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Sex/Gender and the Biosocial Turn

Heather Shattuck-Heidorn¹ and Sarah S. Richardson^{1, 2}

1. Studies of Women, Gender, and Sexuality; Harvard University
2. Department of the History of Science

Corresponding Author: Heather Shattuck-Heidorn, faegre@fas.harvard.edu

Sex/Gender and the Biosocial Turn

Feminist scientists have offered clear frameworks and research methods for empirically investigating sex/gender within the biological sciences^{1,2,3,4,5}. Yet many scientists continue to struggle to operationalize gender in research design^{6,7}. In a review of epidemiological research conducted between 2006 and 2014, Jahn et al. found that researchers frequently discuss sex/gender in the introduction and discussion of a publication, but rarely actually incorporate sex/gender theory into study design or statistical analysis.

Recent policies by elite bioscience funders and journals requiring documentation of sex differences in preclinical research exemplify and amplify this disconnect. For example, a 2016 National Institutes of Health (NIH) guidance and infographic (Figure 1) released in tandem with the rollout of their new mandate for analyzing sex in basic research included but one example of how gender may influence a biological trait - the simplistic and highly stereotyped scenario of the effects of wearing high heels on knee joints. The NIH's guidance is a high-profile example of how the influence of gender on biological traits and health outcomes is frequently poorly

¹ Schiebinger, Londa. *Gendered innovations in science and engineering*. Stanford: Stanford University Press. (2008). [Return to text]

² Springer, Kristen W., Jeanne Mager Stellman, and Rebecca M. Jordan-Young. "Beyond a catalogue of differences: a theoretical frame and good practice guidelines for researching sex/gender in human health." *Social Science & Medicine* 74.11 (2012): 1817-1824. [Return to text]

³ Ritz, Stacey A., et al. "First steps for integrating sex and gender considerations into basic experimental biomedical research." *The FASEB Journal* 28.1 (2014): 4-13. [Return to text]

⁴ Singh, Sarah, and Ineke Klinge. "Mining for Methods." *FZG–Freiburger Zeitschrift für GeschlechterStudien* 21.2 (2015). [Return to text]

⁵ Krieger, Nancy. "Genders, sexes, and health: what are the connections—and why does it matter?." *International journal of epidemiology* 32.4 (2003): 652-657. [Return to text]

⁶ Ruiz-Cantero, María Teresa, et al. "A framework to analyse gender bias in epidemiological research." *Journal of Epidemiology & Community Health* 61.Suppl 2 (2007): ii46-ii53.[Return to text]

⁷ Jahn, Ingeborg, et al. "Examples of sex/gender sensitivity in epidemiological research: results of an evaluation of original articles published in JECH 2006–2014." *Health Research Policy and Systems* 15.1 (2017): 11. [Return to text]

understood or downplayed among biomedical researchers. Despite the routine inclusion of the concept of gender alongside that of sex in NIH literature, in practice the NIH assumes that biological differences between men and women stem primarily from intrinsic sex differences, and the NIH policy mandates only the consideration of sex, not gender, in research.

Feminist critics argue that new policies requiring the study of sex as a biological variable reify sex differences, contributing to ideological conceptions of sex differences as binary, pervasive, and biologically fixed across human populations and organismic phylogenies. In overlooking gender, such calls to study sex are unlikely to redress urgent sex/gender health inequities. But such policies are also conceptually flawed. Though we may understand sex and gender as analytically distinct concepts, materially sex and gender are always interacting; human biology, including cells and biochemistry, should be understood as emerging in concert with the environment and experience broadly defined, rather than as a product of innate sex.

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The interaction of gender and biology goes much further than high heels. It is intimately entwined even with such seemingly basic molecular aspects of sex-biology as testosterone and estrogen levels. For instance, testosterone levels in men are responsive to childcare-giving, with

⁸ Ruiz-Cantero, María Teresa, et al. "A framework to analyse gender bias in epidemiological research." *Journal of Epidemiology & Community Health* 61.Suppl 2 (2007): ii46-ii53. [Return to text]

⁸ Jahn, Ingeborg, et al. "Examples of sex/gender sensitivity in epidemiological research: results of an evaluation of original articles published in JECH 2006–2014." *Health Research Policy and Systems* 15.1 (2017): 11. [Return to text]

⁸ Richardson, Sarah S., et al. "Opinion: focus on preclinical sex differences will not address women's and men's health disparities." *Proceedings of the National Academy of Sciences* 112.44 (2015): 13419-13420. [Return to text]

⁹ Joel, Daphna, et al. "A discussion on experiments and experimentation: NIH to balance sex in cell and animal studies." *Catalyst: Feminism, Theory, Technoscience* 1.1 (2015). [Return to text]

¹⁰ Eliot, Lise, and Sarah S. Richardson. "Sex in Context: Limitations of Animal Studies for Addressing Human Sex/Gender Neurobehavioral Health Disparities." *Journal of Neuroscience* 36.47 (2016): 11823-11830. [Return to text]

¹¹ Ritz, Stacey A. "Complexities of Addressing Sex in Cell Culture Research." *Signs: Journal of Women in Culture and Society* 42.2 (2017): 307-327. [Return to text]

men who provide care and live in close proximity to their infants exhibiting lower testosterone than men who do not^{12,13}. This is not because men with low testosterone are more likely to become parents or engage in fathering; in a longitudinal study, men who became parents and lived with their children experienced decreases in testosterone¹⁴. A controlled experiment demonstrating that men who respond in a caring way to comfort a realistic crying baby doll show decreases in testosterone offers further support for a causal relationship between nurturance and testosterone level in men¹⁵. Cultural or gender beliefs that influence parenting behavior would therefore be expected to influence testosterone levels, perhaps with attendant effects on downstream biological and health indicators. Women too, experience shifts in testosterone in relation to parenting¹⁶. Other research suggests that testosterone levels in women may respond to gendered performances of wielding power¹⁷.

Estrogen, as well, is not solely a sex-related human biological variable. Women in calorie-replete, low-activity, post-industrial environments often have higher levels of estrogen than women in more nutritionally-limited environments¹⁸; such women are also more likely to consume exogenous estrogen. Relatedly, because adipose tissue can aromatize hormones (aromatization is the process by which androgens are converted into estrogens), the global rise

¹² Gray, Peter B., et al. "Marriage and fatherhood are associated with lower testosterone in males." *Evolution and Human Behavior* 23.3 (2002): 193-201. [Return to text]

¹³ Fleming, Alison S., et al. "Testosterone and prolactin are associated with emotional responses to infant cries in new fathers." *Hormones and Behavior* 42.4 (2002): 399-413. [Return to text]

¹⁴ Gettler, Lee T., et al. "Longitudinal evidence that fatherhood decreases testosterone in human males." *Proceedings of the National Academy of Sciences* 108.39 (2011): 16194-16199. [Return to text]

¹⁵ van Anders, S. M., Tolman, R. M., & Volling, B. L. et al. "Baby cries and nurturance affect testosterone in men." *Hormones and Behavior*, 61.1 (2012): 31-36 [Return to text].

¹⁶ Kuzawa, Christopher W., et al. "Mothers have lower testosterone than non-mothers: Evidence from the Philippines." *Hormones and Behavior* 57.4 (2010): 441-447. [Return to text]

¹⁷ van Anders, Sari M., Jeffrey Steiger, and Katherine L. Goldey. "Effects of gendered behavior on testosterone in women and men." *Proceedings of the National Academy of Sciences* 112.45 (2015): 13805-13810. [Return to text]

¹⁸ Ellison, Peter T.. *On fertile ground: A natural history of human reproduction*. Harvard University Press, 2009.[Return to text]

in obesity is theorized to be accompanied by heightened estrogen levels in men ¹⁹. While factors like the nutritional environment may not at first seem related to gender, in fact diet, obesity, weight-loss, and health-conscious behaviors are all strongly influenced by gender constructs^{20,21,22}.

In this essay, we pose the biosocial turn – what Dorothy Roberts has called “the new biosocial science”²³ – as presenting an opportunity to creatively expand the range of empirical inquiries into gender as a biosocial variable and to newly articulate the importance of attending to gender in biological science. The Russell Sage Foundation’s new Integrating Biology and Social Science Knowledge initiative, introduced in 2016, refers to the biosocial turn as “a paradigm shift in the life sciences, spurred by the realization that many biological processes, rather than being fixed, immutable mechanisms that consign people to particular life outcomes, are instead fluid, dynamic responses to features of the social and physical environments humans inhabit.” This shift, the Foundation writes, has “led researchers to launch interdisciplinary studies that seek to integrate approaches from the social and biological

¹⁹ Cohen, P. G. "The hypogonadal–obesity cycle: role of aromatase in modulating the testosterone–estradiol shunt—a major factor in the genesis of morbid obesity." *Medical Hypotheses* 52.1 (1999): 49-51. [Return to text]

²⁰ Wardle, Jane, et al. "Gender differences in food choice: the contribution of health beliefs and dieting." *Annals of Behavioral Medicine* 27.2 (2004): 107-116. [Return to text]

²¹ Wardle, Jane, Anne M. Haase, and Andrew Steptoe. "Body image and weight control in young adults: international comparisons in university students from 22 countries." *International Journal of Obesity* 30.4 (2006): 644. [Return to text]

²² Wells, Jonathan CK, et al. "Associations of economic and gender inequality with global obesity prevalence: understanding the female excess." *Social Science & Medicine* 75.3 (2012): 482-490. [Return to text]

²³ Roberts, Dorothy. November 3rd, 2016. “The New Biosocial and the Future of Ethical Science”, Tanner Lecture, Harvard University, Mahindra Humanities Center. [Return to text]

sciences, recognizing the potential for a deeper understanding of how social inequalities are initiated, maintained, and transmitted.²⁴

In its Call for Proposals, the Foundation highlights research on biological plasticity in relation to racial, ethnic, and socioeconomic variables in neuroscience, endocrinology, immunology, and epigenetics as exemplary of the biosocial turn. Here, as elsewhere, gender analysis and gender-related variables are largely missing in the burgeoning streams of research and theory that characterize the biosocial turn. Feminist scientists and science theorists, we argue, would do well to engage the reservoir of innovative new biosocial research as a resource for developing methods and theories for the study of sex/gender. Similarly, we call on biosocial scientists to attend as assiduously to gender as they have to other intersecting foci of analysis, such as racial discrimination and socioeconomic disadvantage.

Starting Frameworks: Racism, Poverty, and Biosocial Science

The study of relationships among poverty, race, and biology provides a worthy model for building biosocial approaches to gender, body, and biology. Studies of poverty, race, and biology have shifted in remarkable ways over the last several decades, from a frame of biological determinism to one in which the social and physical environment is recognized to have lifelong (and at times intergenerational) biological effects^{25,26,27}. This unification of social science and biology has productively generated novel hypotheses and provided insight into

²⁴ "Call for Proposals: Integrating Biology and Social Science Knowledge (BioSS)" Russell Sage Foundation <https://www.russellsage.org/research/funding/bioss> accessed on 4/17/18 [Return to text]

²⁵ Williams, David R., and Selina A. Mohammed. "Racism and health I: pathways and scientific evidence." *American Behavioral Scientist* 57.8 (2013): 1152-1173. [Return to text]

²⁶ Krieger, Nancy. "Discrimination and health inequities." *International Journal of Health Services* 44.4 (2014): 643-710. [Return to text]

²⁷ Massey, Douglas S. "Brave new world of biosocial science." *Criminology* 53.1 (2015): 127-131. [Return to text]

biological phenomena. Research in this domain is broad, ranging from better understanding how Jim Crow laws created disparities in health outcomes among U.S. populations to unpacking the relationships between poverty and the developing brain. For example, researchers have shown, in large longitudinal datasets, that lower income is associated with reduced hippocampus volume and prefrontal cortex volume in growing children, perhaps due to stress²⁸ and that race-based discrimination is related to blunted cortisol profiles in African-American adolescents and adults, a sign of an exhausted hypothalamic-pituitary-adrenal system²⁹.

A central claim of this work is that social inequality has physiological outcomes. Stress hormones, immunological markers of inflammation, and chronic disease indicators like glucose are frequent targets of investigation. Recent years have seen a proliferation of methods for measuring discrimination, analyzing the factors that contribute to resilience, and examining how constructs such as neighborhood segregation may reflect surrounding structural racism. Presently, at least 27 scales are available to assess how experiences of racism and discrimination relate to health.³⁰ Newer methods, including measurements of telomere length and variation in methylation patterns among populations, are now being extended to studies of the biosocial dimensions of poverty and racial discrimination.^{31,32}

²⁸ Hanson J, Hair N, Chandra A, Moss E, Bhattacharya J, Pollak SD, and Wolfe B. "Brain development and poverty: A first look", in *The biological consequences of socioeconomic inequalities*, eds Wolfe, Evans and Seeman. New York: Russell Sage Foundation 2012. [Return to text]

²⁹ DeSantis AS, Adam EK, Doane LD, Mineka S, Zinbarg RE, Craske MC. "Racial/ethnic differences in cortisol diurnal rhythms in a community sample of adolescents." *Journal of Adolescent Health* 41(2007):3-13. [Return to text]

³⁰ Bastos, Joao Luiz, et al. "Racial discrimination and health: a systematic review of scales with a focus on their psychometric properties." *Social Science & Medicine* 70.7 (2010): 1091-1099. [Return to text]

³¹ Chae, David H., et al. "Discrimination, racial bias, and telomere length in African-American men." *American Journal of Preventive Medicine* 46.2 (2014): 103-111. [Return to text]

³² McGuinness, Dagmara, et al. "Socio-economic status is associated with epigenetic differences in the pSoBid cohort." *International Journal of Epidemiology* 41.1 (2012): 151-160. [Return to text]

Based on this body of research, some suggest that many adult diseases might be considered developmental disorders, due to the relationship between later life health and biology and social conditions across the life course. In their description of the relationship between structural poverty and biology, Shonkoff and Garner state, “In simple terms, the process of development is now understood as a function of ‘nature dancing with nurture over time’...That is to say, beginning prenatally, continuing through infancy, and extending into childhood and beyond, development is driven by an ongoing, inextricable interaction between biology (as defined by genetic predispositions) and ecology (as defined by the social and physical environment)”³³.

This, of course, sounds strikingly similar to longstanding feminist theoretical frameworks for understanding sex/gender as a dynamic developmental process. Fausto-Sterling has eloquently described how bones “imbibe culture”, developing in concert with environmental influences over the life course³⁴. As Jordan-Young has written, “Very few developmental endpoints are truly ‘final’; instead, they are interim states, with the possibility of growth and change until death. This is the meaning of plasticity. In this ongoing process, the interaction of physiological and experiential variables is iterative.”³⁵.

Yet the full potential of gender as an organizing aspect of human experience across the life course still needs to be adequately recognized by biosocial scientists and in the human biological sciences in general. Some of this oversight may be the perception that race/racism and poverty are more profound, or more tractable, determinates of stratified health outcomes

³³ Shonkoff, Jack P., et al. "The lifelong effects of early childhood adversity and toxic stress." *Pediatrics* 129.1 (2012): e232-e246., quote on Page 234 [Return to text]

³⁴ Fausto-Sterling, Anne. "The bare bones of sex: Part 1—sex and gender." *Signs: Journal of Women in Culture and Society* 30.2 (2005): 1491-1527. [Return to text]

³⁵ Jordan-Young, Rebecca M. *Brain storm*. Harvard University Press, 2010. Page 286. [Return to text]

than gender. Some may be due the now widespread appreciation of race as primarily a human social construct, leading researchers to eliminate biological hypotheses in favor of research programs exploring the social dimensions of racial variation. In contrast, while gender, like race and class, is a complex variable with pervasive influence across the life course, the alternative hypothesis of innate biological drivers of sex/gender differences remains robust, if not hegemonic, among biomedical researchers.

The widespread operationalization of racism and poverty as complex biosocial variables could provide a model for how researchers and funders could move to more rigorously study gender. Reigning biosocial models developed for research on race and social class, however, cannot be simply cross-applied to capture the interactions between sex, gender, and biology. For example, whereas inquiries into the influence of race and poverty in biological variation have focused on cumulative effects of stress, stress and discrimination may not be the most appropriate constructs for appreciating how gender contributes to human biological variation and health outcomes. Though gendered social and belief structures bestow women with lower social status than men, men often have worse health outcomes than women. Gender-based physiological stress may not be primarily related to discrimination; competition or safety concerns may be more appropriate constructs. Moreover, although the effects of gender will be pervasive across the life course such effects may not be primarily stress-related.

Appreciation of the rich complexity and specificity of gender as a biosocial variable, we believe, is essential to efforts to integrate gender as a variable in all research – biosocial and beyond – and is also central to the intellectual excitement and promise of sex/gender research.

Despite the pleas of feminist theorists³⁶, gender remains too-frequently portrayed in mainstream health science research as a unidimensional and independent causal factor that is either present or absent in a dataset: is gender at work, or not? Instead, gender must be conceptualized as a contextual theoretical construct that is pervasively intersectional and relationally multidimensional, in ways that we elaborate below.

Gender as Intersectional

Intersectionality is a key contribution of feminist theory, emerging from critical insights of black feminists regarding the influence of social location on experiences and perceptions. One's experiences as an individual lie at the intersections of multiple categories; gender is a constitutive part of our experiences of race, class, sexual orientation, ability-status, and immigration-status, and our membership in these other social groupings influences our experience of gender^{37,38}. Intersectional research recognizes and seeks to understand the variation within and between social categories³⁹. For bioscientists looking to better discern the effects of gender, and feminist theorists looking to support them, understanding gender as intersectional is essential in research design, choice of methodology, and analysis and interpretation of data.

Intersectional theory originated in cultural and legal studies and is now widely applied within the social sciences. But recognition of how social categories interact to create distinct

³⁶ Springer, Kristen W., Olena Hankivsky, and Lisa M. Bates. "Gender and health: relational, intersectional, and biosocial approaches." (2012): 1661-1666. [Return to text]

³⁷ hooks, bell. "From margin to center." *Boston, MA: South End* (1984). [Return to text]

³⁸ Crenshaw, Kimberle. "Mapping the margins: Intersectionality, identity politics, and violence against women of color." *Stanford Law Review* (1991): 1241-1299. [Return to text]

³⁹ McCall, Leslie. "The complexity of intersectionality." *Signs: Journal of women in culture and society* 30.3 (2005): 1771-1800. [Return to text]

experiences is also important in understanding human biology. For instance, the higher rate of allergic dermatitis in women than in men is known to be a result of gender-linked differences in exposure and contact factors^{40,41}. But environmental factors like chemical exposure at home and in the workplace, or the tendency to wear jewelry made of certain metals, vary according to class, race, and gender, all of which interact to influence who develops dermatitis. Societal definitions of masculinity and femininity, which vary across class and cultural background, will influence the distress the dermatitis causes and the willingness to report to a medical provider. Class and immigrant status will affect access to medical care, and therefore affect measured dermatitis rates.

An intersectional perspective that includes gender is essential in scientific research design. In the broadest sense, intersectionality may be considered as an epistemological starting point, influencing how scientists approach the entire research process^{42,43}. An intersectional perspective can provoke scientists to question their own location within the research process, in particular how their own social position may influence their background assumptions, hypotheses, methodology, and data interpretation. In this way, intersectionality shares common ground with other bodies of feminist theory, such as standpoint theory, in encouraging scientists to better understand how their own social location influences the research process.

⁴⁰ Leyden, James J., and Albert M. Kligman. "Allergic contact dermatitis: sex differences." *Contact Dermatitis* 3.6 (1977): 333-336. [Return to text]

⁴¹ Modjtahedi, B. S., S. P. Modjtahedi, and H. I. Maibach. "The sex of the individual as a factor in allergic contact dermatitis." *Contact Dermatitis* 50.2 (2004): 53-59. [Return to text]

⁴² Shields, Stephanie A. "Gender: An intersectionality perspective." *Sex Roles* 59.5-6 (2008): 301-311. [Return to text]

⁴³ Hankivsky, Olena. "Women's health, men's health, and gender and health: Implications of intersectionality." *Social Science & Medicine* 74.11 (2012): 1712-1720. [Return to text]

Fundamentally, intersectionality theory helps researchers determine which variables may be relevant when exploring a topic and conceptualize how such variables may interact to influence a measured outcome. Intersectionality may be particularly useful in focusing attention on how effects may shift through time or vary across populations. Krieger's recent analysis of breast cancer rates among black and white women in the Jim Crow south exemplifies how an intersectional perspective can motivate temporal research hypotheses. Black women often have higher rates of estrogen receptor-negative (ER-) breast cancer than white women, a difference often proposed to have genetic roots. However, Krieger shows that black women who were born and raised in the Jim Crow south have *higher* rates of ER- tumors than black women born outside Jim Crow, indicating that cancer subtype is susceptible to social and environmental influences⁴⁴.

To demonstrate how an intersectional perspective could motivate investigations of intra-population variation, consider research that accidentally uncovered how a race- and gender-related stressor affected African-American college students⁴⁵. In 2006 researchers at Duke University were conducting a project aimed at understanding the relationships between social stress and cortisol when an African-American woman charged several Duke lacrosse players with rape. The case was highly publicized in the media and the campus atmosphere was charged. During this time, African-American women, but not African-American men, were found to have extremely high cortisol levels – so high, in fact, that they were unaffected by the

⁴⁴ Krieger, Nancy, Jaquelyn L. Jahn, and Pamela D. Waterman. "Jim Crow and estrogen-receptor-negative breast cancer: US-born black and white non-Hispanic women, 1992–2012." *Cancer Causes & Control* 28.1 (2017): 49-59. [Return to text]

⁴⁵ Richman, Laura Smart, and Charles Jonassaint. "The effects of race-related stress on cortisol reactivity in the laboratory: implications of the Duke lacrosse scandal." *Annals of Behavioral Medicine* 35.1 (2008): 105-110. [Return to text]

stress test during the study. This research suggests that acute social context can manifest as stress experienced on the individual level, and that gender, race, and other aspects of social location, such as being a Duke student, may all intersect to influence how our biology relates to our social circumstances.

An intersectional perspective allows scientists to hone hypotheses and predictions, or reexamine existing data, to better understand how race, gender, social class, and other factors interact to influence human physiology. Intersectionality must not be reduced to addition or multiplication. In an “additive model”, for example, race + gender + class = disadvantage⁴⁶. Instead, categories intersect in dynamic, complex, and surprising ways depending on context, posing new questions for research⁴⁷. Interaction is an area in which many quantitative scientists excel. Scientists standardly use statistical techniques to consider how effect sizes vary in relation to other variables, techniques that, when critically deployed with awareness of the assumptions involved, are well-suited to exploring intersectional hypotheses⁴⁸.

Consider, for instance, a study that uncovered an interaction between obesity and reports of race-based discrimination. McClure and colleagues set out to examine how ethnic discrimination interacts with health outcomes. They found no differences in levels of self-reported discrimination between obese and non-obese men. But obese Hispanic women reported higher levels of race-based discrimination than non-obese Hispanic women, and that

⁴⁶ Bowleg, Lisa. "When Black+ lesbian+ woman≠ Black lesbian woman: The methodological challenges of qualitative and quantitative intersectionality research." *Sex Roles* 59.5-6 (2008): 312-325. [Return to text]

⁴⁷ Choo, Hae Yeon, and Myra Marx Ferree. "Practicing intersectionality in sociological research: A critical analysis of inclusions, interactions, and institutions in the study of inequalities." *Sociological theory* 28.2 (2010): 129-149. [Return to text]

⁴⁸ Else-Quest, Nicole M., and Janet Shibley Hyde. "Intersectionality in quantitative psychological research: II. Methods and techniques." *Psychology of Women Quarterly* 40.3 (2016): 319-336. [Return to text]

discrimination was associated with higher fasting glucose in women (discrimination did not correlate with fasting glucose in men)⁴⁹. This finding suggests that obese women may be subject to race-based discrimination at higher rates than non-obese women, and further, that this has biological effects. Using these data, an intersectional perspective can provoke explorations of how glucose levels are partly an embodiment of racial discrimination and gender-based body norms. There is some evidence that weight stigma itself is associated with cortisol levels, independent of adiposity⁵⁰, and experimental work demonstrates that exposure to weight-based discrimination elicits cortisol responses in women⁵¹. In the McClure et al. study, any physiological stress associated with race-based discrimination (including activation of the HPA axis), must be also viewed as rooted in gender-based body norms. Hispanic women who violate the body norms of the dominant culture are subject to multiple, overlapping forms of discrimination and social stress, all of which have effects on physiology. There are many similar examples of how an intersectional perspective can help explain scientific research results that are accidentally uncovered – but rarely is intersectional gender theory explicitly sourced to motivate biological and biosocial hypotheses, research design, and interpretation.

Gender as Relationally Multidimensional

⁴⁹ McClure, Heather H., et al. "Discrimination, psychosocial stress, and health among Latin American immigrants in Oregon." *American Journal of Human Biology* 22.3 (2010): 421-423. [Return to text]

⁵⁰ Tomiyama, A. Janet, et al. "Associations of weight stigma with cortisol and oxidative stress independent of adiposity." *Health Psychology* 33.8 (2014): 862. [Return to text]

⁵¹ Schvey, Natasha, Puhl, Rebecca, and Brownell, Kelly. "The stress of stigma: Exploring the effect of weight stigma on cortisol reactivity." *Psychosomatic Medicine* 76.2 (2014): 156-162. [Return to text]

A relationally multidimensional perspective recognizes that gender is pervasive and that gender is experienced by individuals at several different levels⁵². Understanding these multiple dimensions of gender is essential for biosocial scientists seeking to conceptualize how the developmental effects of gender may unfold. As gender theory has classically held, gender can be a set of prescribed social norms and mores, imparted through interpersonal relationships and enculturation throughout life. Gender can also act structurally, through large-scale societal institutions, to limit resources and choices of individuals. Finally, gender is also composed of internally-held beliefs that orient individuals to the world and mediate experiences within it. These different levels or dimensions of gender influence human health and biology in complex ways.

At one level, individuals biologically experience gender as societal norms that influence environmental exposures, behaviors, social interactions, diet, and a plethora of other factors. Take body size and diet. While young boys do not tend to report body dissatisfaction, girls begin to report a desire to be thinner around age six⁵³. Body dissatisfaction in young girls is correlated with how girls describe their mother's body-image. Dominant cultural messages around body size and shape are internalized through relationships in the home, peer relationships, and media exposure⁵⁴. In a Swedish longitudinal study following children and adolescents for 5 years, girls who wished they were thinner at the beginning of the study were more likely to develop disordered eating habits, including repeat dieting, eating alone, skipping meals, and

⁵² Connell, Raewyn. "Gender, health and theory: conceptualizing the issue, in local and world perspective." *Social Science & Medicine* 74. 11 (2012): 1675-1683. [Return to text]

⁵³ Lowes, Jacinta, and Marika Tiggemann. "Body dissatisfaction, dieting awareness and the impact of parental influence in young children." *British journal of health psychology* 8.2 (2003): 135-147. [Return to text]

⁵⁴ Sands, Emma R., and Jane Wardle. "Internalization of ideal body shapes in 9–12-year-old girls." *International Journal of Eating Disorders* 33.2 (2003): 193-204. [Return to text]

reporting that being thinner would improve their relationships and lives⁵⁵. Nutrition and dieting behavior has biochemical effects, including on glucose metabolism, immunological factors, hormones, and neuropeptides. Through such mediators, social pressures that result in behavioral modifications to diet and body size will have inevitable effects on neurological pathways related to hunger, satiety, reward, and motivation, not to mention the associated mental health effects of monitoring food and body size. Dieting for weight loss is associated with reduced scores on cognitive function tests⁵⁶, and even moderate dieting in healthy subjects is well-known to have effects on amino acids in the brain and on serotonin function^{57,58}. A fuller consideration of how gender relates to diet and body size would include understanding how eating disorders have recently risen among boys, how food choice can be conflated with gendered behavior (do real men eat salad?), and the societal pressure for boys and men to increase their body size, among other topics. In diet and nutrition, gender becomes biology, including neurological function and propensity for mental health disorders, via social norms, media messages, and relationships that impart ideology around ideal body types, which then influences the behavior of individuals. These sorts of socially-influenced diet and body-monitoring patterns can create different developmental conditions across the life course for men and women.

⁵⁵ Westerberg-Jacobson, Josefin, Ata Ghaderi, and Birgitta Edlund. "A longitudinal study of motives for wishing to be thinner and weight-control practices in 7-to 18-year-old Swedish girls." *European Eating Disorders Review* 20.4 (2012): 294-302. [Return to text]

⁵⁶ Green, Michael W., et al. "Impairment of cognitive performance associated with dieting and high levels of dietary restraint." *Physiology & Behavior* 55.3 (1994): 447-452. [Return to text]

⁵⁷ Anderson, I. M., et al. "Dieting reduces plasma tryptophan and alters brain 5-HT function in women." *Psychological Medicine* 20.4 (1990): 785-791. [Return to text]

⁵⁸ Cowen, P. J., et al. "Moderate dieting causes 5-HT 2C receptor supersensitivity." *Psychological Medicine* 26.6 (1996): 1155-1159. [Return to text]

At another level, gender is experienced as a set of structural forces and patterns, reflected in employment options, economic class mobility, criminal sentencing, and other outcomes. Disparities in prison sentencing are an example of how structural forces have effects on human biology. An analysis of nearly 80,000 U.S. criminal cases revealed that women receive shorter prison sentences than men do, even when controlling for the type of crime, prior record, income, and education⁵⁹. Controlling for the same factors, blacks receive longer sentences than whites. Due to these compounding structural forces, which embed gender and race-based discrimination into our criminal justice system, black males receive much longer prison sentences and are much less likely to receive no prison term than women or white men. Incarceration functions as both an acute and chronic stressor, and prison has a variety of health effects on inmates, including exposure to disease, violence, stress, isolation, and poor nutrition^{60,61}. Prison is associated with an increase in hypervigilance, social withdrawal, and psychological distancing, and many inmates develop PTSD related to the traumatic stress of the prison experience⁶². After release, formerly incarcerated individuals face poor job prospects and social stigma, leading to lasting effects on mental health⁶³. The prison system and the differential sentencing of black men also have effects on the biology of the families of inmates. Women with a family member in prison have poorer mental health and a higher risk of

⁵⁹ Mustard, David B. "Racial, ethnic, and gender disparities in sentencing: Evidence from the US federal courts." *The Journal of Law and Economics* 44.1 (2001): 285-314. [Return to text]

⁶⁰ Baillargeon, Jacques, et al. "The disease profile of Texas prison inmates." *Annals of epidemiology* 10.2 (2000): 74-80. [Return to text]

⁶¹ Massoglia, Michael. "Incarceration as Exposure: The Prison, Infectious Disease, and Other Stress-Related Illnesses*." *Journal of health and social behavior* 49.1 (2008): 56-71. [Return to text]

⁶² Haney, Craig. "The psychological impact of incarceration: Implications for post-prison adjustment." *Prisoners once removed: The impact of incarceration and reentry on children, families, and communities* 33 (2003): 66. [Return to text]

⁶³ Schnittker, Jason, and Andrea John. "Enduring Stigma: The Long-Term Effects of Incarceration on Health*." *Journal of Health and Social Behavior* 48.2 (2007): 115-130. [Return to text]

depression, obesity, cardiovascular disease, and stroke, even controlling for potentially confounding associated factors like early life events, income, or education level^{64,65}. The direct stress effects of having a family member imprisoned will be compounded by loss of economic input into the family and high levels of fees associated with incarceration. Understanding structural aspects of gender, in this case interacting with race to disproportionately distribute severe prison sentences to black men, can help researchers understand health effects which radiate through imprisoned men and their families.

A third dimension of gender is as a set of internally-held beliefs orienting how individuals interpret and experience the world, including gender roles and structural forces. An individual's gender beliefs mediate their experience of the world, meaning the same event can carry different emotional and physiological valence depending on an individual's gender beliefs (Figure 2). For example, gender beliefs, including awareness of sexism, can influence cardiovascular and cortisol responses to laboratory stress tests, with experimental exposure to sexism eliciting different physiological responses depending on an individual's beliefs^{66,67}. Gender also mediates the effects of unemployment on psychological well-being, with marital status, gender, and broader societal beliefs around gender, such as who should be the

⁶⁴ Wildeman, Christopher, Jason Schnittker, and Kristin Turney. "Despair by association? The mental health of mothers with children by recently incarcerated fathers." *American Sociological Review* 77.2 (2012): 216-243. [Return to text]

⁶⁵ Lee, Hedwig, et al. "A heavy burden: the cardiovascular health consequences of having a family member incarcerated." *American Journal of Public Health* 104.3 (2014): 421-427. [Return to text]

⁶⁶ Eliezer, Dina, Brenda Major, and Wendy Berry Mendes. "The costs of caring: Gender identification increases threat following exposure to sexism." *Journal of Experimental Social Psychology* 46.1 (2010): 159-165. [Return to text]

⁶⁷ Townsend, Sarah SM, et al. "From "in the air" to "under the skin": Cortisol responses to social identity threat." *Personality and Social Psychology Bulletin* 37.2 (2011): 151-164. [Return to text]

household breadwinner, all acting to influence perceived distress^{68,69}. Such gender beliefs can be a part of cultural beliefs - for instance, there is a strong, positive relationship between beliefs in traditional gender roles and ethnic pride in some immigrant communities, and in turn, ethnic pride appears to protect against depression⁷⁰.

Through these multiple pathways, and others, gender organizes an individual's experiences over the life time, interacting with other aspects of an individual's social location throughout. Grasping the full picture of the relationally multidimensional character of gender as a component of body and biology ultimately requires a developmental and longitudinal framework. In recent research, Fausto-Sterling has worked to map and integrate current evidence for how sex/gender influences the first three years of life^{71,72}. Applying developmental systems theory to this critical developmental timeframe, Fausto-Sterling demonstrates how gendered interactions with parents and environments may intertwine with early and slight sex-linked differences to allow sex/gender to become embodied, leading to sex-differentiated behavioral and biological outcomes in young children. Such rigorous theoretical and hypothesis-building work lays the foundation for empirical research into how gender influences human health and biology across the life course.

⁶⁸ Artazcoz, Lucía, et al. "Unemployment and mental health: understanding the interactions among gender, family roles, and social class." *American Journal of Public Health* 94.1 (2004): 82-88. [Return to text]

⁶⁹ Strandh, Mattias, et al. "Unemployment, gender and mental health: the role of the gender regime." *Sociology of Health & Illness* 35.5 (2013): 649-665. [Return to text]

⁷⁰ Mahalingam, Ramaswami, Sundari Balan, and Jana Haritatos. "Engendering immigrant psychology: An intersectionality perspective." *Sex Roles* 59.5-6 (2008): 326-336. [Return to text]

⁷¹ Fausto-Sterling, Anne, Cynthia Garcia Coll, and Meghan Lamarre. "Sexing the baby: Part 1—What do we really know about sex differentiation in the first three years of life?." *Social Science & Medicine* 74.11 (2012): 1684-1692. [Return to text]

⁷² Fausto-Sterling, Anne, Cynthia Garcia Coll, and Meghan Lamarre. "Sexing the baby: Part 2 applying dynamic systems theory to the emergences of sex-related differences in infants and toddlers." *Social Science & Medicine* 74.11 (2012): 1693-1702. [Return to text]

Conclusion

Gender is a profound dimension of variation in human health and biology. As such, in contrast to the exclusive emphasis of the NIH on sex as a biological variable, when considering sex differences in human biology and health research, pervasive sex/gender interaction should be the default, null hypothesis⁷³. Outside of sex research, we are experiencing a widespread shift in scientific embrace of models of biological plasticity in relation to dynamic environments. We hope that both sex and gender researchers will recognize the “biosocial turn” as an exciting opportunity to innovate, test, and sharpen sex/gender hypotheses. As in the case of biosocial research on racism, poverty, and biology, collaborations between social scientists familiar with gender theory and scientists schooled in quantitative research in large datasets will be essential to the development of methods and models for understanding gender as a biosocial variable.

We strongly suspect that gender is a lurking, underexplored variable in public health data sets, ripe for the picking. Feminist researchers should look to these datasets as resources for exploring challenging and novel hypotheses. For instance, recent work by Gettler et al. uses publically-available National Health and Nutrition Examination Survey (NHANES, a large sample study designed to be representative of the U.S. population) data to gain insight into how variation in social circumstances (such as residing with children) may be associated with hormone levels, which may in turn influence the development of adiposity and downstream

⁷³ Springer, Kristen W., Jeanne Mager Stellman, and Rebecca M. Jordan-Young. "Beyond a catalogue of differences: a theoretical frame and good practice guidelines for researching sex/gender in human health." *Social Science & Medicine* 74.11 (2012): 1817-1824. [Return to text]

health metrics⁷⁴. Krieger similarly utilized large data-sets to demonstrate the health effect of Jim Crow laws on black Americans⁷⁵. Other promising options include the National Survey of American Life- Adolescents (NSAL-A), which has produced excellent analyses of how gender and ethnicity intersect with mental health and perceived discrimination in African-Americans and Caribbean-immigrant Black youth^{76,77}. In the modern funding environment, such large, open-access datasets combining biological, health, and social metrics represent a relatively untapped resource for quantitative work that explores explicitly gender-based biosocial hypotheses.

In rendering gender as a “biosocial variable,” researchers should take care not to occlude its multidimensionality. This may be particularly difficult because some dimensions of gender are better-studied than others. It is well-known that gender bias in occupations influences exposure rates to occupational hazards, and we increasingly recognize that broadly held societal beliefs about gender influence diagnosis rates and treatment recommendations^{78,79}. Less is known about how gender-enculturation over the lifespan and internalized gender beliefs influence factors such as stress, health and disease risk, and

⁷⁴ Gettler, Lee T., et al. "Adiposity, CVD risk factors and testosterone: Variation by partnering status and residence with children in US men." *Evolution, Medicine, and Public health* 2017.1 (2017): 67-80. [Return to text]

⁷⁵ Krieger, Nancy, et al. "The unique impact of abolition of Jim Crow laws on reducing inequities in infant death rates and implications for choice of comparison groups in analyzing societal determinants of health." *American Journal of Public Health* 103.12 (2013): 2234-2244. [Return to text]

⁷⁶ Assari, Shervin, and Cleopatra Howard Caldwell. "Gender and ethnic differences in the association between obesity and depression among black adolescents." *Journal of racial and ethnic health disparities* 2.4 (2015): 481-493. [Return to text]

⁷⁷ Assari, Shervin, and Cleopatra Howard Caldwell. "Neighborhood safety and major depressive disorder in a national sample of black youth; gender by ethnic differences." *Children* 4.2 (2017): 14. [Return to text]

⁷⁸ Messing, Karen, et al. "Be the fairest of them all: challenges and recommendations for the treatment of gender in occupational health research." *American Journal of Industrial Medicine* 43.6 (2003): 618-629. [Return to text]

⁷⁹ COPD is one example of a disease that is underdiagnosed in women. In a random sample of physicians given a hypothetical case, COPD was diagnosed correctly for 58% of men, but only 42% of women. Chapman, Kenneth R., Donald P. Tashkin, and David J. Pye. "Gender bias in the diagnosis of COPD." *Chest* 119.6 (2001): 1691-1695. [Return to text]

willingness to seek treatment. Some of these factors may be easier to incorporate into existing research than others. For instance, occupational hazard exposure rates are currently available through data on employment categories and consumer data. In contrast, internally-held gender beliefs are rarely included in studies. All of this points to a need for better methodological tools to measure gender beliefs, gender-based stress, and similar concepts. Scientists must begin including metrics and analyses of gender automatically within research, and funders should consider supporting experimental pilots designed to develop better metrics for gender⁸⁰.

Biosocial researchers have modeled interpretational and methodological boldness in forging new research on the biological markers of racism and poverty. Will gender, too, find its place at the forefront of the biosocial moment? Gender is hard to capture and operationalize, but so is any biosocial variable. The key, we have argued, is a rigorous understanding of gender as an intersectional and relationally multidimensional construct. Starting from this theoretical perspective, social and biological researchers can forge innovative hypotheses and pinpoint causal relationships between gender, other biosocial variables such as racism and poverty, and biology.

⁸⁰ Sharman, Zena, and Joy Johnson. "Towards the inclusion of gender and sex in health research and funding: an institutional perspective." *Social Science & Medicine* 74.11 (2012): 1812-1816. [Return to text]

Figures

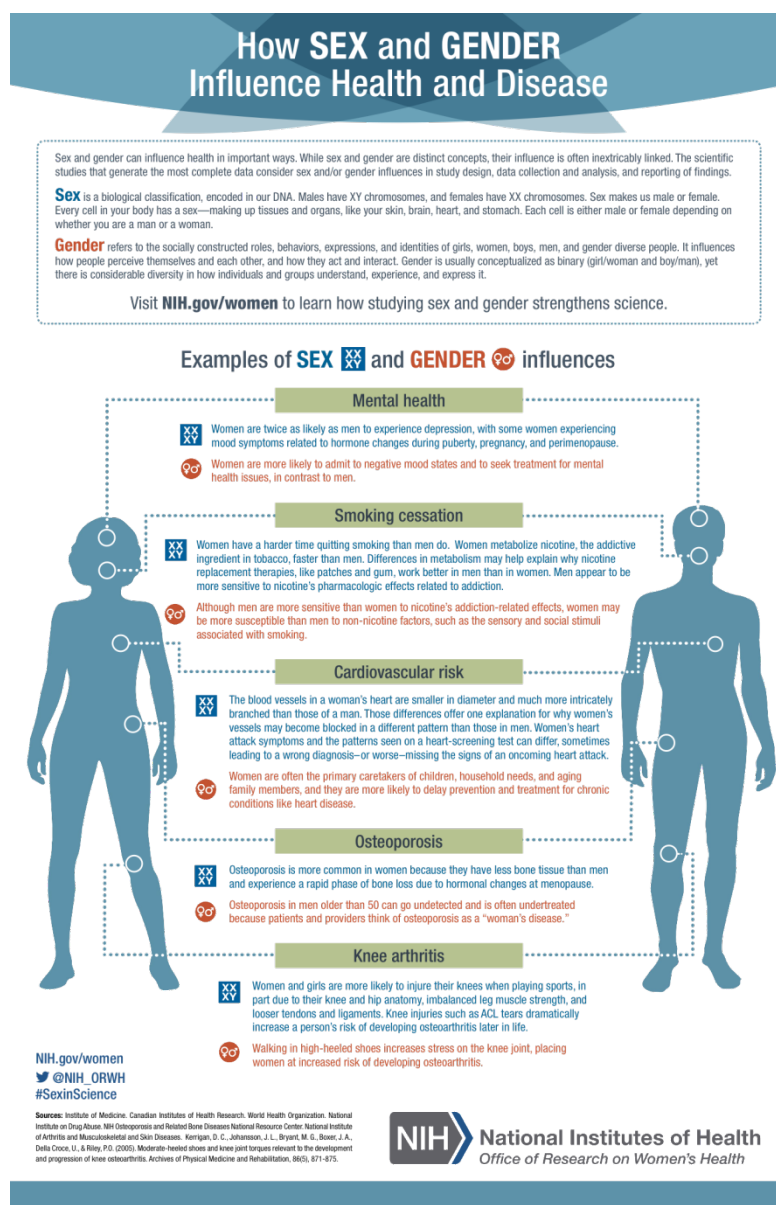


Figure 1. Office of Research on Women's Health 2017 infographic explaining sex and gender.⁸¹

⁸¹ NIH Office of Research on Women's Health, Infographic: How Sex/Gender Influence Health & Disease (<https://orwh.od.nih.gov/research/sex-gender/infographic-influence-on-health-and-disease/>, accessed 9/22/2017) [Return to text]

Figure 2. Gender beliefs mediate the effects of sexist experiences and stratified gender roles (authors' illustration).