

# Integrating Intersectionality Into the Exposome Paradigm: A Novel Approach to Racial Inequities in Uterine Fibroids

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 See also the Intersectionality section, pp. 88–109.

Intersectionality is a critical theoretical framework that emphasizes the influence of intersecting systems of oppression on the lived experiences of people marginalized by inequity. Although applications of intersectionality are increasing in public health, this framework is absent in environmental health, which has instead focused on the exposome, a paradigm that considers the totality of an individual's environmental exposures across the life course.

Despite advancements in the biological complexity of exposome models, they continue to fall short in addressing health inequities. Therefore, we highlight the need for integrating intersectionality into the exposome. We introduce key concepts and tools for environmental health scientists interested in operationalizing intersectionality in exposome studies and discuss examples of this innovative approach from our work on racial inequities in uterine fibroids.

Our case studies illustrate how interlocking systems of racism and sexism may affect Black women's exposure to environmental chemicals, their epigenetic regulation of uterine fibroids, and their clinical care. Because health relies on biological and social-structural determinants and varies across different intersectional positions, our proposed framework may be a promising approach for understanding environmental health inequities and furthering social justice. (*Am J Public Health*. 2021;111:104–109. <https://doi.org/10.2105/AJPH.2020.305979>)

**A**s communities across the United States struggle with the devastating consequences of COVID-19, we are once again faced with our nation's glaring social and economic inequities and the consequent disproportionate impacts of the pandemic on Black and Brown communities marginalized by inequity. As we debate the best approaches for rebuilding our fractured public health system, we must also reexamine our approach to health research and consider new frameworks to better understand and intervene in health inequities.

We highlight the need for integrating intersectionality into the exposome. We discuss the application of this novel approach using examples from the

Fibroids, Observational Research on Genes and the Environment (FORGE) study, a transdisciplinary effort that uses expertise from environmental health (EH), epidemiology, gynecology, epigenetics, social psychology, and bioinformatics to address racial inequities in uterine leiomyomas (fibroids). We describe benefits of our proposed approach, challenges we have encountered, and recommendations for future work.

The exposome is a contextual model of chronic disease risk that considers the totality of an individual's environmental exposures across the life course.<sup>1</sup> This paradigm differs from traditional epidemiologic approaches in three major ways: expanded and dynamic exposure

assessment, the integration of data on exposure and response over time and space, and the use of high-dimensional "big data" for the data-driven discovery of unexpected exposure–disease associations and the generation of new hypotheses.<sup>2</sup> Common external measures of exposure include chemical and physical environmental hazards in food, consumer products, water, air, soil, and the built environment. The internal environmental exposures, or biomarkers of response, are often measured on "omics" technologies, which use the power of genomics, epigenomics, transcriptomics, proteomics, and metabolomics to provide information about mechanisms of disease. In the United

States, federal funding agencies (e.g., National Institute of Environmental Health Sciences) have advanced efforts to implement the exposome within EH by supporting capacity and infrastructure development.<sup>2</sup>

Most exposome models mention the importance of an individual's social position (e.g., educational attainment) and psychosocial stress in shaping health. The public health exposome<sup>3</sup> and socioexposome<sup>4</sup> go further and call for the integration of political processes (e.g., civic governance) and social-structural factors (e.g., residential segregation) into the exposome. However, none of the previous models explicitly mentions intersectionality.

First coined by Kimberle Crenshaw to address the synergistic experiences of Black women who endure multiple forms of oppression as both Black and female,<sup>5</sup> intersectionality is a critical theoretical framework that has been expanded to examine how multiple social identities such as race, gender, sexual orientation, and socioeconomic status intersect at the microlevel of individual experience to reflect interlocking systems of privilege and oppression (i.e., racism, sexism, heterosexism, classism) at the macro-social-structural level.<sup>6</sup> The integration of intersectionality into the exposome (Figure A [available as a supplement to the online version of this article at <http://www.ajph.org>]) has the potential to enrich EH through greater attention to causal processes producing health inequities<sup>7</sup> and the development of more effective interventions and public policy.

## THE ENVIRONMENTAL INJUSTICE OF BEAUTY

Although environmental chemicals in cosmetics and other consumer products are commonly included in the

exposome, the social context of these exposures is rarely considered. Zota and Shamasunder<sup>8</sup> were the first to frame racial/ethnic inequalities in beauty product-related chemical exposures as an environmental justice concern. We posited that elevated exposures to beauty product chemicals in women of color are, in part, attributable to the “environmental injustice of beauty”—a framework that links intersectional systems of oppression (i.e., racism, sexism, classism) to racialized beauty practices, which, in turn, leads to unequal environmental exposures and poor health.<sup>8</sup>

Because of historical and ongoing racial discrimination and cultural imperialism, there is a hierarchy of global beauty norms that prioritizes whiteness and White femininity. For example, racism, sexism, and classism intersect in Black hair discrimination, which penalizes Black people, especially Black women, for wearing their hair in natural styles. Black hair discrimination often operates in the workplace: some employers discourage, or even prohibit, Black women from wearing natural hairstyles.<sup>8,9</sup> This form of intersectional discrimination can negatively affect professional opportunities for Black women and consequently their long-term wealth.<sup>9</sup> To comply with racialized beauty norms, Black women may feel pressure to straighten their hair using beauty products that contain harmful endocrine-disrupting chemicals, which can affect reproductive health.<sup>8</sup> Indeed, hair relaxer use is associated with an increased risk of fibroids among Black women.<sup>10</sup>

We encourage EH scientists to move beyond individual risk factors and examine intersections of racism and sexism as determinants of environmental exposures, especially for hazards that

are shaped by social inequity. This type of research would increase the understanding of EH risks and help secure environmental justice by moving interventions further upstream. Analyses should jointly consider distal sources of pollution (e.g., racist housing policies such as redlining), exposure pathways (e.g., lead dust, air pollution), and biomarkers of exposure and response (e.g., blood lead, epigenetic modifications). This work would benefit from transdisciplinary collaborations that include experts from the social sciences and humanities. For example, our environmental injustice of beauty framework integrates theory and data from the social sciences, humanities, marketing, medicine, and public health.

## RACE, ENVIRONMENT, AND THE FIBROID EPIGENOME

Fibroids are the most common tumor in women. Seventy percent of White women and more than 80% of Black women will have fibroids; severe symptoms develop in 15% to 30% of these women.<sup>11</sup> These noncancerous tumors of the uterus can substantially burden the millions of women they affect by contributing to pelvic pain, heavy bleeding, pregnancy complications, and infertility. Hysterectomy, the only permanent intervention, compromises women's ability to preserve fertility during their reproductive prime.<sup>11</sup>

Black women are disproportionately burdened by fibroids. They experience a higher risk of fibroids, an earlier age of onset, and more severe symptoms than do non-Black women.<sup>12</sup> Drivers of these racial inequalities are poorly understood. Most scientists in the field have conceptualized race as a biological

factor and have focused on identifying molecular and genetic mechanisms responsible for racial disparities. Although isolated studies have found some biological differences in fibroids between Black and White women,<sup>11</sup> a recent study concluded that genetic and molecular differences do not explain the increased fibroid burden for Black women.<sup>13</sup> Therefore, there is a need to identify modifiable risk factors of fibroids and specifically examine how intersectional discrimination can become biologically embedded in Black women.

Because ovarian steroid hormones are crucial to the fibroid life cycle, we developed the FORGE study to evaluate the contribution of endocrine-disrupting chemical exposures to fibroid outcomes. Our study population included 57 premenopausal women undergoing surgery for fibroid management; participants were predominately Black, college educated, and privately insured. In our initial study, we observed positive associations between multiple phthalate metabolites and uterine volume, a clinically relevant measure of fibroid burden.<sup>14</sup> To examine mechanistic pathways linking phthalate exposures to fibroid biology, we quantified the expression of 754 microRNAs (miRNAs) in participants' fibroid tumors. We focused on miRNAs, noncoding RNA molecules that regulate posttranscriptional gene expression, because these epigenetic alterations are common internal measures of environmental exposures and miRNAs help regulate mechanisms important to fibroid development.<sup>15</sup>

We found that the expression of certain miRNAs in fibroid tissue was associated with phthalate biomarkers. We also observed that eight phthalate-miRNA associations significantly varied

between Black women and Latina or White women.<sup>15</sup> We reject the premise that differences in phthalate-miRNA associations by race/ethnicity are attributable to biological differences between racial/ethnic groups. There were no significant differences in miRNA expression by race/ethnicity. Furthermore, a recent study that characterized the fibroid epigenome, exome, and transcriptome reported no differences in molecular subtypes of fibroids between Black and White women.<sup>16</sup> Rather, we conceptualize race as a social category. Racism and other social-structural stressors associated with race can influence a wide range of physical and psychosocial exposures.<sup>17</sup> Thus, our data support the idea that the epigenome may have the potential to act as a biological sensor of cumulative exposure to chemical and nonchemical stressors related to inequity.

There are substantial limitations to our preliminary analysis, including the small sample size, the cross-sectional study design, the inclusion of only one self-identified Latina participant, and the lack of data on racism, sexism, and intersectional discrimination. However, these compelling findings open the door to new hypotheses, which can be tested in future studies through an intersectional framework. We encourage researchers to use validated measures of gendered racism such as the Gendered Racial Microaggressions Scale, which captures the experience of racism and sexism simultaneously.<sup>18</sup> We also recommend that researchers differentiate between the social influence of race and the biological influence of genetic ancestry, which can differ between racial groups. Researchers typically account for the latter by genotyping blood samples for validated markers of

continental ancestry and estimating admixture proportions.<sup>17</sup>

## CENTERING GROUPS MARGINALIZED BY INEQUITY

A key tenet of intersectionality is that the experiences of people marginalized by inequity must always be the focal point—a concept that challenges the inherent biases of biomedical research.<sup>6</sup> For example, sexual and gender minorities at different intersections of race and class are often excluded from gynecologic research, which generally prioritizes the health issues of White, middle-class, cisgender, heterosexual women. Indeed, there are no published fibroid studies that include sexual and gender minorities, rendering these populations and their experiences empirically invisible.<sup>19</sup>

In an effort to recognize the intersectional realities of patients' lived experiences and address early challenges in recruitment, we expanded the FORGE study to include transgender men across intersections of race and class seeking gynecologic care as a unique control group because we aimed to recruit patients undergoing hysterectomies without fibroids. Some experts have questioned the appropriateness of transmen in fibroid research because hormonal therapy can affect biological mechanisms of gynecologic disease or complicate the traditional, epidemiologic definition of a "control." However, we argue that hormonal therapy should not be a reason to exclude transmen because ciswomen who use hormonal therapy for various reasons (e.g., birth control) are still included in fibroid studies.

If we maintain the status quo, our field will remain complicit in the

omission of sexual and gender minorities in health research and help to perpetuate the marginalization of sexual and gender minorities. Because multiply marginalized populations may not be readily accessible using traditional sampling approaches, Bowleg and Bauer recommend respondent-driven sampling or time-space sampling as useful tools for intersectionality researchers.<sup>19</sup> Greater efforts to engage people at different intersectional positions in exposome studies will help ensure that scientific findings are more inclusive.

“Centering” marginalized groups also means ensuring that the research reflects the experiences of the population under study. As part of this effort, we conducted a qualitative study of Black women in the FORGE study to learn more about their health care experiences (VanNoy et al., unpublished) because fibroid treatments vary for women at different intersections of race, class, and gender. Black women are more likely to undergo hysterectomy than are White women, even after adjusting for socioeconomic status and fibroid characteristics.<sup>12</sup> Moreover, compared with non-Black women with private insurance, Black women with public health insurance are more likely to undergo open, abdominal surgeries than minimally invasive procedures.<sup>12</sup> These inequities underscore the historical and contemporary impacts of intersectional discrimination against Black women in obstetric and gynecologic settings (e.g., medical experimentation of enslaved Black women, forced sterilization, Black maternal mortality rates).<sup>20</sup> Indeed, poor patient-doctor interactions, including delayed diagnoses, limited treatment options offered, and feelings of mistrust and devaluation, were featured in many Black women’s

treatment-seeking experiences (VanNoy et al., unpublished).

Compatible with intersectionality, the structural competency framework posits that patients’ health care experiences extend beyond interpersonal interactions with clinicians and are also shaped by macro-social-structural factors (e.g., infrastructure, institutional discrimination) that drive health inequities.<sup>21</sup> Our qualitative findings reinforce this concept by shedding important insight into how upstream factors, such as discrimination in health care settings and community norms about reproductive health, can influence fibroid treatment decisions (VanNoy et al., unpublished). Clinicians and researchers must be trained to not only address their own biases but also recognize and address the historical and social-structural context within which Black women seek clinical care. In practice, this means prioritizing the unique perspectives and experiences of Black women, offering a range of management options, and partnering with communities to disseminate culturally relevant information on fibroids that minimizes structural barriers to medical care. These efforts can increase structurally competent clinical care for Black women and help reduce racial inequities in fibroid outcomes and treatment.

## METHODOLOGIC AND STATISTICAL CONSIDERATIONS

Although researchers have primarily relied on qualitative methods to investigate intersectionality, applications of intersectionality in quantitative research are emerging.<sup>7,22</sup> Else-Quest and Hyde assert that intersectionality can be applied to multiple aspects of the

quantitative research process, including theory, study design, sampling techniques, measurements, data analysis, and data interpretation.<sup>23</sup> Because of space constraints, we focus our discussion on data analytic strategies for advancing intersectionality in exposome research.

Epidemiologic measures of statistical interaction, such as multiplicative product terms in regression models, are commonly used to evaluate the health impacts of multiple social identities. Jackson et al. have proposed the “joint disparity” measure to describe the excess intersectional disparity that pertains to dually marginalized groups.<sup>24</sup> However cross-product terms and joint disparity measures focus mostly on social identities and not systems of oppression. Multilevel modeling is one approach that allows for explicit examination of the interplay between individual factors (e.g., personal identity) and group-level processes (e.g., structural discrimination).<sup>22</sup>

Mediation analysis can be a useful tool to estimate the extent to which racial inequalities in health outcomes are mediated by environmental exposures. These methods can be modified to examine environmental mediators of intersectional health inequities. Lastly, some of the methods employed to analyze complex environmental mixtures in exposome studies may be relevant. For example, unsupervised methods such as principal components analysis and latent class analysis organize a population into mutually exclusive and exhaustive classes or subgroups on the basis of exposures or other characteristics. In exposome studies with high-dimensional exposure data, these techniques can help to identify subgroups with similar environmental exposures. In intersectionality research,

these techniques have been used to identify subgroups with similar experiences of disadvantage or privilege.<sup>23,25</sup> Because many of our traditional statistical tools are directly challenged by intersectionality, which examines inequity across multiple (nonadditive) social and structural dimensions, method development for quantifying intersectionality is an area of ongoing research.<sup>7</sup>

## CONCLUSIONS

Despite advancements in the biological complexity of exposome models, they continue to fall short in advancing health equity and securing environmental justice. Because health relies on the confluence of biological and social–structural determinants across the life course and is affected by dynamic intersectional positions, integrating intersectionality into the exposome may be a promising approach for addressing these shortcomings.

Integrating intersectionality may seem like a daunting task. To increase feasibility, we have introduced key concepts and tools for EH scientists interested in operationalizing intersectionality and discussed applications of our proposed approach from the FORGE study on racial inequities in fibroids. Furthermore, as Agenor<sup>22</sup> explains, population health scientists interested in intersectionality can design interrelated studies that together provide an intersectional analysis on a health issue. However, the integration of intersectionality into the exposome is not simple, and innovation in theory, study design, sampling, measurement, and analytic methodologies is required to realize the power of the proposed framework. We hope the benefits, challenges, and

recommendations discussed will inform the next generation of exposome studies. *AJPH*

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The George Washington University institutional review board approved the research activities described in this commentary.

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