environmental health sciences, including researchers, clinicians, and communities, can provide a unique opportunity to find real and practical solutions to advancing women's health equity and justice.

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