Inclusion and Exclusion: Institutional Reproductions of Sex and Gender

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ABSTRACT

This dissertation examines how practices of regulation and rule-making enable scientific accounts of sex as binary, biological, and distinct from gender. Looking to biomedicine and sport as two significant institutional spheres where definitions of gender and sex have been asserted through regulation and contested in recent years, I ask: how are accounts of biological sex difference shaped by acts of regulation? Moreover, how do such practices suppress alternative accounts of sex and gender as complex, dynamic, and entangled? In answering these questions, this dissertation contributes an institutional perspective to feminist critiques of science and medicine, showing how regulation matters to both the production and nonproduction of certain accounts of difference across two quite different institutional spheres.

I draw on textual data and 105 interviews to analyze two cases: regulations for sex inclusion in biomedical research, and particularly the Sex as a Biological Variable (SABV) policy of the National Institutes of Health (NIH) in the United States (US); and the regulation of women athletes with naturally elevated testosterone, with a focus on rules enforced by the International Association of Athletics Federations (IAAF). Whereas the former policy mandates the *inclusion* of sex in preclinical research, the latter seeks the *exclusion* of women on the basis of their biological profile. In both cases, regulations define sex in binary and biological terms, promote sex as more fundamental than gender (to health, athleticism, and the pursuit of scientific knowledge), and are politically and scientifically contested.

Chapter One explores how epistemological ascendancy in debates over the regulation of women athletes with high testosterone is established within a legal setting. It focuses on proceedings from 2015 when the Court of Arbitration for Sport (CAS) was asked to decide whether an Indian sprinter, Dutee Chand, could compete as a female athlete. Approaching

regulation as an institutional act that defines forms of embodied difference, the legitimacy of which may be called into question, I show how sexed bodies are enacted through and as part of determinations of expertise. Chapter Two draws on interviews with 65 stakeholders to explore how individuals within the elite international track-and-field community were able to protect their existing epistemic investments when the exclusion of women athletes with high testosterone was called into question. Proposing a framework of ignorance as an institutional process, I identify the strategies and structural arrangements that allow stakeholders to turn away from and ignore claims that threaten their commitment to binary sex. Chapter Three looks to the case of the NIH SABV policy as an opportunity to consider how feminists have differed over time in their approaches to sex, gender, and science. Using textual materials and 40 interviews with key stakeholders, I show that the SABV policy was not inevitable, but rather was achieved through the ontological, epistemological, and political alignment of "biomedical feminists" with dominant notions of science, embodied difference, and "women's interests." Additionally, however, it relied on the disinvestment in and misrepresentation of research agendas advancing a more complex account of sex, gender, and their relationship to health. Chapter Four takes the concept of complexity as its theoretical and empirical focus. It combines data from the two cases to consider the mechanisms by which institutions resist complex approaches to gender/sex, and argues that such resistance to complexity can be seen as a broader institutional phenomenon with scientific, political, and social justice implications.

This dissertation is distinguished from existing scholarship by: drawing attention to contestation and revealing how more complex ways of thinking about gender and sex are systematically resisted and suppressed; contrasting the institutional production of gender and sex in two quite different spheres of regulation, allowing me to explore broader patterns in these

processes; and considering how scientific claims about sex difference are not anti-feminist but instead stem from a particular form of feminist politics, and one that is currently resonating in the US context as the boundaries of sex, gender, and science are being called into question.

ACKNOWLEDGEMENTS

I begin with a brief account of my journey, since it is central to how my graduate studies and this dissertation unfolded. The completion of this dissertation marks the end of an accidental seven years spent in Madison, Wisconsin, in the United States of America. When I first joined the Department of Sociology at the University of Wisconsin-Madison as a graduate student in 2012, I confess that I hoped I would never have to complete the PhD program. My career as an elite 800m runner came to an abrupt end following a string of unsuccessful surgeries on a bone spur behind my left Achilles. I arrived in Madison during what would turn out to be a painfully long five years without the ability to jog, let alone compete on the track. But I wasn't to know that when I arrived. Being the dreamer and the optimist that I am, I told myself that I would only spend a year or two in Madison, and then return to Australia ready to pick up my running career where I'd left off. That dream didn't come true, no matter how badly I wanted it to. To this day I carry the pain of what I lost and I am convinced that I would still, even as I write these acknowledgements and reflect on everything I've experienced over the past seven years, give it all back in exchange for the chance to run at the elite level of my sport again.

But enter another accident, which is that by some small mercy, my running life and academic life have actually become intertwined. While I had come to UW-Madison thinking I would specialize in environmental sociology, in my second year here I chanced upon a body of feminist scholarship focused on exactly the area that fascinated me the most: the complexities of athletic performance, and what constitutes "fairness" in women's sport and in international track-and-field in particular. What's more, in recent years this area of feminist scholarship has been focused on exactly the controversy I witnessed unfolding when I competed at the World Championships in Berlin in 2009: around South African 800m runner Caster Semenya, then 18

years old, who I raced against in the heats of our event. When I watched her win the gold medal from the stands of that Berlin stadium, I could never have guessed that the years to follow would lead me to Madison, WI, and to a personal journey during which I would shift from resisting Semenya's right to compete to fighting for it. I would like to express my respect and gratitude to the women who have borne the burden of standing up to the discriminatory regulatory regimes of the International Olympic Committee (IOC) and International Association of Athletics Federations (IAAF), amongst them Maria José Martínez-Patiño, Santhi Soundarajan, Dutee Chand, and most recently, Caster Semenya. All of them have profoundly influenced how stakeholders in the sport of track-and-field—including myself—think about sex and gender, as have all the supporters who have fought alongside them, such as Payoshni Mitra, Katrina Karkazis, Bruce Kidd, and Steve Cornelius. I thank them for offering mentorship and friendship as well as opportunities to bring my voice into the public discussion surrounding this topic.

Returning to Madison, I want to thank my peers—the graduate students in the Sociology program at UW-Madison—for challenging me constantly to be both a better academic and a better person. When I arrived from Australia in 2012, I brought with me a multitude of blind spots and a limited language for talking about and understanding the experiences of people different from myself. Every day my peers make an impression on me, whether it's the insights they bring to seminar discussions, the research they present, the political action they engage in, or the sharp insights they share on social media. I am grateful for the many lessons to date, the high intellectual and critical bar that they set for me, and their forgiveness of my shortcomings.

I was blessed with two fascinating women for my advisors, both of them giants in their respective fields: Myra Marx Ferree and Joan Fujimura. They complemented each other well, focusing on different aspects of my work and professional development and therefore identifying

different areas for improvement: double the fun, but hopefully also double the growth. It was Myra who drew me to sociology of gender, and my scholarship and life are both so much richer as a result. Myra has been the model of a tireless, reliable, generous, strong, rigorous, and forgiving advisor. Her wonderful partner, Don, has also been a central part of my seven-year journey, bringing his good humor and top-notch hospitality to every "Femsem" gathering, retirement dinner, conference reception, and wedding. I look forward to joining them in Maine for lobster in the near future. Joan helped me to make Science and Technology Studies my second scholarly home and has been the model of an inspired, committed, rigorous, and tireless social scientist who is deeply invested in her craft and the contributions that it enables her to make to knowledge and our understanding of its political contours. I am grateful to Joan for encouraging me to spend more time in amongst the weeds exploring my data.

Erik Olin Wright has heavily influenced my journey as a sociology trainee. Amongst his many wise insights and pieces of advice were to focus not only on critique, but on bringing the tools of sociology to bear on imagining solutions, and to see the good in every person no matter what their politics. I have internalized these as guiding principles for both my work and life. This dissertation falls short of imagining solutions, but thankfully I have a postdoctoral fellowship to take the next steps in my research, as well as a public platform that I can continue to build in order to promote the kinds of changes I wish to see. I am forever grateful to Erik, Marcia, and their family for all they have generously given to graduate students like myself.

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welcomed me (and my parents) into their home wholeheartedly. I treasure my time with them in Milwaukee, up at “the shack” in Door County, and traveling the Wild Atlantic Way of Ireland. The Heiles, including Claire and Andi, make Wisconsin a very special place for me. Their love and support helped to make this dissertation possible.

Now to say something about my parents and my home. It’s hard for me to put into words the pain I feel being away from my homeland of Australia. I very often find myself imagining being on the streets of Melbourne, which I remember so vividly. I can hear the trams and the parrots, smell the Eucalypts, feel the sunlight, remember every intersection, park, and high street. I can remember the silhouettes of the landscape and recall the sound and smell of the ocean. I yearn to be there with my family, and especially my parents, to be with them for the day-to-day as they go about their lives and grapple with my dad’s multiple myeloma. It seems I have often made choices that take me away from my family. And yet my parents have always supported those choices and encouraged me to follow the path of my own choosing, ready to celebrate and commiserate with me at every step. Their generosity, love, and selflessness know no bounds. I dedicate this degree to Claire and Peter Pape.

On a lighter note, I thank my soul mate, my dear little cat, Oven. Oven knows not what he does for me. This little creature has brought so much pure joy and love into my life, brightening up the darker days with spontaneous smiles and laughter. I truly don’t know how I would have survived this rocky journey without the companionship of this little rascal. What a blessing, to have come to Wisconsin to complete a Ph.D. and gain Oven in the process. He alone makes it all worthwhile.

It’s fair to say that all in all, this accidental seven-year journey hasn’t been a bad consolation prize. On reflection, perhaps I wouldn’t trade it in after all.

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INTRODUCTION

In 2014, the National Institutes of Health (NIH) in the United States (US) released a new policy mandate requiring the inclusion of equal numbers of male and female cells and animals in all pre-clinical research it funds (Clayton and Collins 2014). Called Sex as a Biological Variable (SABV), the goals of these policies are twofold: first, they aim to address women's health inequities, and particularly the presumed contribution of fundamental biological differences to higher rates of adverse drug reactions among women. Second, the policies advance the NIH goal of addressing the reproducibility crisis in preclinical biomedical research, with inattention to sex difference presented as a key contributing factor (Francis and Tabak 2014). But could such efforts to address reproducibility inadvertently reproduce sex itself?

In 2015, an international court suspended regulations intended to limit the participation of women with intersex characteristics in Olympic sport, and particularly track-and-field. The court ruled that the regulations, which were based on testosterone levels, were insufficiently supported by scientific evidence. Unsatisfied with this decision, many stakeholders in the sport of track-and-field responded to the subsequent Olympic success of three black, African female 800m runners suspected of having intersex characteristics—including South African athlete, Caster Semenya—with accusations of unfair advantage and demands for the reinstatement of the regulations. The sport's governing bodies and wider community largely ignored the scientific and ethical complexities of defining sex in terms of binary, testosterone-based categories.

These two cases take place in separate institutional and geographic contexts, yet numerous parallels are immediately evident. Both involve the development of policy intended to

define, determine, and measure sex in binary terms. Both allege that "biological" sex is distinct from "social" gender, and indeed prior to it, and is therefore the rightful focus of policy and regulatory efforts. Both involve concern for women's rights and a fear that existing institutional arrangements undermine or fail to attend to "women's interests:" in the NIH case, women's specific health needs are considered neglected within existing research arrangements; in the case of international track-and-field, there are fears that women athletes will be pushed out of the sport by an onslaught of unregulated intersex (and transgender) athletes. The two sites are significant to the broader reproduction of sex in relation to gender. As the world's largest funder of biomedical research, the impacts of NIH policy mandates can be far-reaching (Epstein 2007). Similarly, the Olympic Games and the institution of sport more broadly represent key sites for the popular legitimation of certain accounts of sex and gender, as well as a mechanism by which such accounts become imprinted on the body (Connell 1995). However, both cases also involve resistance to the accounts of sex being promoted by lead governing bodies. In particular, scholars aligned with Feminist Science Studies (FSS) have to convince other stakeholders that binary and biological models of sex difference are *scientifically* flawed and may have broader repercussions for women and gender equity.

In sum, we find in the realm of sport and biomedicine examples of the institutionalization of sex difference, wherein sex is defined as binary and distinct from gender, at a time when the boundaries of sex and gender are in flux and forms of resistance are increasingly visible. Moreover, alternative scientific configurations of sex and gender have become available through the efforts of scholars in FSS and adjacent fields. The overarching question here becomes: given the existence of evidence to the contrary, how can the persistence of models of sex as binary and distinct from gender be explained? More specifically, how do practices of regulation and rule-

making enable the production and protection of binary and biological accounts of sex difference? Moreover, how do they suppress alternative accounts of gender and sex as complex, dynamic, and entangled?

Feminist and other scholars have demonstrated that the production of biological knowledge is shaped by the assumptions and research paradigms of individual scientific researchers (Fujimura 2006; Haraway 1988; Lorber 1993; Martin 1991; Nelson 2016; Pitts-Taylor 2016). The purpose of this dissertation is to examine the institutional processes that enable the production of such accounts of sex in relation to gender. Via an analysis of policy-making in sport and biomedicine, I consider how sex is produced as binary, biological, and distinct from gender through the actions of governing bodies and with support from other stakeholders and institutional actors, who provide the ideological and material resources needed to realize such definitional efforts. Researchers are influenced by the policies and priorities of governing bodies. For their part, governing bodies influence—and are influenced by—their constituents and supporters. Yet little is known about the role of these institutional factors in reproducing certain forms of biological difference as scientific facts (Sanz 2017). This dissertation seeks to provide such theoretical and empirical insights.

The Political and Institutional Contours of Sex, Gender, and Science

A Critical Sociology of Gender, and Sex?

Much sociological scholarship on questions of gender and science have focused on the under-representation of women in scientific fields (see Glass et al. 2013; Rhoton 2011; Zippel 2017). The goal of such research is to identify barriers at the individual, organizational, and institutional level that impede efforts to correct the over-representation of men in scientific fields. A common

metaphor here is that of the leaky pipeline: the notion that as women progress through their education, they encounter a disproportionate number of barriers and disincentives that draw them away from a science career more often than men. An alternative approach to addressing persistent gender biases in the personnel and content of the biomedical sciences, and that preferred by FSS scholars, is to critically examine and reimagine the gendered practices of knowledge-making that comprise the institution of biomedical science itself. The argument here is that gender equity projects in STEM (Science Technology Engineering and Mathematics) fields will encounter limits, and have indeed stalled in many countries, because they fall short of reimagining the fundamental epistemological underpinnings of the scientific enterprise (Charles and Bradley 2009; England 2010; Subramaniam 2009).

FSS has grown into a robust interdisciplinary field within gender and women's studies that is increasingly providing feminist scientists, and especially those aligned with feminist biology, with the ontological and epistemological tools to explore the intersection of "biological" sex and "social" gender in innovative ways. For example, Anne Fausto-Sterling has conducted research on infants and their mothers to empirically demonstrate how her theory of dynamic gender development unfolds in practice (Fausto-Sterling et al. 2012). In this research, Fausto-Sterling and her collaborators measure differences between how male and female babies are treated, which in turn helps to explain how children come to develop gender-specific behaviors and capabilities. The purpose here is not to deny the existence of some sex differences at birth, but to consider how they might be amplified as part of a dynamic social developmental process. In another example, social endocrinologist Sari van Anders has developed methods to explore the social modulation of testosterone. Like Fausto-Sterling, van Anders does not to deny the influence of biology but instead examines how levels of testosterone rise and fall in the body in

response to certain behaviors and experiences, which are influenced but not determined by sex and gender (see van Anders, Steiger, and Goldey 2015).

As Lisa Wade (2013) argues, this "new science of sex difference" offers sociologists of gender a way to overcome their longstanding skepticism and black-boxing of the biological sciences and re-theorize the dynamic role of biological sex in processes of embodiment and the reproduction of gendered inequalities.[1] Such work supplements studies of the suppression of intersex variation, such as those by Kessler (1990), Fausto-Sterling (2000), and Davis (2015), which reveal binary notions of sex difference as rooted in ideology rather than nature. Taken together, sociologists of gender can approach biological sex as both non-binary and entangled with gender in complex and dynamic ways. Bringing critical sociological perspectives to bear on the efforts of feminist biologists to redefine sex and its relationship to gender is all the more important given the uneven institutionalization of different sciences of sex. For example, and as explored in this dissertation, constructions of sex as binary and distinct from gender remain dominant in international sport and US biomedicine. Sociological perspectives focused on questions of political struggle and practices of governance can make valuable contributions to FSS and institutional change (Pape 2019a).

Framework: The Politics of Knowledge and Feminism

The frameworks that I develop in this dissertation draw on my training in sociology of gender, STS, and political sociology. Common across all three chapters are the following two threads. First, and reflecting an argument central to the sociological literature on scientific and medical

[1] As I explore in Chapter Three, sociologists of gender in the 1970s pursued the study of gender as a way of circumventing biological essentialist claims about the inevitability of women's lesser status and propensity for care work (Oakley 1972). Social constructivists in the 1990s similarly ceded the study of sex to the biological sciences by arguing that "biology is ideology" and hence binary sex a social construct (Lorber 1993).

knowledge production, all three chapters in this dissertation explore how the epistemological ascendency of certain knowledge claims depends upon favorable institutional conditions. Here the driving question is: how is it that *certain forms* of science acquire intellectual authority? Answering this question demands attention to the historically established and context-specific "social organization of knowledge production" (Suryanarayanan and Kleinman 2013: 218). Doing such research can reveal how the uneven distribution of political power and other resources shapes ascendency in such debates, rather than the intellectual or even scientific merit of the contending arguments (Frickel et al. 2010).

Within this broad area of scholarship concerned with the institutional conditions for scientific and medical authority, sociologists have looked to the concepts of expertise and ignorance to explain the mechanisms by which certain claims become ascendant. Expertise is a relational concept in the sense that expert status is not objectively held but is granted or achieved within a given institutional setting (Carr 2010; Eyal 2013; Wynne 1992). Government agencies can shape the politics of expertise by drawing selectively on scientific advisors to develop and legitimate policy, in the process establishing privileged and private spaces for scientific knowledge production (Jasanoff 1990). The institutionalized allocation of power, resources and opportunities for knowledge production may also lead to certain forms of knowledge being either left "undone" or "done" but ignored, particularly if a research agenda conflicts with or undermines existing ideologies and interests (Croissant 2014; Frickel et al. 2010; Gross 2007; Kleinman and Suryanarayanan 2012; McGoey 2007; McGoey 2012; Proctor and Schiebinger 2008). This dissertation looks to explore and theorize how the institutional dynamics of expertise and ignorance unfold when competing accounts of biological sex are at stake.

Additionally, all three chapters point to tensions within feminism related to how to define sex and gender, and pursue scientific knowledge about them, in ways that advance the interests of women. In both sport and biomedicine, proponents of sex exclusion and inclusion believe that such regulations will positively advance the place of women in those institutional settings. In the case of sport, it is believed that excluding women with high testosterone will "safeguard the right of female athletes to engage in meaningful competition by competing on a level playing field" (CAS 2019, p. 72). In the case of biomedicine, sex difference researchers have argued that "the genetic sex and hormone cycles of female animal models … remain urgently in need of investigation if we are to fulfill the mission of improving quality of life for women as well as men" (Beery and Zucker 2011, p. 571). The choice between emphasizing women as socially and biologically distinct, versus seeking to deconstruct such categories, represents a longstanding ontological "divide" within feminism that has been inadequately addressed by FSS scholars (Snitow 1990; Stimpson 1980). By studying these dynamics in the context of sport and biomedicine, this dissertation offers insights for feminist scholars concerned with understanding the implications of the current political moment for models of feminist change. Notions of scientific authority are currently being challenged in the US by political conservatives, while the boundaries of sex and gender are increasingly in flux as a result of queer, transgender, and intersex activism: but with what consequences for feminist politics and "women," broadly defined?

Some other commonalities across the three chapters are worth mentioning. While sport and biomedicine appear to represent distinct institutional settings with independent histories and stakeholders, the cases of sex inclusion and exclusion examined in this dissertation involve overlapping experts and also similar ideological divisions. For example, at least four of my

interviewees could have responded to questions about either topic. Further illustrating this point, in May 2019 the Organization for the Study of Sex Differences held their annual meeting in Washington, DC. The first day of the meeting featured an educational session led by representatives of the NIH Office of Research on Women's Health during which the background to and implementation of the SABV policy was described and discussed. The day's proceedings closed with the Inaugural Arthur Arnold Distinguished Lecture, in which geneticist Eric Vilain, advisor to the IOC, explained his opposition to the IAAF's 2019 Eligibility Regulations for Female Classification (see Vilain and Patino 2019). In another example of overlap, Cara Tannenbaum, Scientific Director of the Institute for Gender and Health (IGH) at the Canadian Institutes for Health Research (CIHR), both participated in a panel on new directions in "Sex and Gender Science" at OSSD in 2019 and has co-authored a critique of the IAAF's 2019 Regulations published in *The British Medical Journal* (Tannenbaum and Bekker 2019). This is not to say that opinions towards the two issues are neatly aligned: sex difference researchers may be supportive of the SABV policy but opposed to the IAAF Regulations, for scientific and/or ethical reasons, revealing the complex political contours of sex difference research and its wider applications.

Overview of Subsequent Chapters

The empirical chapters for this dissertation are written as stand-alone articles and are presented in the order that they were written. I begin with an examination of expertise in debates over the scientific legitimacy of the claim that women with naturally elevated testosterone levels experience equally elevated athletic abilities. I then move to an exploration of ignorance within the broader elite track-and-field community in order to consider how certain ideas about sex,

testosterone, and athletic ability remain dominant within this institutional sphere in spite of the scientific and ethical questions that have been consistently raised about such regulatory efforts. The third empirical chapter takes feminist politics as its focus and considers feminist debates over the relationship between sex, gender, and science, particularly when it comes to the pursuit of biomedical knowledge about sex differences in the US context. The fourth and final empirical chapter combines the two cases and considers how the concept of complexity, and its ontological, epistemological, and political implications in the case of alternative constructions of gender/sex, can be theorized as a focus of institutional resistance. The remainder of this opening chapter describes the background, data, and methods for each institutional focus of this dissertation, beginning with sex and gender exclusion in sport followed by sex and gender inclusion in biomedicine. For each institutional focus, I describe the background to my empirical investigation. I then provide a brief overview of my data, methods, and main arguments for each of the empirical chapters. In the conclusion of the dissertation, I consider the similarities and differences between sport and medicine as sites for feminist theorizing about sex, gender, and science and propose avenues for future research.

Institutional Focus One: Sex and Gender Exclusion in International Sport

Background: A Brief History of Gender Eligibility Regulation

Olympic sport is characterized by two forms of gender eligibility regulation, both of which are applied only to women. One form of gender eligibility regulation concerns the participation of transgender women,[2] the other seeks to regulate women with differences of sexual development. This dissertation focuses on the latter form of gender eligibility regulation in sport. Though

[2] Transgender men are not currently regulated by the IOC or IAAF.

distinct, in recent years the two forms of regulation provoke similar anxieties about "fairness" for female athletes and have been developed by similar groups of experts. They also share similar origins, dating back to the at least the 1936 Olympic Games in Berlin. In the months leading up to the Games, President of the American Olympic Committee and future IOC President, Avery Brundage, had written to the IOC to argue that "rules should be made to keep the competitive games for normal feminine girls and not monstrosities."[3] Such fears gathered speed during the Games, with two female sprinters—American Helen Stephens and Polish Stella Walsh—both accused of being men (Bohoun 2015; Carlson 2005; Ritchie et al. 2008). A German high jumper, Dora Ratjen, competed as a woman but was later revealed to identify as a man, prompting speculation that Nazi Germany had intentionally sought to "cheat" (Berg 2009). By the late 1950s, at which time women represented around 11% of Olympic athletes, the IAAF had introduced formal verification procedures to ensure that there were no "male imposters" in the female athlete category (Pieper 2016, p. 139).

The IAAF introduced mandatory verification of women athletes in the late 1950s in the form of genital examinations, also known as "nude parades" (Rogol and Pieper 2017), before moving to a chromosome-based testing regime in 1967. The technology employed was a buccal smear test, or Barr body test, the purpose of which was to determine the presence of a Y chromosome. The IOC soon followed suit, introducing the same test in 1968.[4] Chromosomally "verified" female competitors were required to present "certificates of femininity" or "femininity cards" in order to compete (Wackwitz 2003). By the late 1990s, following decades of critique

[3] Letter from Avery Brundage, President of the American Olympic Committee, to Count Henri de Baillet-Latour, President of the IOC, June 23, 1936.

[4] Indeed, the IAAF and IOC have often worked collaboratively to introduce parallel regulations for gender eligibility (Henne 2014).

from geneticists and endocrinologists, the IOC and IAAF abandoned chromosome-based tests and looked to endogenous testosterone as an allegedly more accurate way to identify "hypermuscular" women with a natural but "unfair" athletic advantage (Pieper 2016). In a departure from previous regimes, when sex testing was mandatory for all women athletes, testing is not universal in the current "hyperandrogenism era" is not (Pape 2020). Rather, only those athletes deemed "suspicious" by designated medical staff are required to undergo examination (IAAF 2011), a situation that enables the uneven scrutiny of certain women (Henne and Pape 2018; Karkazis et al. 2012). Regulations specifically addressing the participation of transgender women athletes in Olympic sports were formally distinguished and adopted in 2003.

The 2009 World Championships in track-and-field marked the beginning of a controversial era for practices of gender eligibility regulation, prompted by the experiences of black South African 800m runner Caster Semenya. Semenya, then only 18 years old, won the women's 800m in controversial circumstances after the IAAF announced on the eve of the final that they were conducting tests to determine whether Semenya was "100 percent" a woman (Longman 2016). The announcement led to unprecedented public scrutiny of her body and gender. The IAAF's reckless breach of confidentiality drew considerable critique, particularly in South Africa, where it was framed as racially motivated (Cooky et al. 2013). The controversy led the IAAF to revise their procedure for investigating women athletes believed to have differences of sexual development, leading to the release of the Hyperandrogenism Regulations in 2011 (IAAF 2011).

The Regulations specified a limit of 10nmol/L for functional endogenous testosterone in women athletes.[5] "Suspect" athletes were required to undertake initial blood testing, followed by

[5] The Hyperandrogenism Regulations of the IOC specified a limit of 8nmol/L (IOC 2012).

a clinical examination if their testosterone levels were above the specified limit, the purpose of which was to assess the extent of "virilization" (visible signs of high testosterone exposure in the breasts, pubic hair, skin, etc.). This clinical assessment was taken to be equivalent to measuring the extent to which an athlete's testosterone levels were conferring an "unfair" athletic advantage. The Regulations required that those women believed to be benefiting from high testosterone lower their levels before returning to competition. Importantly, in the absence of mandatory testing for all women athletes, the criteria for identifying athletes "suspected" of having high testosterone were vague and open-ended, with potential sources including any "information received by the IAAF Medical Delegate or other responsible medical official" (IAAF 2011, p. 3). Women of color from Global South nations appear to be those most likely to be singled out for scrutiny under the Regulations (Henne and Pape 2018; Karkazis and Jordan-Young 2018).

In 2015, Dutee Chand, an 18-year-old Indian sprinter who was barred from international track-and-field competition under the Regulations, refused medical interventions and instead opted to appeal this regulatory regime at the Court of Arbitration for Sport (CAS) in Switzerland. Expert debate during the appeal focused primarily on the relationship between testosterone, sex difference, and athletic ability, with Chand's legal team arguing that the Regulations were "based on flawed factual assumptions" about testosterone's role in athletic performance (CAS 2015, p. 2). Ultimately, the CAS adjudicating panel ruled that while the Regulations were *not yet* sufficiently supported by scientific evidence, such evidence *could* be generated by the IAAF. Thus, they suspended the Regulations for two years and encouraged the IAAF to undertake new research to enable their reinstatement (CAS 2015, p. 156). In other words, despite the inconclusiveness of the scientific debate before them, the CAS was generally supportive of a

policy aimed at excluding women with high testosterone and shared the IAAF's belief that endogenous testosterone could be shown to decisively impact athletic ability.

In the season following the suspension of the Regulations, Caster Semenya won Olympic gold in the women's 800m at the 2016 Olympic Games in Rio di Janeiro. She was publicly accused by media commentators and track-and-field stakeholders of having elevated testosterone and an unfair advantage, as were the silver and bronze medalists, who were also women of color from Sub-Saharan African nations. In a comment that highlighted the geopolitical dynamics of this outcome, Poland's Joanna Jozwik, who came fifth in the event behind Canada's Melissa Bishop, stated following the race, "I'm glad I'm the first European, the second white" (Karkazis and Jordan-Young 2018). In 2018, the IAAF announced a revised set of regulations, the "Eligibility Regulations for the Female Classification [Athletes with Differences of Sex Development]" this time with an endogenous testosterone limit of 5nmol/L and applying only to those women's events in which Semenya is likely to compete in (IAAF 2018).[6]

In May 2019, the CAS had endorsed these new eligibility regulations following an appeal by Semenya and Athletics South Africa. In a departure from their decision in the Chand case, this time the CAS panel concluded that they were unable to assess the legitimacy of the scientific evidence before them, stating that it was beyond their scope as an adjudicating body that was "not required to appraise the adequacy of the IAAF's policy-making process" (CAS 2019, p. …). At the time of writing, Semenya had subsequently appealed the CAS decision at the Swiss

[6] IAAF researchers claim a correlation between testosterone levels and performance in the women's hammer throw, pole vault, 400m, 400m hurdles, and 800m. By contrast, the subsequent proposed (and then suspended) "Eligibility Regulations for Female Classification" apply to the women's 400m, 400m hurdles, 800m, 1500m, and mile (Bermon and Garnier 2017; IAAF 2018).

Federal Tribunal on the grounds that the IAAF Regulations are discriminatory and violate the most fundamental principles of Swiss public policy.

Chapter One: Overview, Data, and Methods

My research concerning the topic of regulating women with high testosterone, which underpins the first and second empirical chapters of this dissertation, was conducted in two stages. The second empirical chapter, "Expertise and the Regulation of the Female Athlete Body: The Case of Dutee Chand," offers an analysis of the proceedings from Chand's 2015 appeal to the CAS. The chapter stems from the question: how do institutions respond to expert contests over epistemologies of sex and gender? I use this chapter to explore how epistemological ascendancy in debates over the regulation of women athletes with high testosterone is established within a legal setting. Approaching regulation as an institutional act that defines forms of embodied difference, the legitimacy of which may be called into question, I show how sexed bodies are enacted through and as part of determinations of expertise. I focus on proceedings from 2015 when the CAS was asked to decide whether an Indian sprinter, Dutee Chand, could compete as a female athlete. Although the CAS adjudicating panel acknowledged that sexed bodies are unruly, they nevertheless proceeded to endorse the use of testosterone as the fundamental determinant of male-female differences in athletic performance, and therefore a legitimate marker of membership in the female athlete category. Thus, the CAS decision found a way to transform the unruliness of the body back into a two-category model of biological difference. I suggest that the legitimacy of these regulatory efforts was established through the concurrent narrowing of expertise and the body: binary sexed bodies are the product of expert debates, but so too is expertise achieved by representing the sexed body in binary terms.

The data for this chapter were drawn from the 161-page interim arbitral award document available on the Court of Arbitration for Sport's (CAS) website (CAS 2015). In it, members of the CAS adjudicating panel provide their account of the legal questions before them, the key evidence provided by Chand and the IAAF, and their interpretation of the relevance of that evidence to the matter at hand, namely whether the discrimination inherent to the IAAF's 2011 Hyperandrogenism Regulations was necessary and proportionate. Through a close reading and textual analysis of the Panel's account, I sought to identify the relationships among representations of the body, the achievement of expertise, and the legitimation of regulatory regimes. Drawing on abductive coding techniques and informed by feminist methodology, I iteratively read and coded small excerpts of the proceedings at a time (Charmaz, 2006; Cook and Fonow, 1986; Timmermans and Tavory, 2012). The goal of this methodological approach was to generate new theoretical insights about how the achievement of expertise relates to representations of the female body.

Chapter Two: Overview, Data, and Methods

The second empirical chapter of this dissertation, "Ignorance and the Gender Binary: Resisting Complex Epistemologies of Sex and Testosterone," explores patterns of ignorance within the elite international track-and-field community. The chapter is motivated by an overarching question: since feminist and other scholars have unsettled binary accounts of biological sex, through both their critiques of such claims and a growing body of evidence demonstrating an alternative account of sex as dynamic, non-binary, and entangled with gender, how is it that institutional actors are able to ignore their accounts? I look to the regulation of women with high levels of naturally occurring testosterone in international track-and-field in order to provide some

answers to this question. In particular, I sought to understand how ideas about biological sex and testosterone circulate within the broader sport of track-and-field and are used to legitimate the regulation of women athletes with differences of sexual development. Drawing on interviews with 65 stakeholders, this chapter examines how individuals within the elite international track-and-field community were able to protect their existing epistemic investments when the Chand appeal and an international backlash against the IAAF Regulations called into question the exclusion of women athletes with high testosterone. Proposing a framework of ignorance as an institutional process, I identify the strategies and structural arrangements that allowed stakeholders to turn away from and ignore claims that threaten their commitment to binary sex. I suggest that attention to these dynamics can aid the feminist cause of challenging the institutional marginalization of more complex representations of sex and gender.

Data collection for this chapter began in the aftermath of the Rio Olympic Games in 2016, where all three medalists in the women's 800m were accused of having high testosterone and hence an unfair advantage. This scrutiny occurred without any formal evidence that the three women had high testosterone, and despite questions about testosterone's effects on performance remaining unanswered following Chand's 2015 appeal to the CAS. I conducted 65 semi-structured interviews with diverse individuals connected to the elite level of the sport, including athletes, coaches, managers, team staff, officials including governing body representatives, media personnel, and activists, with the aim of understanding how their convictions, knowledge, and non-knowledge reflected their particular social and institutional environment. I limited my interviews to stakeholders who were either involved in track-and-field at the elite international level between 2009 and 2016 or had engaged in some way with decision-making processes related to the regulation of women with high testosterone. Ten countries were represented in this

sample, the majority of which were English-speaking and located in the Global North. Most of the interviews were completed before the 2018 announcement of the IAAF's revised regulations, meaning this chapter offers insights into the views of key stakeholders at a moment when the future of regulating women with high testosterone was especially uncertain.

The interviews were recorded and later transcribed. To analyze the interview transcriptions, I began by reading all interviews in full and noting emerging themes. I then iteratively read and coded the data, working with small excerpts at a time and applying existing theories to the data in order to identify opportunities for novel theoretical insights (Timmermans and Tavory 2012). To aid in the coding process, I imported the transcribed interviews into Nvivo, a qualitative data analysis software. I use the second chapter of this dissertation to explore three dimensions of the institutional reproduction of ignorance: adherence to misinformation and harmful misrepresentations; ideologically motivated rather than scientifically informed policy priorities; and avoidance of becoming informed. I close the chapter by suggesting that feminist engagement with the concept of ignorance offers a means of revealing the considerable institutional work that goes into preventing the production and recognition of alternative accounts of sex and gender.

Institutional Focus Two: Sex and Gender Inclusion in Biomedicine

Background: The US Experience of Biomedical Inclusion

In the third chapter of this dissertation, I look to biomedicine as a second institutional sphere where the rule-making efforts of governing bodies intersect with debates over the pursuit of scientific knowledge about sex and gender. Gender and sex inclusion has emerged in recent years as a policy priority in the governance of biomedicine and health-related research in many

national and international settings. Typically impacting preclinical and clinical research and sociological studies of health behaviors, such policies primarily seek to expand the study of gender and sex as determinants of health, inattention to which is believed to have compromised understanding of the specific health needs of women and men (Clayton and Collins 2014; Kim Tingen and Woodruff 2010; Schiebinger 2014; Zucker and Beery 2010). In a social context where gender and sex are being reconfigured through transgender, intersex, queer, and feminist activism and scholarship (Davis 2015; Meyerowitz 2002), research regulations offer a less conspicuous but important means of institutionalizing certain accounts of gender and sex. In the process of encouraging inclusion, funding agencies also promote particular conceptualizations of difference that define gender, sex, and the relationship between them, rendering them significant interventions in a broader politics (Epstein 2007; Fishman et al. 1999; Richardson et al. 2015). There is the potential for regulations to promote a nuanced account of gender and sex as non-binary, dynamic, and entangled forms of embodied difference that influence health in complex ways (Phillips 2005; Springer et al. 2012). However, they may also privilege sex as binary, biological, and more significant than gender, overlooking important health determinants in the process (Eliot and Richardson 2016; Phillips 2005).

In this chapter, I focus on the National Institutes of Health (NIH) in the United States (US) and the unfolding over time of the organization's approach to regulating the inclusion of sex and gender in biomedical and health research. Most recently, the NIH introduced a policy mandating attention to sex in preclinical research, called Sex as a Biological Variable (SABV).

Announced in 2014 and formally adopted in 2016, the SABV policy requires researchers to "consider" the relevance of sex to their research design (Clayton and Collins 2014).[7] In practical terms, this means including equal numbers of male and female animals and reporting findings by sex. The goals of SABV policy are twofold: first, they aim to address women's health inequities, and particularly the presumed contribution of fundamental biological differences to higher rates of adverse drug reactions among women. The argument here is that an over-reliance on male animal models has compromised understanding of female-specific health and disease mechanisms. Second, the policies advance the NIH goal of addressing the reproducibility crisis in preclinical biomedical research, with inattention to sex difference presented as a key contributing factor compromising the ability of researchers to replicate findings and translate from animal models to human research (Francis and Tabak 2014).

The SABV policy extends the inclusion requirements that emerged from the NIH Revitalization Act of 1993. At that time, the emphasis was on participants in clinical trials and particularly the inclusion of women and ethnic and racial minority groups. Both groups were argued to be under-represented within and therefore underserved by clinical trials funded through the NIH, which were believed to rely overwhelmingly on white men (Epstein 2007). In some regards, the SABV policy departs from this earlier clinical inclusion requirement, particularly given its focus on biological sex alone, which it constructs as having its own independent mechanisms that are distinct from social context and universally measurable across species. In other regards, its case for inclusion relies on the same logic of presumed fundamental differences between men and women that has been institutionalized at the NIH since 1993 (Epstein 2007). In

[7] With the exception of research where a focus on a single sex is justifiable, such as research related to sex-specific diseases such as breast or prostate cancers.

other words, the SABV policy both reaffirms male-female difference and establishes sex as a uniquely universal biological variable that has fundamental and distinct effects on health.

Although the dominant policy narrative in the US has become "every cell has a sex" (Wizemann and Pardue 2001: 28), the SABV policy was by no means inevitable. Rather, it reflects an intersection of feminist politics, epistemologies of embodied difference, and scientific knowledge-making that is particular to the US context. In developing a policy focused specifically on sex inclusion at the preclinical level, NIH policy-makers have uniquely departed from approaches to gender and sex inclusion seen in other national and international contexts in biomedicine, which tend to address gender and sex inclusion under the same policy umbrella, represent determinants of women's health as being both biological and social, and at least not formally privilege one over the other (Johnson and Beaudet 2014; Schiebinger 2014; Sharman and Johnson 2012). Additionally, this policy trajectory has unfolded in the US despite efforts by some actors to redefine the relationship between sex and gender in biomedical research, and to emphasize the social underpinnings of health outcomes (Fausto-Sterling 2000, 2012; Fausto-Sterling et al. 2012; Richardson et al. 2015; Springer et al. 2012).

FSS scholars have expressed concern about the SABV policy and sought to publicly engage NIH policy-makers and the wider community of sex difference researchers. They argue that it is unscientific to impose a sex inclusion requirement rather than allow the inclusion of sex to be hypothesis- driven. Given their understanding of health outcomes as reflecting a complex entanglement of sex and gender-related factors, FSS scholars suggest further that a policy focused on biological sex alone may do little to advance knowledge in ways that actually improve health outcomes for women and men (Eliot and Richardson 2016; Richardson et al. 2015). FSS scholars are also concerned about the broader impacts of the policy, given it may

promote research findings that are easily interpreted as "proving" the existence of fundamental female-male differences. Such critiques are part of a longer history of efforts by FSS scholars—and social scientists—to reconfigure dominant ideas about sex and gender inclusion in US biomedicine. The purpose of my third dissertation chapter is to explain how a policy that emphasizes the importance of biological sex differences to health was achieved in the US context in spite such resistance.

Chapter Three: Overview, Data, and Methods

In the third empirical chapter, I look to the case of the SABV policy as an opportunity to consider how feminists differ in their approaches to sex, gender, and their relevance to experiences of health and disease. More specifically, I ask: what ontological, epistemological, and political factors explain why one feminist perspective has been more easily institutionalized while the other has remained more marginal? At a broader level, what do such debates reveal about the current moment in feminist politics, and particularly feminist responses to a political environment in which the boundaries of sex, gender, and womanhood are in flux? I argue that the SABV policy was not an inevitable outcome, but rather was achieved over time, through: first, the ontological and epistemological alignment of "biomedical feminists" with dominant notions of science and embodied difference in the US and at the NIH; and second, the diverse range of empowered stakeholders that biomedical feminists were able to mobilize. Additionally, however, this process of institutionalization relied on disinvestment in alternative research agendas and the discrediting and misrepresentation of the claims advanced by researchers aligned with FSS. These insights reveal the challenges to advancing complex accounts of sex and gender in the US context and raise important questions about how to increase the relevance and impact of

scholarship emerging from FSS, feminist biology, and academic feminism more broadly, particularly when it calls into question dominant constructions of womanhood and science.

To make these interventions, this chapter draws on a variety of qualitative materials. To begin, I analyzed 65 documents published between 2014 and 2018 that directly discussed the policy, including reports, policy statements, editorials and commentaries, research articles, and published debates. Amongst the authors were representatives of the NIH, the women's health movement, professional societies, and researchers aligned with the biomedical sciences, social sciences, and FSS. Recognizing that the announcement of the SABV policy in 2014 reflected a longer history of sex and gender inclusion efforts, I also considered an earlier period of policy-making represented by two major reports published in 1999 and 2001 (ORWH 1999; Wizemann and Pardue 2001). I supplemented this textual data with 40 semi-structured interviews conducted with authors and other stakeholders as well as transcripts created from seven NIH meetings that addressed the topic of sex and gender inclusion from 2014 to 2017, recordings of which are available publicly online. Finally, I used a FOIA request to obtain responses to a 2015 NIH call for stakeholder input on the SABV policy.

Given the amount of data collected, I began by reading each of the texts and interviews in full in order to identify and collate relevant excerpts of text. I then moved towards a finer-grained analysis, working with these smaller excerpts of text to identify emergent themes and patterns. This iterative coding process was aided by the use of Nvivo, a qualitative coding software program. Informed by my prior reading of feminist and STS scholarship and my initial immersion in the data, I worked towards identifying the ontological, epistemological, and political factors that differentiated proponents of sex differences research from those advancing a more complex approach to the biomedical study of sex and gender.

Chapter Four: Overview, Data, and Methods

The final empirical chapter takes the concept of complexity as its theoretical and empirical focus. Recognizing that all three preceding chapters involve institutional resistance to complex orientations towards gender/sex, and that resistance to complexity frequently appears in STS scholarship concerned with the dynamics of expertise, ignorance, and regulation, I approach this chapter as an opportunity to explore the disunity of science when it comes to gender/sex and reveal some of the specific ways that regulatory institutions resist complexity. Drawing on the data from both cases outlined above, I identify eight mechanisms, including: maintaining the ontological independence of sex from gender, promoting the pursuit of scientific knowledge forms that affirm sex as distinct from rather than fundamentally entangled with gender, constructing sex-based variation in terms of binary differences rather than overlap and similarity, avoiding external critique, and failing to recognize the complex intersections of gender/sex with race and nation. I also reflect on how these two cases might reveal more general insights about the relationship between complexity, knowledge, and rule-making, and particularly how resistance to complexity can serve as a key mechanism by which institutions succeed in upholding dominant ideologies and interests. I conclude by arguing that the equal recognition of complex accounts of gender/sex is a key prerequisite for socially legitimate and scientifically robust regulations aimed at advancing inclusion in institutional spheres like biomedicine and sport, which are grappling with both the traditional under-representation of women and the shifting politics of gender/sex.

CHAPTER ONE

Expertise and the Regulation of the Female Athlete Body: The Case of Dutee Chand

> *I was born a woman, reared up as a woman, I identify as a woman and I believe I should be allowed to compete with other women.—Dutee Chand, cited in CAS 2015, p. 8*

In 2011 the participation of women in the sport of track-and-field became subject to formal Hyperandrogenism Regulations stipulating a limit to the amount of naturally occurring testosterone allowed in their bodies. In 2014, Indian sprinter Dutee Chand was barred from international track-and-field competition for ostensibly having "violated" this regulation. When she subsequently contested the legitimacy of this regulatory regime before the international Court of Arbitration for Sport (CAS) in 2015, the adjudicating panel ruled that the Regulations were not yet sufficiently supported by scientific findings, suspending them for two years but encouraging the pursuit of new evidence to support their reinstatement. Given the role of sport and law as institutions that affirm the scientific basis of binary sex differences (Henne, 2015; Meadow, 2010), the CAS decision potentially represented a moment of ideological destabilization and change. However, with the international governing body for track-and-field announcing new regulations in 2018, the implications of the Chand appeal are now clear: sport remains stubbornly committed to a binary model of embodied difference, with measures of testosterone endorsed as the legitimate means of regulating this binary in practice.

Feminist scholarship in the social and biological sciences has shown that dominant epistemologies of sex and gender—and especially those that represent biological sex in terms of

the distinct, binary categories of male and female—can be contested and even abandoned in favor of a scientific approach to embodied difference that is less troubled by oppressive gender ideology and more rigorous as a result (Fine and Jordan-Young 2017; Lorber, 1993; Fausto-Sterling, 2000; van Anders, 2012). Given the existence of alternative scientific accounts of the sexed body as complex, dynamic, and indeterminate, as well as recent shifts in the political boundaries of gender identity as a result of intersex, transgender, and queer activism (Davis, 2015; Meyerowitz, 2002), it is by no means inevitable that the legal and administrative governance of sport continues to endorse a restrictive biological account of the female athlete body. Since sports governing bodies themselves have acknowledged that determinations of gender and sex can be neither scientifically nor ethically justified (CAS, 2015; IOC, 2015), how did the CAS succeed in legitimating the regulation of binary sex-based categories for sports competition? On a broader level, what does this case reveal about the institutional mechanisms that underpin the stubborn persistence of binary and biological epistemologies of sex and gender?

In this article, I consider the role of expertise in the legal proceedings that enabled the International Association of Athletics Federations (IAAF)—the peak governing body for the sport of track-and-field—to continue pursuing its long-standing regulatory agenda targeting the bodies of women with differences of sexual development. According to theories of expertise as developed within Science and Technology Studies (STS), the achievement of expertise relies upon favorable institutional conditions for both the *production* and the *recognition* of particular knowledge claims (Frickel et al., 2010; Jasanoff, 2005; Suryanarayanan and Kleinman, 2013). At the level of production, state and non-state agents of governance enable and privilege certain forms of science by drawing selectively on expert scientific advisors to develop and legitimate

policy efforts, who often interpret available facts in ways that are politically expedient (Jasanoff, 1990: 282; Lentsch and Weingart, 2011). Legal decision-making bodies represent key recognition-granting institutions, and may favor certain kinds of scientific knowledge claims, given that the mutually constitutive or coproductive cultures of law and science "jointly produce our social and scientific knowledge" (Jasanoff, 1995: 8; Merry, 1998). I suggest that these institutional practices also jointly produce particular understandings of bodies. I examine how the granting of expertise in legal settings enables the production of the binary sexed body, and inversely, how such bodies support the achievement of expertise. In doing so, I argue that the body can be understood as both the *product* of expertise and the *unruly material* that aspiring experts must contend with in order to lay claim to epistemological ascendancy.

A central project for Feminist Science Studies has been to reveal this unruliness, particularly as concealed within scientific claims about binary sex difference. In the process scholars have demonstrated that scientific representations of the body in terms of binary sex categories are deeply gendered, with researchers pursuing such knowledge in ways inseparable from their own gendered social locations and paradigmatic assumptions while engaging in considerable work to align their findings with strongly held social expectations of binary sex difference (Lorber, 1993; Martin, 1991; Spanier, 1995; Tuana, 1988). The "gender panic" surrounding intersex bodies can be explained by the challenge they pose to the alleged biological basis of the gender binary, leading to their forced alignment at the hands of medical practitioners (Davis, 2015; Fausto-Sterling, 2000; Kessler, 1998; Westbrook and Schilt, 2014). The "awkward surpluses" of biological matter that leak beyond the boundaries of the binary and reveal its social nature also occur in the laboratory in the study of animals and genetic sex difference (Fujimura, 2006: 51). Such insights have laid the foundation for a growing body of feminist empirical

research in the biological sciences exploring the complexity and dynamism of sexed bodies (see Fausto-Sterling, 2012; Ritz, 2018; van Anders, 2012).

However, colleagues and policy-makers have often been resistant to the alternative epistemologies of sex and gender advanced by feminist scholars in the social and biological sciences (Fausto-Sterling, 2003; Fine and Jordan-Young, 2017). Despite this resistance being relatively well documented, there has been little attention to the specific institutional mechanisms by which these feminist claims about biological difference exit the laboratory and are granted or denied legitimacy in other settings. Charting this step offers a crucial addition to existing feminist research in and on the biological science, completing the analytical circle from the gendered production of knowledge, to the uptake of that knowledge in regulatory efforts, to their effects on the actual enactment of binary sexed bodies, and finally to their influence on the worldviews of scientific researchers (Epstein, 2004; Haraway, 1988; Sanz, 2017).

The regulation of women with high testosterone in international sport is ripe for the pursuit of such an agenda. Feminists have long critiqued the deployment of medical and scientific knowledge through regulatory interventions designed to police intersex, chromosomal, and hormonal variation among women athletes (Jordan-Young and Karkazis, 2012; Kane, 1995). These regulatory acts can be understood as institutional interventions that actively produce forms of embodied difference (Epstein, 2007). However, the actions of sports governing bodies do not take place in a vacuum and these regulations are contestable, involve diverse stakeholders, and are subject to the many forms of formal and informal, legal and non-legal ordering that generate complex regulatory effects and consequences within a given social context (Parker and Braithwaite, 2003). Moreover, approached from the perspective of global legal pluralism, the CAS is not an isolated legal decision-making body (Berman 2005, 2009; Merry, 1984, 1988).

The ways in which the CAS grants legitimacy to certain expert claims and representations of the body can be investigated as an instance of legal norm articulation with relevance to proceedings in other international, national, and local contexts (Henne, 2010, 2015). The Dutee Chand appeal thus presents an important opportunity to examine how legal decision-making bodies respond when regulatory interventions that seek to define sexed, athletic bodies in terms of testosterone are called into question.

Through a close reading and textual analysis of the court documentation,[5] I consider the relationships among representations of the body, the achievement of expertise, and the legitimation of regulatory regimes. I show how sexed bodies are enacted *through* and *as part of* determinations of expertise. In this case, the legitimacy of the Hyperandrogenism Regulations was established through the *concurrent narrowing* of expertise *and* the body by the CAS adjudicating panel, such that recognition could only be granted to binary accounts of testosterone as the basis of sex difference and athletic ability. Moreover, only certain expert accounts of the body could be realized and acknowledged in the future, due to the research agendas endorsed by the panel.

I develop this argument in three sections. Following a brief description of the Regulations in question, in the first empirical section I show how the first step in narrowing expertise and the body was to disqualify certain knowledge claims, and especially those involving athletes' lived

[5] The analysis draws primarily on the 161-page interim arbitral award document released by the CAS in 2015 (CAS, 2015). I conducted a textual analysis of the panel's representation of the case, informed by feminist methodology and drawing on abductive coding techniques in an effort to generate new theoretical insights based on how the panel constructed relations between expertise, the body, and regulation (Charmaz, 2006; Cook and Fonow, 1986; Timmermans and Tavory, 2012). Working with small excerpts at a time, I iteratively read and coded the proceedings, seeking to identify the discursive moves by which the CAS adjudicating panel represented the body and related knowledge claims.

experiences of regulation. Also marginalized were social scientific accounts, with the result that the athletic body was reduced to a partial instantiation, represented in terms of hormones alone and measures of testosterone in particular (Berg and Akrich, 2004: 4). This created a scenario where the regulated body could only legitimately be contested— and expertise claimed—in terms of simplistic narratives about the biological mechanisms of testosterone, which were given additional weight over other types of knowledge claims. In section two, I consider how the adjudicating panel excluded even those scientific accounts that acknowledged the workings of testosterone, and specifically those that emphasized testosterone as complex, such that the hormonal body could only be represented in binary terms. In section three, I show how the panel encouraged only the *pursuit* of knowledge that would contain unruly bodies within a binary framework, revealing the institutional limits on realizing alternative forms of expertise and alternative bodies *in the future*. In sum, this configuration of expertise explains how, and despite the existence of evidence to the contrary, the CAS came to view testosterone as the basis of binary sexed bodies, thereby legitimating the regulation of women with high testosterone.

Background: Appealing the Regulation of Testosterone in Women

The Chand case focused on the Hyperandrogenism Regulations of the IAAF and International Olympic Committee (IOC),[8] developed following the IAAF's mishandling of the gender controversy surrounding South African athlete Caster Semenya in 2009.[9] Part of a much longer

[8] The IOC is the peak governing body for the Olympic Games. Both organizations released their Hyperandrogenism Regulations in 2011.

[9] During the 2009 World Championships, the IAAF announced that they were investigating Semenya for suspected ambiguities in her sexual development (Clarey, 2009). They were subsequently criticized for not having a clear testing protocol and disregarding Semenya's right to confidentiality (Cooky et al., 2013).

history where sports governing bodies have variously surveilled competitors in international women's sporting events, the 2011 Regulations defined endogenous (naturally occurring) testosterone in women athletes' bodies as the key factor determining their athletic abilities and compromising the "fairness and integrity" of women's competition (IAAF, 2011b: 1). Distinct from anti-doping efforts, they alleged that women with naturally elevated testosterone are technically not cheating but gain an unfair advantage from having masculine physiology. There have been no equivalent regulations specifying "fair" levels of naturally occurring testosterone in men. Under the Regulations, the limit to the amount of functional endogenous testosterone in female athletes was arbitrarily defined as the start of the "normal male range" or 10nmol/L (IAAF, 2011a: 12). Importantly, the 2011 Regulations did not mandate the testing of all female athletes and allowed considerable room for interpretation with respect to how a "suspect" athlete may be identified.[3] Increasingly, it appears such regulations have been applied in practice in ways that disproportionately target women of color from the Global South, suggesting that the geopolitics of race and nation also shape the constructions of femininity that are privileged in international sport (Henne and Pape 2018; Karkazis and Jordan-Young 2018).[4]

Women singled out for testing and found to be above the specified limit were subjected to examinations to determine the functionality of their testosterone, with a clinical assessment of "virilization" (or the extent to which they had developed masculine characteristics) erroneously taken to indicate the extent of their athletic abilities. The Regulations did allow women athletes

[3] In Chand's case, the Athletics Federation of India (AFI) allegedly investigated the 18-year-old athlete after several competitors allegedly "expressed concern … that the Athlete appeared to be very masculine in her physique" (CAS, 2015: 112).

[4] As several scholars have convincingly shown, earlier efforts at gender eligibility regulation were similarly underpinned by geopolitics (Bohuon, 2015; Henne, 2014; Pieper, 2016). Regulatory efforts during the Cold War era targeted allegedly masculine women athletes from Eastern bloc nations.

who violated the policy to be reinstated, but only by undergoing medical interventions to return their testosterone to levels deemed appropriate by the IAAF and IOC. Chand stood accused of violating this standard and her appeal was heard at the CAS headquarters in Lausanne, Switzerland over four days in late March 2015, with the adjudicating panel ultimately ruling to suspend the Regulations for a period of two years. The IAAF was invited to submit new evidence during that time.

Part I: Paring Down the Regulated Body

Epistemological ascendancy in debates over expertise is shaped by the historically established and context-specific "social organization of knowledge production," which produces an uneven terrain for the recognition and valuation of different knowledge claims (Suryanarayanan and Kleinman, 2013: 218). This is shown to have particular implications for the efforts of non-scientists, social scientists, and feminists to have their knowledge claims legitimated. In the case of expertise and policy-making, for instance, demarcation efforts may seek to exclude non-scientific or "lay" considerations such that contested policy issues are reduced to matters of scientific expertise alone (Wynne, 2008: 26). Similar efforts to distinguish "science" from "non-science" occur in the context of legal proceedings, where decision-making bodies committed to particular ideologies of science focus on demarcating "true" (objective and falsifiable) science from that which is "pseudo" or "junk" (Cole, 2007: 807; see also Cole and Bertenthal, 2017; Jasanoff, 2005; Kirkland, 2012). These narrow definitions of science may exclude social scientific claims to expertise, as seen in the efforts of witnesses from the social sciences to articulate complex structural accounts of institutional racism and other forms of discrimination (Nelson et al., 2008: 104–105). Demarcations of legitimate knowledge during legal proceedings

may also be gendered. For instance, feminist legal studies scholars have shown that legal decision-making bodies narrow their recognition of expertise by marginalizing women's lived experiences, devaluing feminized ways of knowing, and disqualifying critical feminist perspectives that emphasize social structure and other perceived intangibles (Azocar and Ferree, 2015; MacKinnon, 1987).

My analysis reveals that this narrowing of legitimate evidence to *certain* forms of scientific knowledge also occurs when the regulation of women's bodies is called into question. Faced with an overabundance of data and perspectives, including Chand's lived experiences of being subjected to the IAAF's regulatory regime and social scientific accounts of the complexities of testosterone and athletic performance, the CAS adjudicating panel constructed which ways of knowing the body would be recognized as relevant to the legitimacy of the IAAF's regulatory efforts. Mirroring other arenas where expertise is established, the panel here drew a line between "science" and "non-science" and prioritized the former (Wynne, 1992). The exclusion of social science from this framing meant that expertise was reduced to a *certain kind* of science, with scientific legitimacy defined in biological terms alone. Matters of implementation, including Chand's embodied experiences of regulation as a woman of color from a Global South nation, were cast as secondary to the narrowly hormonal content of the Hyperandrogenism Regulations. By excluding these ways of knowing the regulated gendered (and racialized) body, the panel limited relevant expertise to the seemingly biological realm and to questions about how and to what extent testosterone matters to athletic performance.

Witnesses discussed a range of actual and potential harms inflicted on women's bodies under the IAAF's regulatory regime and demands that "suspect" bodies undergo medical interventions in order to compete. Consistent with the treatment of other women athletes under

gender eligibility policies, Chand's case included violations of her right to confidentiality and informed consent (Karkazis et al., 2012). For example, without Chand knowing the purpose:

> She was subjected to a 'humiliating' examination by a male doctor, who asked intrusive questions about her body hair, menstrual cycle, surgical history and her hobbies. Several doctors carried out physical examinations of the Athlete body, including on her genital area. The Athlete said she felt vulnerable and did not feel that she had any choice in relation to the testing. (CAS, 2015: 108)

A leak to the media had led to humiliating public scrutiny and "severe distress" for Chand (CAS, 2015: 108), making "life extremely difficult for the Athlete" in a country embedded with commonsense notions about athletic bodies and a culture of "misogyny and violence against women" (CAS, 2015: 111). A social scientist and activist testifying in support of Chand also "cited examples of athletes being forced to undergo surgery without clear information about what the treatment involved" (CAS, 2015: 110). Even an IAAF witness conceded "that it was 'questionable at best' whether young women in that position can give informed consent for medical interventions within the current procedures" (CAS, 2015: 97).

The CAS adjudicating panel acknowledged that the Regulations could lead to "significant detrimental consequences" (CAS, 2015: 146). However, Chand's experiences were described only as "important *background* to the Athlete's case" (CAS, 2015: 107, emphasis added), and addressed in a separate section of the Award document following the issues represented as central to the appeal. In other words, such concerns factored into the panel's assessment only insofar as the Regulations could be scientifically justified. Despite Chand's experience to the contrary, the panel accepted the IAAF's argument that the Regulations provided a clear protocol for ensuring confidentiality and obtaining informed consent, rendering the implementation of the

Regulations irrelevant to their legitimacy (CAS, 2015: 30, 107). In this move, Chand's embodied experiences were constructed as an irrelevant form of expertise, rendering experiential dimensions of the regulated body incontestable and positing them instead as the legitimate outcomes of regulations imposed—on certain women more than others—by international sports governing bodies located in Global North nations (Henne and Pape 2018; Karkazis and Jordan-Young 2018).

The devaluing of social scientific ways of knowing followed a similar path, seen particularly in the experiences of bioethicist Katrina Karkazis, a witness for Chand. Amongst her arguments was the claim that "there is 'a great deal of mythology' about the physical effects of testosterone" (CAS, 2015: 51) on athletic performance. Critiquing the normative basis of the Regulations, she argued "more than half of the indicators specified in the Hyperandrogenism Regulations … are 'entangled with deeply subjective and stereotypical Western definitions of femininity'" (CAS, 2015: 76). These indicators included "deep voice, breast atrophy … increased muscle mass, [and] body hair of male type" (Karkazis et al., 2012: 13). Additionally, Karkazis pointed to the myriad social factors beyond physiology that influence the athletic success of elite athletes, such as access to training facilities, superior coaching, sports psychology, sports science, nutritious food and health supplements, each of which are more widely accessible to athletes in resource-rich countries (see also Karkazis et al., 2012). The panel's response was to describe these claims as "sociological opinion, which does not equate to scientific and clinical knowledge and evidence" (CAS, 2015: 134).

However, the arguments contained in Karkazis' evidence and publications were more than sociological in nature. For example, Karkazis and colleagues provided a comprehensive review of the scientific evidence for and against the claim that testosterone can be relied upon as

a single indicator of athletic advantage (Karkazis et al., 2012: 8, 11). It also reviewed the potential health implications, positive and negative, associated with the IAAF's proposed medical interventions (p. 12). In determining not to "give great weight to this article for the purposes of this case," the panel defined not only the *kinds* of claims that were to be deemed legitimate expertise, but also *who* was credible in making those claims, serving to further narrow the conditions under which representations of the regulated body would be recognized (CAS, 2015: 134). In sum, the vast array of knowledge claims that were presented as evidence to challenge the legitimacy of the Hyperandrogenism Regulations were reduced to a very specific area of expertise: direct engagement with the biological study of testosterone. And here, too, only certain representations of testosterone would count.

Part II: Excluding Complexity

The reduction of the sexed, athletic body to a single biological characteristic can be understood as a partial instantiation or approximation of the "body as a whole," and a strategic step for regulatory efforts that might be crippled if the body's full complexity was acknowledged (Karkazis and Jordan-Young, 2018; Mol and Law, 2004). Similarly, feminist scholar Carol Smart has shown that the "precision" demanded by the legal process simplifies complex gendered experiences, replacing them with oppositional binaries such as truth/untruth or consent/nonconsent, as she documents in relation to rape (Smart, 2002: 26). This binary logic has been shown to extend to transgender identity claims, with courts and state agencies in countries like the United States (US) more likely to recognize those individuals who have undertaken medical interventions to fit within the expected gender/sex binary (Meadow, 2010). Thus, like other regulatory agents, legal decision-makers often reject expert claims emphasizing the

complexity of gender as a lived and embodied experience, aligning instead with those experts who reproduce the simplified binary logic of the "social and cultural status quo" (Wilson 2016, 742).

However, testosterone is an unruly entity (Oudshoorn, 1994; Roberts, 2007). The adjudicating panel was asked by Chand's witnesses (including those with the "appropriate" scientific expertise) to recognize that testosterone evades the efforts of researchers to establish it as both the basis of binary sex difference and the key factor contributing to athletic ability. These expert witnesses argued specifically that two "factual premises" of the Hyperandrogenism Regulations were overly simplified and therefore "fundamentally flawed:" (i) that elevated levels of natural testosterone give female athletes a decisive performance advantage; and (ii) that medical science can delineate distinct testosterone ranges for male and female athletes (CAS, 2015: 34). By contrast, the IAAF's experts argued that testosterone is "the best discriminating factor between male and female athletes in sports" with "no overlap in testosterone levels between men and women" (CAS, 2015: 37, 135). At issue was both expertise and the ontological character of testosterone: was it complex, dynamic, and indeterminate, or could it be relied upon to invariably represent a binary model of sex and athletic ability?

There were signs that the panel was amenable to the position that sexed bodies are complex. For example, the panel agreed with Chand's experts that "sex in humans is not simply binary" and "there is no single determinant of sex" (CAS, 2015: 11). Despite this acknowledgement, the panel accepted the IAAF's claim that the Hyperandrogenism Regulations "do not police the male/female divide but establish a female/female divide within the female category" (CAS, 2015: 147). The panel explained further:

> [Testosterone] is not being used to determine whether an athlete should compete either as a male or as a female. Instead, it is being used to introduce a new category of ineligible female athletes within the female category. (CAS, 2015: 147-148)

This logic permitted the Hyperandrogenism Regulations to be treated as distinct from earlier forms of gender verification, such as chromosomal testing, which had been abandoned for their scientific inaccuracies (Henne, 2015). But although the CAS acknowledged that efforts to represent sexed bodies as binary were problematic, it approximated such accounts by introducing a new binary model of difference, one that continued to rely on a single biological factor—testosterone—to draw a line between "normal" women's bodies on one side, and "superwomen" and men on the other (Pape, 2017). This new binary simulated the sex categories of male and female in all but name, not least since there was to be no third category for competition purposes. Rather, women with functional testosterone above 10 nmol/L who refused to medically lower their testosterone levels would be required to compete with men (IOC, 2015).

This new binary relied on the panel's recognition of the IAAF claim that male and female bodies conformed to distinct and non-overlapping ranges of testosterone once "pathological" outliers were excluded from the analysis. Calculations here were based on data collected from the population of 2127 elite athletes competing across the IAAF World Championships of 2011 and 2013, in which there were "a significant number" of men (n=198) with testosterone below the so-called normal male range, including four whose levels were considered to fall within the female range, and only 13 women whose testosterone levels were above the nominated normal limit for female athletes (CAS, 2015: 44). Chand's experts opted to include these outliers, arguing that it was scientific to include all of the naturally occurring diversity within the elite athlete population, leading them to conclude that there was "complete overlap of endogenous

testosterone levels between the sexes" (CAS, 2015: 42). By contrast, and consistent with the clinical construction of intersex as a disorder, the IAAF experts argued that such outliers were "pathological" and should be excluded when calculating normal and "healthy" testosterone ranges (CAS, 2015: 54–56).[10] In assessing these competing approaches, the panel accepted the clinical representation of outliers as pathological bodies, determining that the IAAF had "provided an explanation for why those outliers should be disregarded," and that the regulators were "reasonably entitled to rely on testosterone" as an approximation of binary sexed bodies (CAS, 2015: 143).

Determining testosterone's role in enhancing athleticism was more challenging. Again, the panel showed signs of acknowledging complexity, noting "other factors besides testosterone … may also contribute to the significant male athletic advantage over females" (CAS, 2015: 150). However, this acknowledgement was forgotten as the panel narrowed in on debates about the nature of testosterone. One such debate was whether endogenous (naturally occurring) testosterone produced similar effects in athletes' bodies to exogenous (artificially administered) forms of testosterone, since the latter was known to be a performance enhancer.[11] In other words, how complex was testosterone itself? Did it have absolutely determined effects on the body regardless of how it arrived there?

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[10] Whereas Chand's experts argued that "*healthy* women with high testosterone levels [may] never present themselves for clinical attention" (CAS, 2015: 57, emphasis added), IAAF experts responded that "the chance of a healthy woman having a testosterone level of 10 nmol/L is 'zero'" (CAS, 2015: 56).

[11] The IAAF relied on data showing a positive relationship between anabolic steroids and athletic performance. Chand's experts argued that doping "involves the introduction of a new biochemical agent that upsets the body's equilibrium," whereas the IAAF argued there is "no biochemical difference between endogenous and exogenous [testosterone]" (CAS, 2015: 35, 54).

Expertise here became a matter of what should constitute legitimate interpretation of secondary studies, since both sides "relied on different published papers to support his or her view on whether there was an exogenous/endogenous divide" (CAS, 2015: 137). In the process, both sides questioned the findings of peer-reviewed articles. But whereas the panel saw the IAAF's critiques as "[coming] directly from their fields of expertise" (CAS, 2015: 138), they would not grant the same right to Chand's experts, stating that they could "not accept unsupported speculation and hypothesis to overcome established data and expert conclusions drawn from those data" (p. 139). In other words, the peer review process was trustworthy when it produced a binary account of testosterone, but questionable when it legitimated findings of complexity.

With Chand's expert interpretations of secondary studies disqualified, the panel saw their complex representations of testosterone as insufficient and lacking an empirical basis (CAS, 2015: 143). According to the CAS, the burden of proof was on Chand to establish on the balance of probabilities that testosterone either *was* or *was not* a material factor in determining athletic performance, with the panel concluding that "the Athlete [had] not established that there is *no* relationship between testosterone and athletic performance" (CAS, 2015: 137, emphasis added). However, this binary burden of proof contradicted Chand's claim that both athletic performance and sex difference are complex and involve multiple biological determinants, including *but not limited* (or reducible) to testosterone. By requiring an impossible confirmation of the null, that is, proof for the negative claim that testosterone does *not* confer an advantage of *any* size, legitimate expertise could only be that which constructed testosterone—and the sexed athletic bodies it was taken to approximate—in binary terms. Expert accounts advancing a more nuanced and complex representation of biological bodies were disqualified by this decision.

Part III: Realizing the Knowable Body

Knowledge production relies on the institutionalized allocation of power, resources and opportunities. The absence of such allocations may also lead to certain forms of knowledge being left "undone" (Frickel et al., 2010). This is particularly likely to occur if a research agenda conflicts with or undermines existing ideologies and interests (Böschen et al., 2010; McGoey, 2007; Kleinman and Suryanarayanan, 2012). Indeed, for this very reason, certain forms of knowledge about gendered and sexed bodies may lack institutional support and become relegated to the realm of ignorance. For instance, Nancy Tuana (2004) shows that medical training and textbooks have historically overlooked the anatomy and functioning of the clitoris, thereby limiting knowledge about how women experience sexual pleasure and containing their sexuality in the process.

The institutional line drawn between knowledge "done" and that left "undone" is significant to the possibility of claiming expertise, since aspiring experts draw on existing or "done" bodies of knowledge. Not all research agendas involving the body will receive institutional support, but those that do will lead to the body becoming knowable in certain "expert" ways (Mol, 2003). The outcome of the Chand appeal, in which the CAS adjudicating panel supported in principle the use of testosterone to regulate women's athletic participation, had the effect of limiting how the sexed body could be known and who could claim such expertise in the future. Although they opted to suspend the Regulations in the short term, the panel encouraged the IAAF to pursue new areas of research to support the re-introduction of their regulatory regime. Moreover, only the IAAF was invited to return to the CAS with new evidence. Thus, although the potential directions of future research were diverse, the CAS

decision endorsed the pursuit of a research agenda that would confirm testosterone as the basis of binary athletic bodies.

The CAS panel was forced to acknowledge remaining uncertainty concerning the *magnitude* of testosterone's effects on athletic ability. They had required the IAAF to demonstrate "the *degree* of competitive advantage conferred by a testosterone level above 10 nmol/L," such that the exclusion of women above this level could be justified (CAS, 2015: 155, emphasis added). In the absence of such evidence, IAAF experts had relied on the claim that "the best analysis of [the physical effects of testosterone] is the clinical response … namely virilisation" (CAS, 2015: 131). The panel was unconvinced that this constituted a definitive measure of testosterone's effects on athletic ability, describing it as inferior to "scientific data from a properly conducted study" (CAS, 2015: 142). However, they expressed their confidence that such a study could be conducted. In other words, the panel determined that more research of a *specific kind* was needed to address remaining uncertainty surrounding the magnitude of testosterone's effects on athletic bodies.

In this instance, the panel deemed the IAAF's overall hypotheses to be worthy of further investigation. According to the panel, while there was "presently no available evidence" that testosterone conferred a male-sized advantage to women with naturally elevated levels, the IAAF's "assumption may well be proved valid" (CAS, 2015: 155). They noted further that "evolving scientific evidence or the compilation of existing evidence and data [may] reach a sufficient level of proof," recognizing in particular the IAAF's stated plans to reanalyze their World Championships dataset (CAS, 2015: 156). In sum, the panel's decision defined the need for more "science" to be done, but *only* about the magnitude of testosterone's effects, presenting this binary claim as probable but as yet unproven. By contrast, the panel was silent on the

possibility that Chand's experts could or should do the same. A line was drawn between doable and undoable research, with that which would challenge binary representations of sex and athletic ability defined by omission as unnecessary science.

This decision in support of the IAAF's overall research agenda belied the extent to which both Chand's and the IAAF's research results were inconclusive about exactly if and to what extent testosterone confers an athletic advantage. This is despite the fact that at key moments during the proceedings, the IAAF hypothesis that testosterone corresponded with enhanced athletic ability was revealed to lack support. For example, in an academic article submitted as evidence to the CAS, IAAF witnesses conceded that "the lack of definitive research linking female hyperandrogenism and sporting performance is problematic," and "there is no clear scientific evidence proving that a high level of T is a significant determinant of performance in female sports" (Bermon et al., 2014: 4334). One IAAF witness acknowledged this uncertainty during the hearing, stating that "we don't have much evidence" and "there was no definitive proof" of the link between testosterone and differences in male and female athletic abilities (CAS, 2015: 57). With both Chand's and the IAAF's claims revealed as inconclusive, both could have been represented as warranting further research. Instead, the legal vision of doable research pushed certain *potential* accounts of the body to the margins, simultaneously discouraging the realization of related expertise.

The panel's assessment of worthy and unworthy research also contained a gendered asymmetry. The outliers excluded by the IAAF when calculating "normal" testosterone ranges included male athletes whose testosterone fell in the "female range," potentially as a result of "hypogonadism" (the underproduction of testosterone), which IAAF experts described as a "medical condition" (CAS, 2015: 93). Despite a key justification for the Hyperandrogenism

Regulations being the IAAF's alleged concern for the health of female athletes with high testosterone, it was stated that "the lower boundary of the male range was a 'non-issue,'" and in regard to men, "a 'huge amount of work' would need to be done to … see if the levels of testosterone were normal or pathological" (CAS, 2015: 53, 93). The panel accepted the IAAF's claim that men's bodies were not worthy of clinical investigation in the same way as women with non-normative testosterone levels, meaning that the attribution of "pathology" was also gendered (Westbrook and Schilt, 2014). Now in the realm of non-knowledge, men's bodies with so-called female levels of testosterone would have no bearing one's ability to claim expertise. Nor would these bodies be constructed as the legitimate targets of regulation. This example reveals the IAAF's agenda to be distinct from health concerns. Rather, the purpose of the IAAF's regulatory efforts is once again the containment of women's bodies in service of the gender binary (Cavanagh and Sykes, 2006).

Concluding Remarks

There is an overarching puzzle underpinning this analysis of expertise in the Chand appeal: if feminist scholars in science studies and biology are providing alternative ways of conceptualizing the sexed body as complex, dynamic, and indeterminate, what institutional mechanisms prevent the broader recognition and experience of the body in such terms? When the regulatory regimes that underpin the practice of binary sex in sport are called into question, so too are the forms of scientific and medical knowledge on which they rely. Yet the purpose of the questions raised in this article is not to outright reject scientific representations of embodied difference since, as argued by Fine and Jordan-Young (2017), complex epistemologies of the sexed body can in fact be considered more scientifically rigorous than the ideologically-driven

binary alternative. Rather, Chand's legal challenge presents a rare opportunity to chart the institutional process by which legitimacy is denied to complex scientific renderings of sex and gender. The contribution of this article to such an agenda is to examine precisely how expertise and the body are co-produced as part of the reassertion of binary accounts of biological sex (Epstein, 2004; Jasanoff, 1995). At the same time, the outcome of the Chand appeal is important to understand in its own right, since the panel's overall support for testosterone as definitive in producing women's athletic excellence paved the way for the IAAF to introduce a revised regulatory regime in 2018. Much like the original Regulations, this version is the focus of yet another heated international debate in and beyond the sporting world.

This debate is additionally salient given the apparent over-representation of women of color from the Global South amongst those athletes singled out for investigation (Bohuon, 2015; Henne and Pape, 2018; Karkazis and Jordan-Young, 2018). This focus is aligned with a history of medical experts marking the bodies of Black women as sexually ambiguous in service of the coproduction of femininity and whiteness (Magubane, 2014). As established in this article, it is notable that arbitration procedures put the burden on Chand, from a working-class family in rural India, to disconfirm the experts of international sports governing bodies located in the Global North, who hold considerable resources to invest in their research agendas (Pape, 2017; Galanter, 1975; Straubel, 2005).[12] This regulatory process thus exposes the intersectional effects of race, class, and nation on decisions about gendered bodies, indicating that gender determination is never a purely one-dimensional process.

In order to reassert sexed bodies as binary, it was necessary for the CAS adjudicating panel to progressively narrow their determinations of expertise. In the first instance, this took the

[12] The IAAF's anti-doping budget, which supports the research of the Medical and Anti-Doping Committee, totaled $2.03 million (US) in 2015 (IAAF, 2016).

form of disqualifying those knowledge claims that did not relate specifically to a narrowly defined focus on the biological mechanisms of testosterone. Particularly troubling here is that the differential treatment of women's bodies can be justified by such science. Although the IAAF and the IOC have long agreed that female athletes should not be subjected to gynecological examinations—the so-called "nude parades" that were initially used to "verify" the sex of competitors in women's events (Bohuon, 2015)—the Hyperandrogenism Regulations preserve and legitimate this precise practice for women whose bodies "fail" a testosterone screening.

The onus of proof requiring Chand to empirically demonstrate that testosterone either *does* or *does not* influence performance disqualified from the outset her actual claim that testosterone is one of many factors implicated in the production of athletic excellence. This aversion to complexity aligns with the interests of the more powerful stakeholders involved in expert debates, as does the exclusion of the social and experiential claims advanced by Chand and her experts (Suryanarananan and Kleinman, 2013: 232; see also Nelson et al., 2008). Also excluded from the panel's narrow vision of expertise to be left undone were the alternative hypotheses advanced by Chand's experts, which were also the research agendas most likely to destabilize the binary embodiments of sex institutionalized in and beyond sport. Determinations of doable and worthy research emerge as significant to both future expertise and potential embodiments: institutional support matters not only to the *recognition* of claims based on "done" research, but also to the possibility of *doing* such research and revealing unruly bodies in the first place.

The uneven terrain represented by the CAS for the recognition of expert claims was also explicitly gendered, not least in legitimizing the prevailing asymmetrical tendency in medicine and sport to problematize and intrude upon women's bodies (Jordan-Young and Karkazis, 2012;

Kane, 1995; Moscucci, 1990; Rapp, 1999; Westbrook and Schilt, 2014). More generally, the CAS decision rendered illegible those accounts of women's bodies that would challenge existing notions of binary embodied difference and related gender inequalities. As such, and as also seen in the regulation of transgender women in sport, the outcome of the Chand case forms part of institutional resistance to change at a moment when alternative accounts of sexed and gendered bodies are gaining broader recognition (Cavanagh and Sykes, 2006; Davis, 2015; Meyerowitz, 2002). There are high stakes attached to the institutional politics of epistemology as a site of contending modes of expertise. In the case examined here, they include whether and to what extent alternative embodiments of sex and gender are rendered legitimate and livable. Yet the stakes are also broader, encompassing a very central concern for feminist scholars and one that affects many more women: the project of reconfiguring the dominant ideological construction of women bodies as fundamentally different from and physically inferior to men's.

CHAPTER TWO

Ignorance and the Gender Binary: Resisting Complex Epistemologies of Sex and Testosterone

> *If you discover new knowledge about something others do not take seriously, do not expect your knowledge projects to have much effect. The veil of ignorance is not so easily lifted. —Tuana 2004, p. 219*

In recent decades, Science and Technology Studies (STS) scholars have increasingly taken up the study of ignorance as part of a broader effort to reveal the political and institutional processes that underpin the selective pursuit of scientific knowledge-making. Also known as agnotology, this area of scholarship seeks to bring attention to absent or unrecognized forms of knowledge and show that these are not simply the passive corollary to that which *is* known, but rather are actively produced (Gross 2007; Tacke 2001). Forms of unrealized or unrecognized knowledge are also sites of contestation, since the exclusion of certain topics from dominant ways of knowing can be highly advantageous for the interests and agendas of powerful stakeholders (McGoey 2007; Proctor and Schiebinger 2008). In other words, the nonproduction and marginalization of alternative knowledge forms is as political as the knowledge that *is* produced and granted recognition, with both reflecting epistemic investments that stakeholders and the institutions they reside in may seek to protect (Hess 2007; Frickel et al. 2010).

The politics of marginalized knowledge can be charted to reveal the institutional dynamics that explain how and why the realization of some areas of knowledge is resisted relative to others (Proctor 2008, p. 6). Yet social scientists more broadly, including many STS

and feminist STS scholars, have typically privileged only the study of those forms of knowledge that *do* achieve institutional viability and visibility. As a result, less is known about the production (or nonproduction) of ignored knowledge forms and the gendered political and social practices that may underpin their marginalization (McGoey 2012).

The scientific study of sex difference constitutes one area where certain ways of knowing are dominant while others have not received the same degree of institutional recognition and support. For several decades, feminist STS scholars have generated a battery of empirical research contesting dominant scientific understandings of sex difference, most particularly the notion that sex is a binary and purely biological form of embodied difference (Fausto-Sterling 2000; Fujimura 2006; Lorber 1993; Martin 1991; Tuana, 1988). This scholarship suggests that researchers in the biological sciences produce knowledge about sexed bodies in ways consistent with socially conditioned expectations and paradigmatic assumptions about the nature of sex difference: as binary, distinct from gender, and discoverable through science. Despite these efforts, the dominant scientific narrative about human sexual variation as divisible into two distinct and opposite biological categories has largely remained in place in Western institutions (Westbrook 2016; Sanz 2017). This is also despite recent developments in feminist biology, a field where researchers combine feminist STS insights with their training in the biological sciences to empirically examine gender and sex as dynamic, nonbinary, and entangled (Fausto-Sterling 2012; Ritz 2018; van Anders 2012). This development further prompts the question: what has prevented the broader recognition of these alternative feminist accounts of sexed bodies?

Olympic sport, and international track-and-field in particular, offers a highly visible setting where answers to this question can be pursued. Feminist scholars have long critiqued the

application of allegedly objective scientific claims about sex difference to regulate the participation of women athletes (Birrell and Cole 1990; Henne 2014; Kane 1995; Pape 2017). Since the late 1950s, the International Olympic Committee (IOC) and International Association of Athletics Federations (IAAF) have worked in tandem to establish gender eligibility rules for women's competition (Henne 2014). After decades of using other technologies such as chromosomal testing, which was ultimately recognized as a scientifically inaccurate measure of sex differences in athletic ability, the IOC and IAAF have most recently ushered in a new "era of hyperandrogenism" in which regulations posit a simplistic understanding of naturally occurring testosterone levels in women (but not men) as a marker of athletic ability. The Hyperandrogenism Regulations of the IAAF and IOC, introduced in 2011, alleged a simplistic link between naturally occurring testosterone levels and "fair" athletic ability in women.[13] Specifically, those women whose bodies naturally produce higher levels of testosterone than is deemed "normal" are thought by the IOC and IAAF to be benefiting from an unfair athletic advantage over their competitors (IAAF 2011; IOC 2012).[14]

However, the assumption of a straightforward relationship between testosterone and athletic ability in women—and the subsequent legitimacy of using such an approach to determine women's eligibility—has been contested on both scientific and ethical grounds (Karkazis et al. 2012). For instance, some male athletes competing at an elite international level in track-and-field are known to have testosterone levels in the so-called women's range (CAS 2015). Ethical concerns have also been raised about the implementation of such regulations,

[13] There are no parallel regulations limiting naturally occurring testosterone levels in male athletes.

[14] While the IOC and IAAF have rules in place to regulate the participation of transgender women, these are distinct from the type of regulation that is the focus of this paper, which concerns those women with high testosterone presumably resulting from "intersex" traits. Since these women may not identify as intersex, I refer to them as women with high testosterone.

given numerous breaches of confidentiality surrounding those who have been tested for hyperandrogenism as well as an apparent targeting of women of color from the Global South (Henne and Pape 2018; Karkazis and Jordan-Young 2018). For the most part, however, recent appeals of these regulatory efforts have largely focused on scientific questions. The 2011 Hyperandrogenism Regulations of the IAAF were suspended for a two-year period by the Court of Arbitration for Sport (CAS) in 2015, with the adjudicating panel citing a lack of scientific evidence to support the claim that naturally occurring testosterone levels serve as a reliable measure of athletic ability (CAS 2015). When the IAAF's revised Eligibility Regulations for Female Classification were challenged in 2019 by Caster Semenya, a Black South African athlete and double Olympic champion, the CAS ruled in this instance that these discriminatory regulations should stand (CAS 2019). Nevertheless, the extent of international debate over the legitimacy of the 2019 ruling reveals a divided scientific landscape (see WMA 2019).

This chapter considers how sports governing bodies are able to legitimately use scientific accounts of binary sex and endogenous (naturally occurring) testosterone to determine eligibility for women athletes, in spite of significant concerns surrounding such policies.[15] More specifically, I explore how certain ways of knowing embodied sex circulate within the elite international track-and-field community, which I suggest both flow from and legitimate the rule-making efforts of sports governing bodies. In this chapter I analyze data from interviews conducted following the 2016 Rio Olympic Games and ask: did the CAS decision prompt the

[15] Consistent with the approach of the World Anti-Doping Agency (WADA) (WADA 2018, pp. 36-37), in this paper I use "exogenous testosterone" to refer to both: (a) forms of testosterone that do not occur naturally in the body; and (b) forms of testosterone that *do* occur naturally in the body but have been artificially elevated (i.e. exogenously administered). A key debate during the Chand appeal was whether these two forms of testosterone behaved differently in the body when compared to *naturally occurring levels* of *endogenous* testosterone.

elite track-and-field community to revisit their understandings of sex difference, testosterone, and athletic ability? If not, how did these stakeholders avoid reconfiguring their existing epistemic commitments in the face of such a challenge? More specifically, how were track-and-field stakeholders able to *ignore* unsettling scientific and ethical claims about the regulation of women with high testosterone, thereby protecting their investment in the notion that male and female bodies are characterized by distinctly different—and scientifically measurable—ranges of testosterone and athletic ability?

More broadly, this paper attends to a puzzle that has not received sufficient attention from feminist STS scholars, nor from STS scholars concerned generally with the politics of knowledge production, namely: that binary and biological accounts of sex difference appear to prevail *in spite* of scientific evidence (and political efforts) to the contrary. Turning to the concept of ignorance, I focus on how ignorance can be understood not only as an outcome but also as a *process*: as an act of turning away in a given moment *when it was possible to know differently.* This approach to ignorance is consistent with the concept of "undone science" advanced by Frickel and colleagues (2010), where an alternative research agenda exists—and has been recognized by some stakeholders as worthy of pursuit—but has been systematically undermined by a lack of institutional investment and recognition (see also McGoey 2007).

I suggest further that ignorance can be understood as an *institutional* process. Here I approach institutions in a sociological sense, as "multifaceted, durable social structures" that "comprise regulative, normative, and cultural-cognitive elements that, together with associated activities and resources, provide stability and meaning to social life" (Scott 2014, 56-57). Ignorance is reproduced through both the formal rules and informal cultural and normative practices that structure a given institutional sphere, and which also matter to how gender

relations are understood and reproduced within a given institutional domain (Acker 1990; Lopez and Scott 2000). Ignorance can further be understood as a form of institutional resistance that may unfold in both formal and informal ways when long-standing investments in binary understandings of sexed and gendered bodies are at stake. In the case of sport, and track-and-field in particular, it can serve as a "strategic" means by which stakeholders protect—consciously or otherwise—existing institutional practices, norms, and structures from the destabilization that would result from recognizing the complexities of sex and testosterone's role in the body (McGoey 2012).

I begin by situating recent events in the longer history of gender eligibility regulations for women, focusing in particular on the post-2009 efforts of sports governing bodies to bolster the scientific case for testosterone-based regulations. After describing my methodological approach, I then present data from my interviews that reveal three different forms of ignorance unfolding simultaneously as track-and-field stakeholders seek to protect their existing epistemic investments. First, I present an overview of common misunderstandings and misrepresentations that arose during interviewees' accounts, which I term ignorance-as-misinformation. I then explore how track-and-field stakeholders justify their commitment to a particular policy agenda *despite* the absence of supporting scientific evidence, or what I call ignorance-as-ideology. Finally, I reveal the various means by which track-and-field stakeholders actively resist becoming more informed on the topic of regulating women with high testosterone, or ignorance-as-avoidance. While I largely focus on the perspectives of athletes, coaches, managers, and the media, I also show that the actions taken by governing bodies set the terms for how particular notions of gendered bodies can be known and others *not* known.

Background: Defining the Female Athlete in the Era of Hyperandrogenism

During earlier eras of gender verification, sex testing was a mandatory and hence highly visible part of the elite female athlete experience. Formal testing practices began with genital examinations in the late 1950s before moving to a chromosome-based testing regime that lasted over three decades, during which chromosomally "certified" female competitors were required to present "certificates of femininity" or "femininity cards" in order to compete (Wackwitz 2003). Much of the anxiety during this period stemmed from an "East/West antagonism" that constructed the muscular bodies of successful women athletes in East Germany and the Soviet Union as insufficiently feminine (Bohuon 2015). The technology of gender verification changed in the late 1990s when, following decades of critique from geneticists and endocrinologists, both the IOC and IAAF quietly moved to measures of endogenous testosterone as an allegedly more accurate way to identify "hypermuscular" women with a natural but "unfair" athletic advantage (Pieper 2016). However, rather than subject all women to testing, only those athletes deemed "suspicious" by designated medical staff would be subjected to examination. As a result, the hyperandrogenism regime unfolded with little accountability or broader awareness (Henne and Pape 2018).

This changed following the 2009 World Championships in track-and-field, where a controversy erupted around the victory of the then 18-year-old Caster Semenya in the women's 800-meter competition. On the eve of the final, the IAAF announced that they were conducting tests to determine whether Semenya was "100 percent" a woman (Longman 2016). In this extraordinary move, the IAAF broke with its own protocol by disregarding Semenya's right to confidentiality in the face of such an accusation, leading to unprecedented public scrutiny of Semenya's body and debates about her right to compete. The IAAF's reckless actions drew

considerable critique, particularly in South Africa, where they were framed as racially motivated (Cooky et al. 2013). Following the Championships, the IAAF revisited their procedure for investigating women athletes believed to have high testosterone, culminating in 2011 with the public release of the Hyperandrogenism Regulations (IAAF 2011). Reflecting their longstanding collaboration with the IAAF on this issue, the IOC quickly followed suit and introduced parallel regulations applying to all women's Olympic sports (Henne 2014; IOC 2012).

The IAAF's 2011 Regulations specified a limit of 10nmol/L for endogenous testosterone in women athletes.[16] The criteria for identifying athletes "suspected" of having hyperandrogenism were left vague and open-ended, with potential sources described as including *any* information received by IAAF medical officials (IAAF 2011, p. 3, emphasis added). "Suspect" athletes were subjected to initial blood testing and, if their testosterone was found to be above the specified limit, a clinical examination followed to assess the extent of "virilization" (visible signs of high testosterone exposure in the breasts, pubic hair, skin, etc.). This clinical examination was presumed to be a proxy for measuring the extent of an athlete's "unfair" performance advantage. Athletes believed to be benefiting from higher than "normal" testosterone were required to medically lower their levels before returning to competition. Scholars and activists note that this approach has largely targeted gender nonconforming athletes and especially women of color from the Global South, reflecting the entanglement of race and nation with normative constructions of femininity (Bohuon 2015; Henne and Pape 2018; Karkazis and Jordan-Young 2018; Magubane 2012).

In 2014, an 18-year-old Indian sprinter, Dutee Chand, was barred from international track-and-field competition for ostensibly having "violated" the Regulations. Instead of agreeing

[16] The Hyperandrogenism Regulations of the IOC specified a limit of 8nmol/L (IOC 2012).

to medical interventions, Chand contested this regulatory regime before the Court of Arbitration for Sport (CAS) in Switzerland in 2015. During the appeal, expert witnesses for Chand and the IAAF debated the relationship between testosterone, sex difference, and athletic ability, including whether endogenous and exogenous (artificially administered) testosterone had similar or different effects on the body.[17] Ultimately, the CAS adjudicating panel ruled that the Regulations were *not yet* sufficiently supported by scientific evidence, suspending them for two years but encouraging the pursuit of new research to support their reinstatement. In other words, the CAS supported a policy aimed at excluding women athletes with high testosterone and endorsed the *post hoc* pursuit of scientific evidence, rather than awaiting the outcome of a broader research agenda.

Following the decision to suspend the Regulations, Caster Semenya returned to career-best form, culminating in her victory at the 2016 Olympic Games in Rio di Janeiro where an additional two 800m competitors, both women of color from Sub-Saharan African nations—Francine Niyonsaba and Margaret Wambui—were also publicly accused by media commentators and track-and-field stakeholders of having elevated testosterone. In 2018, the IAAF announced a revised set of regulations, this time with a limit of 5nmol/L and applying only to those women's events where IAAF-affiliated researchers claimed to have established a correlation between testosterone levels and performance (IAAF 2018). Importantly, and contradicting the research on which the Regulations were allegedly based (see Bermon and Garnier 2017), the "Eligibility Regulations for Female Classification" target only those middle-distance events that might potentially be run by Semenya, even though a stronger correlation was found for the women's

[17] The CAS adjudicating panel observed that "this remains an unresolved issue that would benefit from further exploration" (CAS 2015, p. 142).

pole vault and hammer throw.[18] Implementation of the revised Regulations was temporarily suspended as Semenya and Athletics South Africa pursued an appeal process. However, in May 2019 the CAS contradicted concerns within the broader scientific community by deciding that the revised regulations, though discriminatory, provided "a necessary, reasonable and proportionate means of achieving the IAAF's aim of preserving the integrity of female athletics" (CAS 2019, p. 2; Tannenbaum and Bekker 2019; WMA 2019).

In sum, the scientific and ethical controversies that have plagued the hyperandrogenism era—and indeed, all previous eras of gender eligibility regulation (Henne 2014)—have not dissuaded governing bodies and the IAAF in particular from seeking seemingly more sophisticated "scientific" ways to define the boundaries of the female body, presuming its inherent inferiority to a male body, and defend "fairness" amongst women athletes by excluding bodies considered to have some measure of "maleness." This state of affairs reveals a deep institutional investment in particular constructions of sex difference and testosterone that is driven by motivations other than science. Since governing bodies do not operate in a vacuum, the legitimacy of their regulatory efforts depends upon the support of diverse stakeholders (Parker and Braithwaite 2003). As I will show below, decision-makers and stakeholders in the sport of track-and-field frequently work in concert to "turn away" from and ignore that which could otherwise be known about the female athlete body. Before addressing these issues, I first discuss my data collection methods.

[18] IAAF researchers claim a correlation between testosterone levels and performance in the women's hammer throw, pole vault, 400m, 400m hurdles, and 800m. By contrast, the subsequent proposed (and then suspended) "Eligibility Regulations for Female Classification" apply to the women's 400m, 400m hurdles, 800m, 1500m, and mile (Bermon and Garnier 2017; IAAF 2018).

Data and Methods: Perspectives on a Controversy

In the wake of the renewed scrutiny of women alleged to have high testosterone during the 2016 Rio Olympic Games, I conducted semi-structured interviews with diverse individuals associated with elite track-and-field with the aim of understanding how their convictions, knowledge, and non-knowledge reflected their particular social and institutional environment. In all, I collected 62 semi-structured in-depth interviews with athletes, coaches, team staff, managers, officials including governing body representatives, media personnel, academics, and activists. All of these interviewees were either involved in track-and-field at the elite international level between 2009 and 2016 or had engaged in some way with decision-making processes related to the regulation of women with high testosterone. The sample encompassed ten countries, the majority of which were English-speaking and located in the Global North. Few of the interviewees were scientists, reflecting my interest in understanding how ideas about biological sex and testosterone circulate within the broader sport of track-and-field and legitimate associated regulatory regimes (Parker and Braithwaite 2003).

I asked interviewees to describe various aspects of their experiences related to the regulation of women with high testosterone, including: what they knew about the CAS appeal in 2015; how they felt about the claim that testosterone's effects on performance were not yet well established; the kinds of conversations about the topic they had engaged in; their reaction to the women's 800m during the Rio Olympic Games; and their overall position on the regulation of women with high testosterone. The majority of the interviews were completed before the 2018 announcement of the IAAF's revised regulations, meaning this study offers insights into the views of key stakeholders at a moment when the future of regulating women with high testosterone was especially uncertain. Some interviewees had been involved in the sport for

many years and were able to reflect on the 2009 World Championships or even earlier events, thereby offering some important historical context to contemporary debates.

I imported the transcribed interviews into Nvivo, a qualitative data analysis software, to aid in the coding process. I iteratively read and coded the data, working with small excerpts at a time and applying existing theories to the data in order to identify opportunities for novel theoretical insights (Timmermans and Tavory 2012). I found three emergent themes: adherence to *misinformation* and harmful misrepresentations; *ideologically* motivated rather than scientifically informed policy priorities; and *avoidance* of becoming informed.

Findings: Three Modes of Ignorance

Ignorance as Misinformation

Charting the flows and non-flows of knowledge within the elite track-and-field community begins with an exploration of how they feel about the regulation of women with high testosterone and the extent to which these views are well informed. As I show below, various forms of misinformation and misrepresentation abounded. First, and contrary to the IAAF's claim during the 2015 appeal to the CAS that "the 'community of athletes' supports the Hyperandrogenism Regulations" (CAS 2015, p. 27), a few athletes as well as coaches, officials, team staff, and media personnel were ambivalent about or even opposed to the regulation of women with high testosterone. Even two female 800m runners I interviewed, who had competed against Caster Semenya, stated that they supported her right to compete. According to one, "my feelings have changed as more information has come out" and "I'd love [Semenya] to break the world record… I'm supportive of Caster now." Overall, however, women and especially athletes

in my sample were more likely to call for the reinstatement of the Hyperandrogenism Regulations, particularly if they competed in the 800m.

Yet many interviewees also confessed they knew little about the content of the Hyperandrogenism Regulations or the scientific issues raised during the CAS appeal in 2015. Those that did have some knowledge often had a background in sports science and had either encountered critiques of the policies as part of their education or were sufficiently curious to seek out further information. As recalled by one coach, "the only reason why I had an idea of [the CAS decision] was because I'm interested in physiology, so I had read further [and] knew a little bit more than some of the athletes." Amongst other interviewees, it was common to (erroneously) believe that the CAS had suspended the Hyperandrogenism Regulations purely for ethical reasons. For example, one middle-distance coach believed the Regulations were suspended "because of human rights… that's what I seem to recall, but all the details I don't know anything about." One journalist and coach described a conversation with the lead track-and-field journalist for a major French newspaper, who "had this misconception about the whole story regarding the Dutee Chand case" and believed "it's unethical to not let her compete, and that's why CAS suspended the rule." The interviewee had explained "no, if you read the conclusion of the case, it's not about being unfair or unethical … the IAAF didn't have the science to back up the rule." The mis-casting of the issue as purely ethical enables stakeholders to ignore the existence of scientific debate, the presence of which threatens their ability to claim an indisputable relationship between testosterone, sex difference, and athletic ability.

Many interviewees were also not aware of the history of gender verification practices in the sport of track-and-field, especially current athletes without a sports science background who had not experienced the compulsory testing regime of earlier decades. For example, one athlete

advocated for testing based on chromosomes, without realizing that such an approach had previously been implemented and ultimately discarded for lack of scientific rigor and relevance:

> [My teammate] had a really good and a fair way of looking at it, where instead of looking at testosterone levels he's actually like "well, let's just look at chromosomes" … Maybe there needs to be a reclassification of individuals with XX chromosomes and then individuals with XY chromosomes and then we separate categories like that.

In other words, the lessons of the 1980s—when the IAAF and IOC were eventually forced to acknowledge that sex chromosomes are neither binary nor correspond with athletic ability—had not become part of the general knowledge base within the sport. Nor had critical awareness of the scientific challenges associated with such practices.

The interview data also reveals a significant amount of uninformed, derogatory, and harmful language in relation to women with high testosterone. Many interviewees were uncertain about what constituted respectful terminology. For instance, when describing the scrutiny of certain women during the Rio Olympic Games, one athlete said "excuse any improper terminology, but [women] who happened to be a hermaphrodite or hyperandrogenous… I don't even know what the terms are." Indeed, it was not uncommon for athletes and coaches to use the problematic term "hermaphrodite." One journalist recalled an article in a major Italian newspaper using the "outdated" term "hermaphrodite," the author of which was also the President of the International Sports Press Association.

It was also not uncommon for interviewees to have heard of women with high testosterone being referred to as "men." One athlete described the following scene during the Rio Olympic Games:

> It's coming from these people high up the chain. You know, the talk coming out onto the track or sitting in the stands, there are things from the [team] leaders … they're saying things like, "Oh it's a race for 4th" or "the men are on the track again."

As another Rio Olympian reflected, "in any other situation you'd say it quietly, if it was going to be a negative comment or an assumption or anything like that, but it seems with Semenya it's just fair game [to comment openly]… it's pretty bad."

Additional forms of pathologizing language also surfaced. As stated by one media commentator, who was part of the television coverage of the Olympic Games in his home country, his "superficial understanding is that we've got a different species here. You've got males, you've got females, and you've got intersex… it's a different sort of person." A middle-distance coach interviewee referred to one athlete with high testosterone as "a disabled person because she has an illness or a disease that gives her a very, very high testosterone level." Overall, all interviewees had either encountered or used harmful and derogatory language towards women with high testosterone. There was some evidence of change, with numerous interviewees suggesting that they and the broader track-and-field community had become much more informed and sensitive in recent years. However, disrespectful and harmful descriptions of women with high testosterone remained normalized. Combined with misinformation, these discursive misrepresentations protect the dominant scientific epistemology of the binary sexed body by objectifying—and even dehumanizing—the women affected by Regulations, thereby enabling stakeholders to turn away from thoughtful reflection on the complexities of athletic performance and the real-life impacts of such regulations.

Ignorance as Ideology

In order to develop and legitimate their rule-making efforts, governing bodies may draw selectively on expert scientific advisors, in the process establishing privileged and private spaces for scientific knowledge production that enable the pursuit of certain research agendas to the exclusion of others (Frickel et al. 2010; Jasanoff 1990). When the politics underpinning the designation of certain scientific research agendas and claims as policy-relevant are not broadly recognized, it becomes possible to ignore the existence of alternative approaches (Hess 2007; Frickel et al. 2010). In circumstances where existing epistemic and ideological commitments are strong, policy priorities are likely to *precede* the pursuit of scientific knowledge, rather than policy agendas following from independently conducted (and potentially disruptive) research (Kleinman and Suryanarayanan 2012; Richardson 2013). The regulation of women with high testosterone shows how the *a priori* and ideologically driven determination of policy is a form of ignorance, one based on the active disinvestment in and exclusion of claims that in this case might prompt the track-and-field community to consider alternative policy agendas. According to gender scholar Judith Lorber (1993), "believing is seeing:" biological scientists "discover" binary sex in their data because they are socially conditioned to expect two discrete sex categories (p. 569). The same phenomenon applies outside of the research laboratory.

The strong commitment of interviewees to the belief that testosterone is the basis of performance differences between men and women was unaffected by scientific debates concerning the actual magnitude of testosterone's effects on athletic ability. When asked about the 2015 CAS decision to suspend the Hyperandrogenism Regulations because the IAAF lacked the scientific evidence to justify the exclusion of women based on testosterone levels, many interviewees expressed incredulity. This was particularly the case for those without a background

in sports science, for whom the question of whether there was a relationship between testosterone and athletic performance was presumed long settled. Any suggestion to the contrary contradicted what the majority of interviewees had accepted as the conventional wisdom of the sport: testosterone underpins both athletic ability and sex difference, and therefore also explains average differences between male and female athletes. The presence of scientific disagreement about this relationship was incomprehensible.

Within this ideological context, interviewees widely accepted the unsubstantiated rumor that the three women who medaled in the 800m at the Rio Olympic Games benefited significantly from having elevated testosterone levels. According to one competitor, "well of course they're running these times, of course they're beating all of us if they have more testosterone." One coach from the Rio Olympic Games stated it was "very predictable how [a female athlete] with high testosterone levels runs, because we can just see, particularly in those middle-distance races, the amount of power and the finishing speed and the ability to hold that pace." Another coach similarly stated that "naturally occurring testosterone is the key, in terms of maintaining muscle mass, increased metabolism, production of energy," alleging further that the three Rio medalists who "*obviously* had elevated testosterone levels" were "more manly, larger than all of the other girls, [they] run like a man" (emphasis added). These kinds of anecdotal observations were frequently presented as evidence to justify existing beliefs and dismiss scientific claims about the disparate ways that bodies process testosterone during athletic performance. As stated by one Olympic coach, "we *know* testosterone is critical to performance, so for the CAS to ask for more evidence is nonsensical" (emphasis added).

As stated above, a core issue during the CAS appeal was whether endogenous and exogenous testosterone equally affected athletic performance. When I informed interviewees that

the CAS panel had determined this question could not be answered given the limited amount of available evidence, many interviewees opted to embrace a simplified narrative of testosterone. Most commonly, they collapsed the distinction between endogenous and exogenous forms of testosterone in order to claim the performance enhancing effects of the latter as evidence for their convictions:

> I think that most people do believe that there is an unfair biological advantage [associated with testosterone] and that we'd be hard-pressed to believe otherwise … If there was no advantage … there would be no distinctions between women who choose to take testosterone… If there was no advantage, then why would women dope? (Rio Olympian, woman)

Similarly:

> From what I've read, [the CAS] said that testosterone is not a substance that actually increases performance, and yet it is illegal to take testosterone whilst competing and outside of competition. So, it's obviously helping something … It's the same as when you see a man and a woman race off, like you're going to bet on the man.

In response to such accounts, I often suggested that expert witnesses for Chand had questioned whether endogenous and exogenous testosterone acted similarly in the body. When I did so, many interviewees again turned to doping as evidence of testosterone's performance enhancing effects. As one athlete stated, "the thing is, if [testosterone] didn't affect [performance], then it would be legal … [but] it's been put on the prohibited list." This epistemic investment in testosterone as *always* a decisive performance enhancer preceded the available evidence and relied on a simplified narrative that erased the possibility of an endogenous/exogenous divide,

instead representing testosterone's effects as universal regardless of its origins. As one middle distance coach put it when reflecting on resistance to this aspect of the CAS decision, "mostly people just take what they hear and wrap their story around it to justify their own beliefs … either you were for [the regulation of women with high testosterone] because you were already for it before [the CAS decision], or against it because you were against it beforehand."

When reflecting on the IAAF's rule-making responsibilities, interviewees implied that scientific evidence could be pursued *post hoc*. For instance, a former 800m runner turned television commentator suggested that the IAAF—and the broader track-and-field community—were committed to the Hyperandrogenism Regulations regardless of the scientific evidence:

> If you were the IAAF, what would you do? Because we wanted to exclude [women with high testosterone], but we don't have the science to do it. So now they're competing in our competitions, and we're sort of grudgingly letting them do it, and they know, and we know, and everyone knows that we wish we could have come up with a better argument to exclude them, but we couldn't … [Now] we're just waiting for our language and *our science to catch up with the reality that we can see*.

Interviews also revealed that even the experts involved in drafting both the IOC and IAAF Hyperandrogenism Regulations were committed to their policy stance despite recognizing the lack of supporting evidence. For example, an activist and researcher described a conversation with one such expert, where she "ran everything by him… most especially that I didn't think the evidence was there, and he agreed with everything I said." However, he publicly disagreed with her arguments once they were published.

A similar story was recounted by a researcher and intersex rights advocate who had been invited to participate in a working group convened in 2013 to review the IOC Hyperandrogenism

Regulations. Several members of the IAAF Medical Commission were also present, reflecting the long history of the two organizations working together to establish their gender eligibility rules (Henne 2014). The interviewee described repeatedly pointing out anomalies in the IOC and IAAF's logic, such as the observation that women with complete androgen insensitivity syndrome—meaning their bodies derive no benefit from the testosterone in their bodies—are able to compete at the international level, suggesting that testosterone cannot be as decisive as IOC and IAAF decision-makers claim. Although they acknowledged such anomalies, other working group members "really couldn't understand the difference between data and policy" and were "quite determined to put this hyperandrogenism policy through." She reflected:

> The science to me was sort of the window dressing, the reasoning behind the decision that was already made. There is the famous quote … that a judge knows what he'll decide before the case is over and then he'll come up with the reasons afterward. And that's the way humans are.

Further reinforcing this point, the one IAAF official I interviewed for this study questioned the wisdom of the CAS in asking for further research to justify the exclusion of women with high testosterone. As stated:

> I have a very strong view that … the CAS has to be responsive to the environment in which it's working… They have to look more broadly at their response to these particular cases and they have to understand the consequences of their just constantly saying no, no, no, or we're not sure. Because sport has to go on.

Thus, despite now claiming there exists "broad medical and scientific consensus … that the high levels of endogenous testosterone circulating in athletes with certain DSDs [Differences of Sexual Development] can significantly enhance their sporting performance" (IAAF 2018), the IAAF's rule-making agenda—like the attitudes of other stakeholders in the sport—precedes and exists in spite of current scientific debate, particularly in relation to the precise relationship between testosterone levels and male and female athletic ability. Maintaining an ideological commitment to testosterone as the basis of athletic ability and binary sex categories emerged as a more urgent priority than supporting the pursuit of a more balanced and open scientific process. This constituted a "turning away" from inconvenient scientific evidence and debate, which might have called current policy commitments into question and destabilized a regulatory agenda aimed at maintaining an exclusionary definition of who may "legitimately" be recognized as a female athlete.

Ignorance as Avoidance

The presence of expert advisors—alleged to be the purveyors of objective facts—offer decision-makers a means of deferring responsibility for key decisions and justifying their lack of engagement with alternative knowledge claims that might undermine their existing policy commitments (Jasanoff 1990; McGoey 2007). This kind of avoidance emerged during my recruitment efforts. For example, when I approached individuals associated with the women's committees of the IAAF and IOC to request an interview, they indicated that the regulation of women with high testosterone was not their area of expertise and instructed me to approach the relevant medical committee instead. One of my interviewees, who had previously served on the IOC Women's Commission, had experienced similar avoidance. In his words, "most of those

people were very reluctant to accept advocacy on this [issue]… for the most part they said 'we will defer to the Medical Commission and the physicians,' and basically that's where things end." Similarly, an IAAF official I interviewed stated that he "had not tried to second guess" the organization's medical committee and "perhaps therefore [hadn't] understood … their research justification" for excluding women with high testosterone.

But there was also evidence of more concerted efforts by the IAAF to avoid open and informed discussion amongst key stakeholders on the topic of regulating women with high testosterone. In one account of practices during the early 2000s, at a time when the IAAF had moved to a less visible testing regime for women athletes, an international official described trying to obtain more information about the new rules at successive World Athletic Congresses.[19] In 2003, he was "brushed off by the chairman of the IAAF Medical Commission," who assured him that "they most certainly knew what they were doing concerning gender testing." Unconvinced, in 2005 the official again requested to discuss the regulations:

> I submitted a proposal along with substantial background materials … I came much more prepared … I had sent a lot of materials to the IAAF, but they were never given on to the other countries, to the [other] delegates … When I criticized that and tried to reveal what was going on, the [IAAF] President took away my right of speaking.

Historical actions of the IOC Medical Commission similarly suggest an institutionally sanctioned culture of avoidance. Archival materials reveal that its leadership avoided engaging with critiques of their chromosome-based testing regime that were repeatedly lodged by endocrinologists and various professional scientific associations throughout the 1970s and

[19] The World Athletics Congress is the biannual meeting of the IAAF and its constituent member federations.

1980s.[7] The chairperson at the time resisted raising such concerns at Commission meetings and defended their policy stance as "practical and economical" even if not scientifically sound.[8]

Avoidance of a different kind was visible at the level of national federations, with one national coach and administrator describing his federation as preferring "to leave the decision to the IAAF … [and] not to worry too much about it unless the Regulations actually end up affecting one of our athletes." The notion that certain countries were less likely to have athletes affected by the Regulations emerged in several interviews and was linked to the unsubstantiated belief that women with high testosterone are over-represented in Sub-Saharan Africa relative to countries in the Global North (see Henne and Pape 2018; Karkazis and Jordan-Young 2018). For instance, when I asked one physical therapist from a Global North country whether the Regulations could impact athletes on his national team, he responded that "the general wisdom is that in Africa, the prevalence of certain gender presentations is a lot higher." This logic was offered by numerous interviewees as justification for why their home national federations could afford to be uniformed about the regulations. However, this form of ignorance also reproduces the racialized and imperialist notion that women of color from the Global South are somehow biologically different and hence the legitimate targets of such regulatory efforts, enabling decision-makers from other nations to avoid responsibility for such actions.

Another factor prompting national federations to avoid engagement was a fear of backlash. One athlete perceived that her national federation was "too scared to get involved in the argument… just putting their hands up and going 'I'm not getting involved' … They don't

[7] In a separate research project, I accessed the IOC archives at the Olympic Studies Centre in Lausanne where several files contain correspondence from the 1930s until the 1980s on the topic of eligibility regulation for women athletes.

[8] Letter from Dr. Eduardo Hay (IOC Medical Commission) to Dr. Albert de le Chappelle, 25 April 1983, p. 3.

want to open themselves up to the response they might get." A board member from a national federation that was considering protesting the Regulations described a colleague who "feels that this is maybe not the fight we should be fighting against the IAAF. People that think we should just stick our head in the sand and let other people take this," since not only were their athletes perceived as not being targeted under the rules, but also "we are not a powerhouse… They just don't feel this is the [issue] we should be sticking our necks out for." However, as acknowledged by this interviewee, such avoidance also serves another purpose: "if anything, we have athletes who would benefit from the rules staying in" if other competitors were disqualified.

Athletes also engaged in various forms of avoidance. As with some national federations, fear of backlash appeared to drive some athletes' preference to avoid engagement and understanding. Some women athletes who have expressed support for the Regulations have experienced a social media backlash including threats of violence. One athlete described an 800m runner who "had to sign off social media for six months. She didn't get back onto it just because it is such a controversial topic, and she feels like she can't have a view." Other athletes reported being too preoccupied with their own training and racing to engage with the topic. One female long-distance runner reflected on her lack of awareness during the Rio Olympic Games, stating she didn't "recall being too savvy … I think I was just so caught up in my training and preparation." As another Olympian who had intentionally disengaged reflected, "it's so draining of your energy if you're there to compete and trying to stay in the best mental state you can." Some women athletes who were ambivalent towards or supportive of women with high testosterone qualified their position by stating that it might be different if they competed in the 800m. According to one, "I don't really have a very strong opinion, I think it probably comes back to the fact that they're not running in my race," again assuming that women with high

testosterone were only competing in specific events. Another ambivalent athlete, who stated she might "feel differently if this was my event," suggested further she "maybe didn't read enough, I would only see headlines or it would pop up on Twitter… it wasn't something that I cared to be one-hundred percent informed on." But even women 800m runners I interviewed typically acknowledged not being fully informed, such as one who stated, "I have less knowledge than I should on the whole topic ... I get kind of embarrassed about that."

National federations encouraged this kind of avoidance amongst athletes. For example, ahead of the Rio Olympic Games, one middle-distance runner described being advised by her federation's communications staff:

> …to avoid all questions related to the topic. They literally gave us a list of ways to deflect the topic… For those of us who ran 1500, it was "just say it's not your event, not something you need to worry about or waste energy on…" Just kind of appearing neutral on the issue was the recommended approach.

For my interviewees, this was typically the extent of official directions provided by national federations. But it contrasted with their approach to other issues, where federations more readily assumed the role of educator. As observed by one Rio track-and-field Olympian:

> We have never in a team setting had the discussion with a medical person, or one of the coaches come and say, "look, we recognize there's been talk about this... The [CAS] ruling is this because of this." With other issues, like the plumbing issues, the building, the venues in Rio, mosquitos, Zika, what not, we were given so much education.

A track-and-field Olympian from a different country similarly reflected that "we get random briefings on different topics, but [hyperandrogenism] was never brought up on any of the teams that I've been on in the past three or four years, so it wasn't something that our governing body felt the need to tell us about." Thus, while some athletes had sought to become more informed, the majority appeared to actively avoid arriving at a definitive or informed stance on the topic, an approach that was encouraged by their national governing bodies.

The degree to which athletes have sought an informed opinion is an important concern, since the IAAF argued during the 2015 CAS appeal that "what is unfair is decided, to a large extent, by the community of athletes and other stakeholders who understand and love the sport" (CAS 2015, 82). But rather than correct misinformation, or draw attention to the breadth of opinions regarding the complexity of sex difference and testosterone's role in athletic performance, the IAAF and other leadership bodies appear to readily avoid such education efforts. Within this institutionally sanctioned culture of avoidance, the policy of excluding women with high testosterone goes unquestioned.

Discussion and Conclusion: Ignorance and Epistemological Resistance

This chapter is motivated by a broad question: how do people ignore epistemologies of the sexed body that contradict their beliefs, in this case the alternative scientific accounts of sex difference—as non-binary, dynamic, indeterminate, and irreducible to a single biological factor––espoused by feminist scholars and some members of the scientific community? Sport has emerged in recent decades as a key institutional sphere where definitional battles over binary sex and gender categories are unfolding with increasing regularity and intensity. This is partially due to various international governing bodies' strict commitment to regulating gender eligibility *in*

spite of the absence of supportive scientific evidence and the presence of alternative scientific and ethical perspectives (Cavanagh and Sykes 2006; Sullivan 2011; Pape 2018). In other words, this is a case of ignorance under conditions where it is possible to know sex and testosterone differently, as opposed to a situation where such knowledge has not yet been identified or produced (Frickel et al 2010).

Under such circumstances, ignorance can usefully be conceptualized as an institutional process in which stakeholders collectively "turn away" from knowledge claims that are uncomfortable or disruptive, sometimes deliberately so, but often without reflection. As revealed in this study, ignorance relies on epistemic alignment among the diverse stakeholders that comprise an institutional sphere, in this case the sports governing bodies, affiliated scientists, athletes, coaches, team staff, managers, and media personnel connected to elite track-and-field. Together, these stakeholders co-construct and legitimize particular epistemologies of sex difference and testosterone, while actively excluding alternative accounts through strategies of misinformation, selective and ideologically driven interpretation of evidence, and avoidance. Interestingly, those interviewees with a background in sports science were more willing to recognize the presence of scientific debate. This suggests that efforts to protect binary representations of sex and testosterone are not driven by an investment in "science" *per se* but in the gendered ideologies that underpin these regulatory practices.

It is important to consider the affective dimensions of such rule-making efforts. The "political geography" of this issue is arguably *not* shaped primarily by corporate or industry interests, as often comes to the fore in ignorance studies (Frickel et al. 2010; Kleinman and Suryanarayanan 2012; McGoey 2012), though such interests no doubt shape gender relations in international sport (Lenskyj 1986). Rather, the epistemic investments at stake concern lived

experiences of sex as a binary form of embodied difference: an understanding of one's body that has been created within a specific institutional environment but which is nevertheless "felt" as real and meaningful on a daily basis (Connell 1987). Testosterone, too, has become part of athletes' daily embodied experience and self-understanding, given the prominence of anti-doping regulation and narratives in elite sport (Henne 2015; Jordan-Young and Karkazis 2018). That these stakes are felt as deeply personal is evidenced by the often-emotional reaction of interviewees when asked about the issue of women with high testosterone. This affective dimension is also likely fundamental to the widespread will to ignore—rather than know differently—when it comes to this issue and warrants further examination.

While diverse stakeholders participate, the forms of ignorance identified in this study are legitimated and enabled by the actions of the IAAF and IOC and—to a lesser but still important extent—national federations, all of whom have the resources and structures to engage in education efforts. Through their actions, governing bodies not only select sympathetic scientific experts, and materially support their research agendas, but also prevent the recognition of alternative claims. This insight highlights the importance of an expanded feminist STS agenda: one that goes beyond revealing the gendered biases embedded in scientific claims about binary sex, or supporting feminist biologists to pursue more complex research agendas, to include critical examination of the institutional mechanisms by which feminist claims about biological difference are granted or denied legitimacy in other settings. Studies of ignorance, like that presented in this paper, offer a means by which feminist scholars can reveal the considerable institutional work that goes into preventing the production and recognition of alternative forms of scientific knowledge (Tuana 2004, 2006).

CHAPTER THREE

Margin and Center:
The Feminist Politics of Inclusion in Biomedicine

> Knowledge of the influence of sex at molecular, cellular, and biochemical levels … is imperative to the NIH mission of turning discovery into health. — Janine Clayton, 2016, p.522

In April 2017, two prominent Feminist Science Studies (FSS) scholars published an op-ed in *The Guardian* rejecting claims that they were "political zealots" who were "anti-sex differences." According to Cordelia Fine and Rebecca Jordan-Young (2017), their efforts to challenge the biomedical science community to think in more nuanced ways about precisely how sex influences health and disease had been mischaracterized as a rejection of the scientific study of sex altogether. As Fine and Jordan-Young reminded their critics, "we are all aiming for better science," a goal that is compromised when scientists refuse to consider alternative perspectives on how they ought to be incorporating sex into biomedical research.

This paper considers feminist debates over the place of sex and gender in biomedical and health research. Scholars like Fine and Jordan-Young represent an area of feminist scholarship that is characterized by particular ontological and epistemological commitments regarding sex, gender, and scientific inquiry. A key contribution of this scholarship to feminist thought and activism is the notion that sex and gender are deeply entangled in the body and have a complex and dynamic relationship to health, one that is not yet well understood by biomedical scientists in

part because they are often committed to a strictly biological[20] and binary understanding of sex (Rippon et al. 2014; Springer Stellman and Jordan-Young 2012; Ritz et al. 2014; Subramaniam 2009). However, this is not the only perspective that has emerged over time within feminist debates about the place of sex and gender in biomedicine. A far more influential position, particularly when it comes to biomedical research and policy-making in the United States (US), approaches biological sex as a distinct and binary variable whose effects on the health of women and men are allegedly easier to study and more fundamental than gender.

Part of a longer history of debate over feminist approaches to women's health and science (Clarke and Olesen 1999; Ruzek Olesen and Clarke 1997), these contrasting perspectives have recently surfaced in relation to policies for the inclusion of sex and gender in biomedical and health research in the US. In 2014, the National Institutes of Health (NIH) announced a policy mandate requiring the inclusion of equal numbers of male and female animals in all pre-clinical research funded by the organization (Clayton and Collins 2014). Called Sex as a Biological Variable (SABV), the policy aims to address women's health inequities, such as the presumed contribution of fundamental biological differences to higher rates of adverse drug reactions among women. It also aims to advance the NIH goal of addressing a reproducibility crisis in preclinical biomedical research, suggesting that inadequate attention to sex has been a key contributing factor (Francis and Tabak 2014). The SABV policy relies on and advances a particular understanding of sex: as binary, distinct from gender, and discoverable through the biological sciences. This announcement has brought to the surface differences amongst feminists

[20] While I acknowledge that the term "biological" can be used to refer to characteristics or processes that involve an interaction between social or physical environment and the body, and therefore the term doesn't necessarily imply a "pure" non-social mechanism, I use it here to describe a characteristic or process presumed to be purely non-social.

over how best to conceptualize sex and gender and influence policy-making related to their inclusion in scientific research.

In this paper, I ask: what does the SABV case reveal about the different ways that feminists approach sex, gender, and their inclusion in biomedical and health research? What ontological, epistemological, and political factors explain why one feminist perspective has been more easily institutionalized while the other has remained more marginal? At a broader level, what do such debates reveal about the current moment in feminist politics, and particularly the efforts of feminist academics to intervene in a political environment in which the boundaries of sex, gender, and womanhood are in flux? To answer these questions, I begin by briefly outlining the historical trajectories of feminist science studies and the biomedicine of sex differences as it developed from the women's health movement. While the divergence between them is partially disciplinary, it is also characterized by different ontological and epistemological approaches to sex and gender, with one committed to the principle of biological sex "difference" and the other to sex/gender complexity.

Rather than one approach being feminist and the other not, or attention to sex differences within biomedical research necessarily representing the co-optation of feminism, as Clarke and Olesen have suggested (1999), I suggest that these different approaches to sex and gender inclusion ought to be understood as divergent feminisms. In its broadest sense, feminism in the US context is defined by a commitment to the elimination of gender-based oppression and in particular to the advancement of women's inclusion and empowerment, given their historical and contemporary under-representation and devaluation in many institutional settings (Offen 1988). Feminist approaches to sex and gender inclusion in health can differ in many important ways and while still being guided by the principle of advancing women's interests. The divergent

approaches outlined above map onto a central tension within feminist thought and activism: are women's interests best advanced by exploding the category of "woman" and deconstructing binary notions of sex and gender, or by embracing the category and amplifying its alleged distinctiveness, including at a physiological level (Snitow 1990; Stimpson 1980)?[21] The biomedical study of sex differences, or "biomedical feminism," can be seen as an expression of the latter.

These ontologically and epistemologically divergent feminisms also differ politically: while both have encountered institutional resistance, biomedical feminism has been more easily institutionalized in the US context. I argue that this is partially because the ontological and epistemological position of biomedical feminists, which separates sex from gender and male from female, affirms the authority of "objective" science to reveal sex as binary and biological. It also affirms the distinctiveness of the female category. In doing so, it is also more easily recognized as in women's interests, since the under-representation of female bodies and models within the current biomedical system appears as a straightforward case of gender bias and negligence. The harder task is to achieve legitimacy for the claim that representation within the existing biomedical system, with its commitment to particular notions of sex, gender, and science, may be harmful to women.

In this paper, I begin with a brief account of the history of these forms of feminism and their origins in the women's health movement and the academy. I also provide an overview of

[21] In Catharine Stimpson's terminology, this is described as the feminist debate between the "minimizers" and the "maximizers." To Alice Echols (1989), the divide is between "radical" and "cultural" forms of feminism. As Ann Snitow explores (1990), this divide can also be described in terms of the "equality versus difference" debate, with difference feminists seeking to highlight and celebrate the biological, psychological, and emotional distinctiveness of women, while equality feminists are seeking to explode such notions.

how conceptualizations of the terms “sex” and “gender” have shifted over time, particularly within academic feminism. I then turn to the case of NIH policy-making, and the SABV policy in particular, using interview and textual data to explore the uneven institutionalization of these divergent feminisms. I conclude by considering implications for feminist politics at a time when both the authority of science and the boundaries of sex and gender are being called into question.

Divergent Feminisms of Sex and Gender

When it comes to institutional change, feminists can adhere to quite different strategies, with one source of heterogeneity amongst feminist movements being the extent to which they choose to work within or outside of existing institutional power structures and ally with other challengers or not (Ewig and Ferree 2015). More radical forms of feminist organizing prioritize autonomy and seek to change institutions from the outside. An alternative is to seek change from the inside out, or “occupy and indoctrinate” (Martin 2005, p. 201), a strategy exemplified by the “femocrats” who embedded themselves in Australian politics and health policy in the 1980s (Broom 1991; Eisenstein 1996). Both strategies are important components of successful feminist organizing (McBride and Mazur 2010), in part because they each come at a cost: “outsiders” are often resource-constrained and lack access to key decision-makers, while “insiders” risk becoming depoliticized as they accept the ideological and practical constraints of their institutional environment (Ewig and Ferree 2015; Martin 2005). Such tensions are evident in engagement with science and medicine, which shows ontological, epistemological, and institutional divergence amongst feminists over time.

Women's health: From grassroots to biomedicine

Stemming from the broader feminist movement in the 1960s and 1970s, the women's health movement has encompassed a wide array of organizations, causes, and strategies (Ruzek and Becker 1999). Amongst its more recognized expressions were early grassroots efforts to make women, rather than largely male-dominated medical professions, the authoritative experts of their own bodies (Clarke and Olesen 1999). The 1971 release of *Our Bodies, Our Selves,* published by the Boston Women's Health Book Collective, is an important example of this form of grassroots women's health activism and educational programming in the US. The early movement was characterized by a critical stance towards medical expertise, which was perceived as subjecting women to unsafe and unnecessary practices and undermining their right to self-determination, such as in the case of unwanted pregnancies. This ethos was reflected in the many feminist health centers established in the US over the 1970s to provide women with an alternative health care services (Morgen 1986). Also during the 1970s and into the 1980s, advocates also rallied to make breast cancer a focus of public discourse, demanding improved detection and treatment and particularly legislation to ensure that patients were adequately informed before consenting to surgical interventions (Kolker 2004; Montini 1996).

While the 1980s represented a period of critical reflection and diversification for the women's health movement as women of color, lesbians, women with disabilities, and other groups formed their own movement organizations, grassroots advocacy and organizations experienced an overall decline in the US the 1980s in the context of an increasingly conservative political environment (Nichols 2000; Ruzek and Becker 1999).[22] But although reproductive rights were under attack during this period, advocates of women's inclusion in biomedical

[22] Worcester and Whatley (1988) also attribute this shift to the co-optation of the women's health agenda, and especially feminist health centers, by commercial interests.

research were making inroads at the level of federal policy. The women's health movement had become increasingly professionalized, reflecting changes in the broader feminist movement as women began to consolidate their presence within the institutions that had previously been the focus of grassroots feminist activism (Ruzek and Becker 1999). Women had gained access to Congress, the biomedical sciences, and the governance of biomedicine at the NIH. These professionalized advocates for women's health looked to work with rather than against the biomedical institutions that had traditionally been viewed more skeptically within the wider movement: in place of a more radical agenda of autonomy and demedicalization, women's health "femocrats" inside the institution had by the late 1980s embraced the promise of biomedical knowledge and expertise.[23]

These biomedical advocates of women's health had also aligned themselves with a difference model of feminism, defining women's interests in terms of the equitable representation of women in biomedical research, with women's bodies understood as biologically distinct and hence their under-representation in biomedicine as harmful and discriminatory .[24] In other words, difference justified inclusion, and inclusion in turn reified and institutionalized difference (Epstein 2007). Aided by the greater representation of women in Congress, as well as material resources flowing from a pharmaceutical industry with an interest in the women's market, biomedical feminists focused on policy-making as a route via which

[23] As argued by Emily S. Kolker (2004), the breast cancer movement experienced a similar evolution whereby an elite core of activists moved away from the grassroots focus on care and treatment towards the pursuit of federal funding for research.

[24] This effort to reclaim biomedicine and articulate women's under-representation within it also encompassed efforts to further expand the presence of women as knowledge producers within the biomedical sciences.

institutional change could be pursued from within (Clarke et al. 2003; Ruzek and Becker 1999). These relationships contributed to and were solidified by the establishment of the Office of Research on Women's Health at the NIH in 1990. By aligning themselves with the "inclusion and difference" paradigm that was reshaping the policy-making landscape for biomedical research in the US in the 1990s, these feminists lay the groundwork for later policies mandating the inclusion of male and female models in preclinical research

In sum, changes in the professional landscape of women's health also entailed new ontological and epistemological emphases, elevating male-female biological difference as foundational to women's health experiences and its scientific study as the form of knowledge most in need of greater institutional investment and support. This approach has drawn the criticism of feminists beyond the women's health movement and especially those within the academy.

Feminist Critiques of Science

The field of FSS emerged in the late 1960s and 1970s primarily within the academy. As Richardson (2010) argues in her review of the field, although FSS was aligned in a number of ways with the field of Science and Technology Studies (STS), it is better understood as rooted intellectually and institutionally in academic feminism. Using gender as a theoretical tool, this broader feminist project sought to reveal how disciplines within the academy were shaped by the exclusion and misrepresentation of women and their bodies and experiences (Keller and Longino 1996), a project that FSS scholars extended to the non-social sciences.

Much of early FSS was developed by women who had entered scientific fields, such as Ruth Bleier (1984; 1986), Evelyn Fox Keller (1977; 1985), and Ruth Hubbard (1983; 1990;

Hubbard Henifin and Fried 1979). While their work initially explored the experiences of women in the sciences, their inquiries were quickly expanded to critically examine the gendered content and practices of the non-social sciences (Keller and Longino 1996). Described by Banu Subramaniam as the "classical core of feminist science studies" (2009, p. 955), this area of scholarship interrogated multiple dimensions of scientific knowledge production and made particularly important contributions to the broader epistemological project of academic feminism. Amongst these FSS interventions were critiques of gendered hierarchies of knowledge, taken for granted notions of disembodied objectivity and rationality, positivist ideology, biological determinism, dualistic thinking such as nature/culture, gendered representations of women's bodies and processes of reproduction, as well as the influence of androcentrism, ethnocentrism, and capitalism on science and the broader Western academy (Bleier 1986; Subramaniam 2009). FSS scholars also imagined and debated feminist "successor projects" for the sciences. In the mid to late 1980s, Sandra Harding and Donna Haraway debated how to rethink the concept of "objectivity" such that the pursuit of scientific knowledge could better reflect feminist concerns with reflexivity, embodiment, and the politics of knowledge (Haraway 1988; Harding 1986). As acknowledged by Harding, however, such feminist epistemological projects would likely provoke resistance from "non-feminists and perhaps *even some feminists*," given the extent to which taken for granted notions of scientific rationality permeated everyday life (1986, p. 19, emphasis added).

By the 1990s, divergent views over how feminist scholarship could best advance women's relationship to the sciences had indeed led to an effective redrawing of the field of FSS. FSS had originally encompassed both questions of "women *in* the sciences" and "women/gender *and* the sciences" (Subramaniam 2009, p. 954); alongside FSS critiques of scientific methods

and theories, scholars aligned with FSS had also sought to recover the history of women in the sciences and document their current status in scientific fields (Keller 1983; Richardson 2010; Rosser 1988; Stimpson and Burstyn 1978). However, the desire to fundamentally reimagine the scientific and academic enterprise was perceived by some women in scientific fields as anti-science and indeed anti-women (Ruskai 1990), leading ultimately in the 1980s to the separation of FSS from scholarship concerned with women's under-representation in scientific fields. For many women scientists, as described by Longino and Hammonds (1990), "the only possible connection that feminism could have to science would be to make it possible for more women to do science under the most equitable circumstances" (p. 180). Frequently overlooked and mischaracterized was the oft-repeated FSS claim that they, too, wanted to improve science rather than abandon it altogether (Harding 1986; Nelson 1995). There is some evidence that this divergence also involved different ontologies of sex and gender. For instance, some FSS scholars in the early 1980s had rejected social constructivist accounts of gender and were instead arguing for the recognition of women's distinctiveness and the value of bringing their female qualities to the pursuit of science (Rosser 1989). In sum, FSS scholars and many practicing women scientists (as well as the study of their under-representation) came over time to hold different institutional locations and embody distinct feminist approaches to women and gender within the sciences (Hammonds and Subramaniam 2003; Richardson 2010).

Feminist Approaches to Sex and Gender

Another point of historical divergence between FSS and the biomedical turn in the US women's health movement concerns ontologies and epistemologies of sex and gender. In the 1970s, feminist scholars were grappling with the question of how to account for biological sex without

conceding to biological determinism. Sociologists like Ann Oakley responded by emphasizing a distinction between sex and gender:

> 'Sex' is a word that refers to the biological differences between male and female… 'Gender' however is a matter of culture: it refers to the social classification into 'masculine' and 'feminine.' (1972, p. 16)

According to Oakley, the task for feminist scholars was not to interrogate the existence of biological sex differences per se, which were taken as indisputable though perhaps not as large as imagined. Oakley and others focused instead on how those differences had been translated through social processes into the oppression of women and devaluation of femininity: "the constancy of sex must be admitted, but … prejudice has probably done more to determine the social roles of the sexes than biology ever could" (p. 16). Anthropologist Gayle Rubin similarly developed the concept of the "sex/gender system" in which she differentiated "the biological raw material of human sex and procreation" from the "socially imposed division of the sexes" (1975, p. 159). Feminist proponents of a sex/gender distinction thus sought to combat biological determinism by turning attention away from biological sex and toward the study of social gender.

Some feminist scholars were critical of this approach, however, since it black-boxed "sex" and assumed that claims about the biological bases of sexed bodies were reflecting nature itself. As Judith Lorber summarized, this approach assumed "either that there are two fairly similar sexes distorted by social practices into two genders with purposefully different characteristics or that there are two sexes whose essential differences are rendered unequal by social practices" (1993, p. 570). She argued instead that the imposition of binary "male" and

"female" categories onto human physiological variation was an entirely social process. Similarly, and as part of the performative turn in feminist theories of sex and gender, sociologists West and Zimmerman (1987) offered to define sex as "a determination made through the application of *socially agreed upon* biological criteria for classifying persons as females or males" (p. 127, emphasis added). Postmodern scholars like Judith Butler further collapsed the sex/gender distinction, arguing that since we cannot experience nor interpret the body except through the discursive frameworks that we have at our disposal, "sex, by definition, will be shown to have been gender all along" (1990, p. 12).

FSS scholars in the 1980s and 1990s were similarly collapsing the distinction between sex and gender. Influenced by feminist epistemology and its critique of "value-free" knowledge, their interventions sought to reveal the influence of gender on scientific productions and representations of sex and emphasized the impossibility of an "objective" science of the body. For example, in her influential essay on scientific narratives about the process of reproduction, Emily Martin (1991) shows how researchers impose gender stereotypes onto the behaviors of sperm and eggs. FSS scholars were strongly critical of the ceding of sex to the biological sciences by feminist social scientists (Gatens 1996; Grosz 1994). However, they were also developing more nuanced ways to account for the materiality and agency of the body and reclaim it as an entity that exerts its own forces independently of social context. Applied to sex and gender, feminist physicist Evelyn Fox Keller proposed that although gender is not determined by sex, it is also never entirely independent of it (1987). Building on such contributions, feminist materialist scholars like Elizabeth Grosz argued that the body "is not open to all the whims, wishes, and hopes of the subject" and instead plays an active role in shaping cultural representations (1994, p. 187). These contributions made clear that feminist scholars

could reject choosing only between biological determinism at one end and infinite plasticity or pure social constructivism at the other.

In recent decades, feminist biologists such as Anne Fausto-Sterling and Sari van Anders have used their laboratory research to explore the complex and dynamic ways that sex and gender are expressed in the body, an entanglement that van Anders prefers to describe using the umbrella term "gender/sex" (2012; see also Fausto-Sterling 2000, 2012; Fausto-Sterling et al. 2012). However, this ontological and epistemological approach to sex and gender has not been adopted more broadly in the biomedical and health sciences nor by advocates of women's health. In the early 2000s, Kuhlmann and Babitsch (2002) observed that the theories of sex and gender being developed within the academy had limited utility for the women's health movement, in part because FSS scholars had not sought to translate their work into practical insights for research on women's health. Even those women's health advocates critical of the biomedical paradigm had avoided theoretical debates about the nature of sex and its relationship to gender, fearing it would "disembody" women and undermine attention to their specific health experiences (Kuhlmann and Babitsch 2002). However, as I show below, various scholars aligned with FSS have indeed sought to impact policy-making and make complex notions of sex and gender legible to others. In comparison with biomedical feminists, they have been disadvantaged ontologically, epistemologically, and politically.

Framing the Institutional Politics of Sex, Gender, and Science

In sum, divergent feminisms of sex and gender, particularly as they concern the scientific study of the body and health, diverge in their beliefs about embodiment (ontology), their commitments to ways of knowing (epistemology), and their ability to effect institutional change (politics).

Ontologically, for example, they differ in the extent to which they see male and female bodies as distinct, as well as how they conceptualize gender and understand the magnitude of its effects on the body. This means that a given health outcome can represent different mechanisms to different feminists, which in turn has epistemological implications. Biomedical feminists support the pursuit of research aimed not only at revealing "pure" biological mechanisms, the effects of which are presumed to be discoverable and measurable independently of any social interference, but also begin from an assumption of male/female *differences* rather than similarity or non-binary complexity in these biological mechanisms.

By contrast, feminists adhering to a complex approach to gender/sex are characterized by the following commitments. Ontologically, they believe that effective resolution of a disease or other undesirable health outcome must necessarily combine the study of sex and gender because they presume an interaction of social and biological mechanisms from the outset. Epistemologically, while they do not oppose the biomedical study of sex, and generally support the inclusion of female models in animal research, they are concerned about the over-interpretation of sex differences or the over-attribution of sex as a fundamental cause of disease and other adverse health outcomes. Not only would doing so potentially impede the development of effective health interventions, it may also contribute more broadly to biological determinism and stereotypical thinking about men and women. As I argue below, they have had limited success in being heard or incorporated in the biomedical establishment, particularly in the US context.

By contrast, and arguably because of their ontological and epistemological commitments, biomedical feminists are more likely to be insiders in biomedical research and associated policy-making (Epstein 2007; Ruzek Olesen and Clarke 1997). But for biomedical feminists to succeed

in establishing the institutional supremacy of their account of sex, gender, and health, and secure resources for associated knowledge-making, they must maintain the ontological distinction between sex and gender. I suggest that they must additionally address two further political considerations: the integrity of science, and the interests of women when it comes to research on health and the body. In the case of NIH policy-making, biomedical feminists have experienced a greater degree of institutionalization not only because their ontological and epistemological account of sex and gender is consistent with dominant understandings of "good" science, which in the US is often perceived to be under attack. In addition, and quite importantly, their approach appears to be also more easily recognized as good for women, since it shores up the biological foundations and boundaries of a distinctly female category and addresses its under-representation in biomedical knowledge-making. However, and as I explore below, the institutional success of biomedical sex differences research also relies on impeding the expansion and recognition of more complex approaches to the study of sex, gender, and health.

Case Study: Institutionalizing Sex Differences Research in the US

I now turn to debates triggered by feminist efforts to influence policy-making around sex and gender inclusion in biomedicine in the US context, a trajectory that culminates in the 2016 SABV mandate. In recent years, governing bodies in many national and international settings have sought to mandate the inclusion of gender and/or sex in biomedical and health-related research (Sharman and Johnson 2012; Schiebinger 2014). In developing a policy focused specifically on sex inclusion at the preclinical level, NIH policy-makers have uniquely departed from approaches to gender and sex inclusion seen in other national and international contexts in biomedicine, which tend to address gender and sex inclusion under the same policy umbrella,

represent determinants of women's health as being both biological and social, and not formally privilege one over the other (Johnson and Beaudet 2014; Schiebinger 2014; Sharman and Johnson 2012).

Announced in 2014 and formally adopted by the NIH in 2016, the SABV policy extends an earlier 1993 mandate requiring the inclusion of women in clinical trials by requiring the equal use of male and female animals in preclinical research.[25] The policy requires that all investigators applying for NIH funding "consider" the relevance of sex as a biological variable to their research design, alongside "other basic biological variables," such as age (Lauer 2015). When a proposed project does not feature equal representation of male and female physical materials or analysis by sex, researchers must provide an acceptable justification. The overarching message is that preclinical research, like clinical trials in earlier decades, has been overly reliant on the male sex and inattentive to sex difference as a key determinant of health, leading to findings that are difficult to replicate and fail to address women's specific health needs (Clayton and Collins 2014).

FSS scholars have expressed concern about the SABV policy on the basis that it is unscientific to impose a sex inclusion requirement rather than allow the inclusion of sex to be hypothesis driven. Additionally, the rule overlooks the role of gender as a social determinant of health that is difficult to disentangle from the influence of biological sex, meaning the policy may do little to advance knowledge that actually improves health outcomes for either women or men (Eliot and Richardson 2016). For example, higher rates of adverse drug reactions amongst

[25] The SABV policy were initially intended to also apply to cell-based research. However, this area of research was dropped from the mandate following feedback from the scientific community in 2015, which included criticism by feminist biologists.

women—a key concern of the NIH—may potentially stem largely from social factors, such as women being more likely to take multiple medications at one time, rather than underlying fundamental differences in men's and women's biology (Richardson et al. 2015). An additional concern is that the policy will result in scientific claims that reinforce essentialized notions of male and female.

In order to explore how the biomedical feminist perspective became institutionalized in the form of the SABV policy, despite active interventions from feminists articulating alternative accounts of sex, gender, and health, I analyzed 65 published documents from 2014 to 2018 that directly discussed the policy. These were produced by representatives of the NIH, the women's health movement, professional societies, and researchers aligned with the biomedical sciences, social sciences, and feminist science studies and included reports, policy statements, editorials and commentaries, research articles, and published debates. Recognizing that the announcement of the SABV policy in 2014 reflected a longer history of policy-making efforts, I also considered an earlier period of policy-making represented by two major reports published in 1999 and 2001 (ORWH 1999; Wizemann and Pardue 2001). I supplemented this textual data with 40 semi-structured interviews conducted with authors and other stakeholders as well as transcripts created from seven NIH meetings that addressed the topic of sex and gender inclusion from 2014 to 2017, recordings of which are available publicly online. Finally, I obtained some additional NIH materials using a FOIA request, namely meeting minutes for the Advisory Committee for Research on Women's Health from 1996 to 2018 and responses to a 2015 NIH call for stakeholder input on the content and implementation of the SABV policy.

Following data collection, I iteratively coded the textual and interview materials in Nvivo, a qualitative coding software, working with small excerpts at a time as I moved towards a

finer-grained analysis. In the following analysis, I trace the feminist struggles surrounding the inclusion of sex and gender in biomedicine with the aim of explaining how a particular policy trajectory emerged at the NIH over time. In seeking to build on existing feminist scholarship on institutional change and scientific knowledge production, I identify the ontological, epistemological, and political factors that differentiate the efforts of biomedical feminists from those advancing a more complex health research agenda.

Differentiating Sex Differences from Gender

The late 1990s constituted an important period of agenda setting for women's health research, reflecting the increasing institutional influence of professionalized advocates of women's health following the establishment of the NIH Office of Research on Women's Health (ORWH) in 1990 and the NIH Revitalization Act in 1993. As reflected by ORWH in 2010, this period was characterized by several overarching themes, one of which was "sex/gender distinctions" (ORWH 2010, pp. 13-14). A review of key reports and publications released by the ORWH during this time reveals a concerted effort to clarify the definitions of sex and gender and their relevance to women's health. In part, such efforts were deemed a necessary corrective to the tendency of researchers in the biomedical and social sciences to use the terminology of gender and sex interchangeably. However, it was also a key step in enabling policy-makers to move towards establishing the biological study of sex—and sex differences in particular—as a distinct and necessary field.

Distinguishing sex from gender was a key project for the ORWH over the 1990s and 2000s (ORWH 2010). Reflecting on the activities of the ORWH in the early 1990s, former Director Vivian Pinn recalled in an interview that "most people were viewing women's health

research as a starting with clinical trials. And my feeling was, as a basic scientist … our office should welcome funding research that addresses basic science studies." In order to do so, Pinn and other basic scientists recognized the importance of reclaiming sex as distinct from gender: "everybody talks about gender but they need to use the terms correctly … what does gender mean? What does sex mean? … I remember coming back to NIH and saying we really need to be more specific about these terms."

An opportunity to formalize a distinction between sex and gender came during four workshops convened by the ORWH in 1996 and 1997 as part of a "Task Force on the NIH Women's Health Research Agenda for the 21st Century." In the conclusion to the resulting six-volume report, the following definitions were offered:

> Sex refers to the classification of living things, generally as male or female, according to their reproductive organs and functions assigned by their biological make-up. Gender refers to a person's self-representation as male or female, or how society responds to that person based on the individual's gender presentation. *Gender is rooted in biology* and shaped by environment and experience. (ORWH 1999, p. 1, emphasis added)

Interestingly, the first volume had opened with an introductory chapter authored by bioethicists which had sought to promote a more nuanced distinction between sex and gender. The authors differentiated between "those qualities attributed to biological based differences about a person's 'sex,' male or female, and those qualities that were understood as the result of cultural and social processes that constitute a person as man or woman: one's 'gender'" (Fishman et al. 1999). But they also stated as follows:

> Although there is the desire to separate that which is biologically determined about sex differences and that which is social, cultural, and environmental, scholars have since argued that neither sex nor gender—nor the relationship between them—can be understood so simplistically. (Fishman et al. 1999, 17).

Reflecting in an interview on why ORWH policy-makers had not promoted a more complex definition of sex and gender, one author described the challenge of ensuring gender was included at all. As stated, "I had a very limited goal of keeping the social on the table and not having it erased... just convincing them of its importance." Commenting on the final report's emphasis on pursuing biological sex differences, she observed further that the impact of their intervention was "small" and that "this problem has just gotten worse."

The sex/gender distinction advanced by the ORWH gained further legitimacy in 1999 when it was adopted in an influential Institute of Medicine[26] (IOM) report, released in 2001 to document the work of a "Committee on Understanding the Biology of Sex and Gender Differences" comprised of scientists with expertise in "basic and applied biomedical research." The report used the same distinction between sex and gender offered by the ORWH in 1999 (Wizemann and Pardue 2001, p. 17). Two IOM committee members, amongst them feminist biologist Anne Fausto-Sterling, critiqued the chosen definition for suggesting "a predominance of physiology, with a subsequent fine-tuning by environment" (p. 18). This resistance led the report editors to acknowledge that "there is no such thing as a pure biological effect … [and] the 'biology' of a given individual therefore includes genetic, physiological, and hormonal effects as well as the environmental, behavioral, and societal influences that shape that individual"

[26] The Institute of Medicine is now known as the Health and Medicine Division (HMD) of the National Academies of Sciences, Engineering, and Medicine.

(Wizemann and Pardue 2001, p. 14). They noted further that "it is impossible to know a priori the causes for a particular difference between men and women" (p. 18). However, these clarifications were omitted as the report's explicit definitions of gender and sex traveled.

Although a distinction between sex and gender was not explicitly included in the updated strategy for women's health research released by the ORWH in 2010 (ORWH 2010), a report that heavily emphasized the importance of addressing sex in basic and preclinical research, it has since resurfaced in the efforts of the ORWH to justify the SABV policy. For example, current Director Janine Clayton has integrated the following distinction into her SABV advocacy and education efforts:

> Sex and gender inform various levels of research distinctly. Although sex is a biological attribute relating to genetics, physiology, or anatomy and defines cells and organisms as "male" or "female," gender references behavioral, social, and cultural domains relevant to humans. (Clayton 2016, pp. 519-520)

Sex difference researchers writing in support of the SABV policy have similarly emphasized "the distinction between sex and gender," such as in correspondence published in *Nature* in 2014 describing sex as "the biological result of interplay between sex chromosomes and gonadal hormones" and gender as combining "self- and societal perceptions of a person's sex" (McCollough et al. 2014, p. 340). This separation of sex from gender made it possible to claim the study of sex—understood in terms of binary difference—as a distinct field of research, the expansion of which is in the interests of both women and the advancement of science.

Legitimizing Sex Differences

The title of the 2001 IOM report posed the following question: does sex matter? In addition to distinguishing sex from gender, it was necessary for biomedical feminists to establish the importance of sex as a specific determinant of health that was sufficiently important to warrant further study. Sex differences were actively constructed as mattering across the biomedical sciences, not only for those researchers concerned with reproductive health (Pinn 2005). From the time that the ORWH was established, policy-makers emphasized "the fact that women's health implies more than the reproductive system" (ORWH 1999, p. 6). This notion is also captured in a key phrase that has been broadly adopted from the IOM report: "every cell has a sex" (Wizemann and Pardue 2001, p. 4).

Furthermore, as reflected in the preference of policy-makers and biomedical scientists for the term "sex differences" rather than "sex," sex as a health determining mechanism was further conceptualized specifically in terms of difference, or as a binary distinction between "male" and "female." This move required assurances that these differences were real and important. A key purpose of convening the IOM Committee on Understanding the Biology of Sex and Gender Differences was to "take stock of what is known about differences and similarities in the basic biology of the sexes" and especially in the "nonreproductive areas of biology" (Wizemann and Pardue 2001, pp. ix-x). As recalled by Vivian Pinn, "one of the purposes of doing the Institute of Medicine report was to come up with a credible source that would document that basic research was important to women's health research and begin to look at whether or not there are sex differences." Florence Haseltine, founder of the Society of Women's Health Research, reflected that "you couldn't have sold the basic research [sex inclusion requirement] in 1990, and the reason was there was not a sufficient body of evidence that cells were different. I thought there was, so we got the money from Congress and it was put towards this study."

The report ultimately concluded that "being male or female is an important basic human variable that affects health and illness throughout the life span" and "there are multiple, ubiquitous differences in the basic cellular biochemistries of males and females . . . [that] are a direct result of genetic differences between the two sexes" (Wizemann and Pardue 2001, p. xix and 6). As reflected by Vivian Pinn, "with that whole report, what I think are the most important points out of that is that sex differences are important. That it is important to study sex differences at the basic science level from the molecular and cellular level all the way to the clinical application level and that it is an important part of science." This point was reiterated in the introduction to the updated strategic plan for women's health in 2010, in which Pinn stated that "over the past 20 years, research has revealed that from single cells to multiple biological systems and mechanisms, sex differences exist" (ORWH 2010, p. 6).

At times, policy-makers have acknowledged that the discovery of sex similarities may also be useful for understanding health mechanisms. For instance, a 2013 article by Janine Clayton and Stephanie Joseph described "sex differences research" as the scientific study of "how basic biologic mechanisms, disease manifestations, and therapeutic responses may be similar or different in women and men so that targeted, tailored and highly effective prevention, diagnostic, and treatment strategies may be developed" (Clayton and Joseph 2013). Yet as emphasized by Clayton at a 2017 workshop on the SABV policy, "we know that women and men are both the same and different at the same time [but] knowing when they are different can make all the difference in the world." Even a biomedical scientist who wrote to *Nature* protesting the SABV policy mandate stated that "sex differences lie at the core of biology" and "are the driving force of evolution, and in many cases they are fundamental in health and medicine" (Douglas 2014).

In addition to being real and important, sex differences were increasingly constructed as a "blind spot" in biomedicine that was bad for science (Clayton 2015). As warned in the 2001 IOM report, "there are striking differences in human disease that are not explained at this time" (p. xix) and "until the question of sex is routinely asked … many opportunities to obtain a better understanding of the pathogenesis of disease and to advance human health will surely be missed" (Wizemann and Pardue 2001, p. 4). In 2010, ORWH policy-makers foregrounded the SABV policy by similarly describing "research conducted with both female and male cells, tissues, and animal model systems [as] paramount for developing strategies to improve clinical diagnosis and therapy" (Pinn et al. 2010, p. 1605). The rise of reproducibility as a key concern for the NIH in recent years, particularly in basic and preclinical research, led policy-makers to further sharpen the argument that sex differences research is "good" for science. For instance, the initial announcement of the SABV policy in 2014 stated that the "inadequate inclusion of female cells and animals in experiments and inadequate analysis of data by sex may well contribute to the troubling rise of irreproducibility in preclinical biomedical research, which the NIH is now actively working to address." (Clayton and Collins 2014, 282). More recently, Clayton has stated that "a fundamental pillar of science—reproducibility—was buckling, threatening to collapse the entire edifice" leading the NIH to introduce a range of policies including the preclinical sex inclusion requirement (Clayton 2018, p. 3).

The promise of "good science," however, is insufficient to instigate an NIH-wide inclusion mandate for preclinical research. Even more compelling, I suggest, is the argument that the expanded preclinical study of sex differences will advance the interests of women.

Mobilizing Around the Under-Represented Variable

According to Florence Haseltine, the NIH moves because of "pressure from the outside," and in the months immediately preceding the SABV announcement in 2014 there were "a lot of questions about sex differences" coming from sources other than ORWH representatives and biomedical scientists. Amongst these sources were Congress. In January 2014, Congresswomen Nita M. Lowey and Rosa DeLauro wrote to Francis Collins, Director of the NIH, calling for him to address "gender bias" in basic research:

> Over the last two decades, the National Institutes of Health have made progress in correcting the previous absence of women in clinical trials, but the stark reality is that inequities still exist … Basic science research is still predominantly conducted in male animal models of disease.

Lowey and DeLauro observed that the "lack of inclusion of female animals from the beginning undermines the credibility of research on the biology and pathophysiology of various treatments." More importantly, however, they understood it to be negatively impacting women's lives: "failure to eliminate gender bias from the outset has led to … [drugs] being removed from the market during the late stages of development because of adverse consequences in women."

The case for sex inclusion in preclinical research was brought to Congress by Dr Kathryn Sandberg, Professor and Director of the Center for the Study of Sex Differences in Health, Aging and Disease at Georgetown University. Sandberg recalled the reaction of the congresswomen when they were informed that sex inclusion was not occurring at the preclinical level:

> They were shocked. They really thought they had solved the problem in clinical research, that researchers needed to include women unless there was a reason why it would not be a good idea. They were shocked that it didn't trickle down to the basic scientists.

The under-representation of female animals had been documented in two highly cited articles by Annaliese Beery and Irving Zucker in 2010 and 2011. As they argued in *Nature*, the "prejudice against using female animals" has "serious implications for healthcare in women" (Zucker and Beery 2010, p. 690). The optics of the gender bias were damning: for a series of diseases and conditions including anxiety and depression, stroke, thyroid diseases, and pain, women experienced higher rates than men but female animals were significantly under-represented in related areas of preclinical research (Beery and Zucker 2011; Zucker and Beery 2010). For example, although women experience higher rates of stroke than men, 65% of relevant preclinical studies published in a key journal in 2009 were based on male animals only, with none solely focused on females and only 10% including both sexes (25% did not specify sex) (Beery and Zucker 2011, p. 569). As stated by Sandberg, "it was just a simple concept. If you're going to study a mechanism in an animal model, and that animal model is supposedly representing human disease, then why wouldn't you also be interested in looking at the mechanism in a female model of disease?"

The claim that an over-reliance on male animals would negatively impact women gained legitimacy in late 2013 when the Food and Drug Administration (FDA) in the US announced that they were cutting by half the recommended dose of Ambien (Zolpidem), a popular sleep aid, for women following the discovery that they were experiencing higher rates of adverse reactions to the drug (FDA 2013). As neuroscientist Larry Cahill asked in a 60 Minutes episode covering the controversy, "how did it happen that for 20 some years, women, millions of them, were

essentially overdosing on Ambien?" According to the 60 Minutes story, fundamental sex differences that impact how drugs are metabolized in men versus women are not well understood because basic research relies primarily on male animals, leading to "more problems for women down the road." Reiterating the message of the ORWH, IOM, and biomedical scientists that sex differences are fundamental to understanding the human body, the 60 Minutes explained to a record number of viewers that "drugs are just the beginning: sex differences have been found in pain receptors, liver enzymes, even the wiring of the brain."

As several FSS scholars have since pointed out, however, decreasing the Ambien dose in women may in fact represent average differences in body mass between men and women. If this is the case, it does not represent a strictly biological sex difference, since larger women and smaller men may require different amounts of the drug to be effective (Eliot and Richardson 2016; Richardson et al. 2015). Additionally, women may in general experience higher rates of adverse drug reactions than men since they are more likely to be taking multiple medications at one time: the cause here would be at least partially social, rather than purely biological. However, such alternative explanations were not offered by the biomedical researchers or policy-makers interviewed for the program.

The importance of ensuring the interests of women are addressed by biomedical and health research has long been the driving motivation of the ORWH, reflecting the concerns of the women's health movement where it originated. The inclusion of women in clinical trials, and the "inclusion and difference" paradigm it represented (Epstein 2007), established the expectation that sex representation matters because fundamental differences exist between women and men. In this context, it has been easy to make the case that representing the female model at the basic and preclinical level is in the interests of both science and women. As stated by the ORWH in

1999, “expanding our understanding of normal and abnormal biologic processes and behavior can result in improved prevention, diagnosis, and treatment of diseases, disabilities, and other conditions that affect the health of women and their families” (ORWH 1999, p. 1). Teresa Woodruff, a prominent supporter of the SABV policy and former president of the Endocrine Society, stated with colleagues in the month preceding the 2014 policy announcement:

> Sex-based research will not only improve health care into the future but will also send a message to rising young female scientists and the public in whose interest we work that from early discovery research to the pinnacles of science leadership, *women and their cells have an equal place at the table*. (Woodruff et al. 2014, p. 1183 emphasis added)

In short, the accessibility and tangibility of this claim—that an expanded program of sex difference research at the preclinical level will directly benefit women—has succeeded in mobilizing important external stakeholders, and not simply the association of this cause with “better” science. FSS scholars have been less successful in articulating the value for women of a more complex approach to the study of sex and gender. As I explore below, however, this is partly because generating the knowledge base to support a broader ontological shift around the concepts of sex and gender has not received the necessary institutional investment.

Resisting Gender/Sex

Even as the conditions have been created over the past several decades to mandate the inclusion of sex in preclinical research, gender has not been erased from the language and research priorities of NIH policy-makers. ORWH representatives have consistently referenced the study of gender as relevant and important to understanding women’s health. For example, in the 2010

strategic report for women's health, ORWH policy-makers stated that "health outcomes are influenced by biological sex, gender identity, as well as developmental, cultural, environmental, and socioeconomic factors" meaning that "the scope of women's health research not only encompasses clinical studies, but a full spectrum of scientific investigations" (ORWH 2010, p. 13). Similarly, in a 2015 statement about the SABV policy, Clayton stated that *both* sex and gender "affect us from head to toe" and "can affect health and influence how diseases appear and progress, and they also factor into the development of safe and effective drugs and other interventions" (Clayton 2015). Nor have the social and interdisciplinary sciences been abandoned. In 1999, the agenda-setting NIH report on women's health was described by ORWH policy-makers as "a comprehensive plan" "encompassing behavioral and social research, as well as biomedical studies" (ORWH 1999, 33). The five overarching themes of the report included an emphasis on multidisciplinary research and the "unquestionable" importance of social and behavioral science to research on women's health (ORWH 1999, 14). In other words, the efforts of social scientists and FSS scholars to keep gender "on the table" appear to have been somewhat successful.

Similarly, there is evidence of some recognition of their claim that gender and sex should be seen as entangled. In 2001, the editors of the IOM report noted that "the ability to look at sex and gender as part of a single system in which social elements act with biological elements to produce the body has important consequences for medical treatment" (2001, 19). Several years later, Vivian Pinn also emphasized the importance of investigating "the complex interaction between women's genetic and biological dispositions, their environment, personal health behaviors, racial/ethnic/cultural attributes, access to health care, and many other aspects that may contribute to differences in health status or outcomes between different populations of women"

(Pinn 2005, p. 1407). In a 2015 review of sex and gender inclusion in biomedical and health research, authors including a member of the ORWH Advisory Committee clarified that "current available definitions of these terms [sex and gender] are not unambiguous and cannot always be used in a mutually exclusive fashion due to the interaction of biological and social elements affecting health outcomes" (Mazure and Jones 2015, p. 94). Thus, while ORWH policy-makers often represent sex as something distinct from gender, they simultaneously (though less vigorously) recognize that sex and gender can be conceptualized as entangled, and that this entanglement likely matters to women's health experiences.

Policy-makers have also not been ignorant of the concerns of FSS scholars related to the SABV policy. For example, when the NIH invited the input of the biomedical research community and other interested stakeholders on the development and implementation of the SABV policy in late 2014, a feminist immunologist was amongst the respondents and stated their concern that "an approach involving male-female comparisons will actually *hamper* our ability to understand these issues in a nuanced and sophisticated way and will perpetuate unhelpful notions of biological determinism and essentialism." The respondent also explained that "with respect to transformed cell lines, it is literally impossible to include both male and female cells in the research," or to make claims about "male" processes based on cell lines derived from a male donor, because the procedures for producing and sustaining a cell line render it a highly artificial model.[27] When the SABV mandate came into effect in January 2016, it indeed exempted research involving cell lines, primary cells, and tissues.[28] A 2015 report summarizing responses received by the NIH briefly acknowledged concerns that "an SABV focus may amplify erroneous beliefs that women and men are universally or comprehensively different in all areas"

[27] Other respondents, too, emphasized the difficulty of determining the sex of established cell lines.

[28] However, it still urged such researchers to consider the possible role of sex.

(NIH 2015, p. 9), though this concern has not been prioritized by either policy-makers or the biomedical research community.

Given the recognition these more complex feminist perspectives, what has impeded their broader incorporation into biomedical research? One obstacle is methodological: what would such research look like in practice? In 2001, the editors of the IOM report observed that "an approach that examines how factors outside the body are translated into differences between male and female bodies will break new scientific ground" (IOM 2001, p. 19). In the years since, this has largely remained an "undone" area of scientific inquiry (Frickel et al. 2010), with the exception of the work of a relatively small number of feminist biologists.

There is real resistance to such knowledge. As one feminist neuroscientist stated, the perception in her discipline is that "when you [study gender/sex] you are stepping outside of science." As described by another feminist neuroscientist, "what we are doing here methodologically … is not well seen and is difficult to integrate into the structure of the university and our disciplines." A feminist endocrinologist stated similarly:

> I am one of the only people doing feminist bioscience, from the ground up and not secondary data analysis, you know, designing studies, having a lab… People say 'I want to do feminist bioscience, [but] who could I work with?' … There are not that many people grounding their science practice in feminist principles and ideas.

Recognizing that the methodological tools to integrate more complex notions of gender/sex into basic and preclinical research are currently under-developed, various FSS scholars have collaborated to publish toolkits and recommended best practices in biomedical journals (see Rippon et al. 2014; Ritz et al. 2014; Springer et al. 2012). Such approaches have not yet been

broadly adopted within neuroscience or other biomedical disciplines. Interviewees repeatedly emphasized that in order to influence research policy, one must be able to provide empirical evidence in support of one's claims. In the case of complex approaches to sex and gender, however, this amounts to a vicious cycle: in the absence of "proof" that entanglement matters, policy-makers can defend not allocating the institutional support needed to devise new methods to actually explore the entangled effects of gender/sex on health.

Second, the efforts of FSS scholars to critically analyze existing approaches to sex and gender in biomedicine and engage biomedical researchers in constructive debate have been routinely discredited and misrepresented. The claim that FSS scholars widely oppose the biomedical study of sex and the inclusion of female rats frequently arose in interviews and texts. Their more nuanced message that it is important—for both scientific and social reasons—to exercise caution when designing and interpreting studies of sex in human and animal studies was disregarded. As one feminist psychologist reflected, "it has been difficult to have nuanced discussions." A feminist neuroscientist described her arguments about complexity being misrepresented by her colleagues, who labeled her and similar scholars "sex difference deniers, that we're trying to pretend that there is no difference at all out of some purely political feminist agenda." A prominent sex difference researcher interviewed for this study alleged that FSS scholars "think that there are pretty much no meaningful differences between males and females except those that are created by the environment." Another researcher similarly stated that FSS scholars appeared to be questioning the legitimacy of sex differences research, calling "all this sex difference stuff a bunch of nonsense and [publishing] several op-ed pieces in journals and *The New York Times* saying we're making up this science, but clearly we're not."

At issue is not only whether complex views of gender/sex are scientific, but whose interests they serve. In a published exchange between neuroscientist Larry Cahill and several feminist researchers (Fine et al. 2014), Cahill resisted the opportunity to engage in further dialogue, describing their article as "the response I had been waiting for, from the group I was expecting it from." (Cahill 2014). He noted further: "I hope Fine et al appreciate [the SABV policy], especially as women, who will be the ones to disproportionately benefit from it." Of course, FSS scholars also claim to be acting in the interests of women, and have sought to emphasize the potential harms to women when sex differences are over-interpreted and health outcomes approached as deriving primarily from biological sex rather than gendered behaviors and inequalities. However, such claims appear to be deeply unsettling in the context of a broader institutional setting committed to particular constructions of sex, gender, and science.

Discussion and Conclusions: FSS from Margin to Center?

The conditions for introducing the SABV policy in the US were actively created over several decades following the initial adoption of gender equity as a formal research policy issue by the NIH in the mid to late 1980s. While perceptions of a reproducibility crisis strengthened the ability of biomedical feminists to appeal on scientific grounds for the inclusion of sex in preclinical research, it was first necessary to establish the study of sex as a distinct from gender and as an endeavor that had the ability to reveal the "pure" functions of sex as a fundamental and "real" health determinant. While FSS scholars experienced such a research agenda as politically fraught and insufficient to advance knowledge of health outcomes, other feminists believed that such a policy was in the best interests of women, reflecting fundamental ontological differences

between feminists who embrace the distinctiveness of "woman" and "female" categories, and those who reject their unity and utility.

The epistemological differences between biomedical feminists and FSS scholars have important implications for their institutional influence in a context where the biomedical sciences are distinguished from and valorized over social sciences and humanities disciplines (Gieryn 1999; Ruzek Olesen and Clarke 1997). Harding's observation in 1986 that feminist "successor science" projects would be threatening to scientists and even some feminists remains true today in the US context. Debates around the SABV policy reflect broader differences in how feminists imagine alternative forms of science that better incorporate women as the producers and objects of knowledge. Reflecting on the metaphor of the "leaky pipeline" that many feminists have used in their efforts to address women's under-representation in scientific fields, Banu Subramaniam observes that "the crux of the difference" is that in the eyes of such feminists, "the leaks are seen as the problem," whereas FSS scholars see "the problem [as] the pipe itself" (2009, p. 964). Put differently, it is the contrast between supporting women scientists to survive within the existing institution (such as through improved work-family policies and networking and mentoring programs) versus seeking ways to rebuild the institution itself, from its very epistemological foundations up. Biomedical feminists are institutionally advantaged not just because their account of sex inclusion appears logical in a broader policy context already committed to equity for (presumed) different bodies, but also because their vision of science fits within rather than reimagines the dominant biomedical paradigm for health (Clarke et al. 2003; Ruzek Olesen and Clarke 1997), and therefore affirms it at a moment when the authority of "science" appears to be uncertain.

The notion that including female models in preclinical animal research is "good for women" also appears as straightforward and compelling. After all, and as agreed by several FSS scholars interviewed for this study, a reliance on male animal models is unsatisfactory, not least because it perpetuates the erroneous and still common assumption that women have an inconvenient menstrual cycle that complicates the efforts of biomedical researchers. According to this logic, women's bodies are simply men's plus "pesky hormones" (CBS News 2011), justifying a focus on men and male animals as the less complicated base model from which findings can simply be extrapolated to women. The harder task, and that facing FSS scholars, is to make their more complex approach to sex, gender, and health compelling for women. Ann Snitow reflected in 1990 that feminists committed to essential sex/gender difference offer women the comfort and meaning of a collective identity, and validation of the gender differences they have experienced throughout their lifetime, whereas those feminists erring on the side of complexity and deconstruction of familiar categories offer a more individualistic and uncertain scenario for women (p. 22), which is likely exacerbated in an era when the boundaries of sex and gender are in flux.

The uncertainty surrounding this less traveled route is further exacerbated in a context where the pursuit of alternative research agendas has been slow to receive institutional support. This is where the cost of separating FSS from "women in science" in the late 1980s becomes clear. As argued by Subramaniam (2009), it is critical that FSS scholars and the departments that they belong to approach the non-social sciences as part of—rather than distinct from—gender and women's studies. Recent developments in feminist biology suggest the field is growing, making it an ideal time for new research and curricula bridging gender and women's studies and the biomedical sciences. It is clear from the case explored in this chapter that the strategy of

critiquing science, rather than building scientific practice anew, has political limits and is insufficient to bring about institutional change.

Two notable aspects of the SABV policy are that it has not yet been replicated in other national and international contexts and, unlike the NIH Revitalization Act in 1993, it has not been coupled with other traits considered relevant to health, such as race and age. Converting sex into an asocial, binary biological phenomenon may separate it decisively from race, yet race has re-emerged as a biological construct in US biomedical research in more covert ways (Rajagopalan Nelson and Fujimura 2016; Roberts 2012). Thus, an added challenge (or opportunity) for FSS scholars is to consider not only how to promote more complex gender/sex research in US biomedicine, but to imagine how such work might also be theoretically and empirically intersectional. Additionally, the trajectory of sex and gender inclusion in biomedicine studied in this chapter is tied to the particular institutional and political histories of science and feminism in the US context. Further research could consider the extent to which policy trajectories vary in other national and regional contexts, and the institutional and political factors that underpin them. Where such policies place a greater emphasis on gender as a complex and interacting health determinant, as seen at the World Health Organization and Canadian Institutes of Health Research (CIHR) (Sharman and Johnson 2012), future research could also consider the challenges to realizing such a research agenda in practice.

CHAPTER FOUR

The Institutional Reduction of Complexity: Regulating Gender/Sex in Biomedicine and Sport

> Simplifying body parts in order to layer some conceptual order onto the daunting complexity of the living body is the daily bread of the working scientist.
> —Anne Fausto-Sterling, 2000, p.127)

For several decades, ideas about the boundaries of sex and gender have been shifting as various social movements have converged to challenge the notion that biological sex and gender identity are binary and neatly aligned. Alongside these shifts, a growing number of feminist scholars in the biological sciences and Science and Technology Studies (STS) have been challenging scientific efforts to represent sex in terms of binary differences. In addition to scholars in Feminist Science Studies (FSS) revealing the gendered ideologies that often underlie scientific efforts to characterize biological sex, the related field of feminist biology is increasingly developing new methodologies to empirically examine the complexities of sex and its dynamic interaction with gendered social environments.[29] For example, a 2014 paper published by four feminist researchers offered neuroimaging scientists a new framework for addressing gender/sex in their research design, analysis, and interpretation, underpinned by the principles of overlap, mosaicism, contingency, and entanglement (Rippon et al. 2014). As Rippon and colleagues

[29] Sari van Anders (2012) refers to this as "gender/sex," an umbrella term that captures the complex entanglement of gender and sex without privileging the latter.

argue, these principles offer a "serious challenge" to essentialist notions of biological sex as fixed, binary, and informative for understanding health outcomes (p. 1).

Such challenges to the scientific study of sex likely have institutional implications. In this chapter, I ask: how do rule-makers respond to complexity-oriented accounts of sex and gender, particularly when they are operating within institutional environments that have invested in binary and biological models of sex? As argued by Steven Epstein (2007), regulatory regimes serve as an important means of institutionalizing certain accounts of sex and gender, often in response to external demands. In the case of biomedicine in the United States (US), for instance, Epstein shows that policy-makers in the 1990s responded to demands from women and minority groups for inclusion in clinical trials by introducing a mandate that encapsulated an "inclusion-and-difference paradigm." Under this paradigm, requiring the inclusion of such groups was justified by policy-makers on the basis that differences of sex and race are meaningful determinants of health. As Epstein also argues, such an approach can easily lead to sex and race categories being interpreted as representing biological forms of difference, which are also taken up more broadly as they exit the laboratory. However, demands for inclusion do not only occur within a difference paradigm. In the case of gender/sex, institutions are also being asked to integrate a more complex understanding of sexed and gendered bodies into their rule-making efforts.

In order to examine institutional responses to complexity-oriented accounts of the body, this chapter considers two prominent cases of gender/sex regulation, in two quite different institutional spheres: biomedicine and sport. The first case concerns the National Institutes of Health (NIH) in the US, and particularly feminist debates surrounding the inclusion of gender/sex in biomedical research. In 2014, the NIH announced their Sex as a Biological

Variable (SABV) policy mandating the balanced inclusion of female and male animals in preclinical research, and the analysis of sex differences in the resultant data, a requirement that NIH policy-makers also hope to extend to cell-based research. For some feminists and advocates of expanding women's health research, including policy-makers at the NIH Office of Research on Women's Health (ORWH), the new guidelines correct decades of inattention by preclinical researchers to biological sex and appropriately extend the 1993 NIH requirement to include women and minorities in clinical trials. For others, including many FSS scholars and feminist biologists, the SABV policy promotes a simplistic account of sex and risks reifying its mechanisms as binary, biological, and distinct from—and more important to health outcomes—than social factors (Eliot and Richardson 2016).

The second case concerns the regulation of women with naturally high testosterone in Olympic sports, and especially international track-and-field. In 2011, the International Association of Athletics Federations (IAAF) and the International Olympic Committee (IOC) introduced Hyperandrogenism Regulations specifying a limit to the amount of naturally occurring testosterone allowed in women athletes, intended to target women with intersex traits. In 2015 these regulatory efforts were contested at the Court of Arbitration for Sport (CAS) in Switzerland by an Indian sprinter, Dutee Chand, with the adjudicating panel ruling to suspend the Regulations on the basis that there was currently insufficient scientific evidence of a relationship between testosterone, sex difference, and athletic ability (CAS 2015). Revised regulations were introduced by the IAAF in 2018 and were subsequently appealed by South African 800m runner, Caster Semenya, at the CAS in 2019. This time, the CAS ruled in the IAAF's favor (CAS 2019). Various feminist activists and scholars, as well as feminist and non-feminist biomedical scientists, have questioned the scientific basis of these regulatory efforts

given the complexity of both sex and athletic ability, neither of which can be reduced to testosterone levels. However, such ideas have been rejected by the CAS and have not gained broader acceptance within the track-and-field community. Claims that existing Regulations target women of color from the Global South have also been routinely discredited.

There is growing interest across a range of disciplines in the utility of complexity as an ontological and epistemic framework (Urry 2005). Much of this scholarship focuses on the implications of a complexity framework for knowledge production. This chapter differs by considering its implications for regulatory institutions. In both of the cases outlined above, rule-makers have favored a simplistic account of gender/sex despite the presence of alternative scientific perspectives emphasizing complexity. However, these regulatory outcomes should be understood as neither inevitable nor stable. In some other sports and national contexts, for instance, policy-makers have endorsed a more complex account of gender/sex. Additionally, both cases are characterized by ongoing feminist and scientific debate. As such, this examination of gender/sex regulation can reveal some of the mechanisms by which rule-makers succeed in reasserting simplistic scientific accounts of the sexed body in spite of the presence of more complex alternatives.

The chapter proceeds as follows. In section two, I provide an overview of the disunity of science, with particularly attention to how complexity can be conceptualized as one of many "epistemic cultures" that comprise the pursuit of scientific knowledge. I then characterize the divergent epistemic cultures of the gendered/sexed body that are evident in recent regulatory debates in biomedicine and sport, highlighting in particular the specific mechanisms by which rule-makers in each case are able to privilege and promote science that pursues sex as binary and biological. In the concluding section, I consider how institutional resistance to complexity can be

conceptualized as gendered. I argue that the equal recognition of complex accounts of gender/sex is a key prerequisite for socially legitimate and scientifically robust regulations aimed at advancing inclusion in institutional spheres like biomedicine and sport, which are grappling with both the traditional under-representation of women and the shifting politics of gender/sex. I also reflect on how these two cases might reveal more general insights about the relationship between complexity, knowledge, and rule-making, and particularly how resistance to complexity can serve as a key mechanism by which institutions succeed in upholding dominant ideologies and interests.

The Disunity of Science and the Body

In recent decades the scientific disciplines of physics, biology, mathematics, ecology and chemistry have witnessed considerable growth in the study of complexity and associated concepts of chaos, non-linearity, and dynamical systems analysis (Fujimura 2005; Thrift 1999). Social scientists, influenced by these developments in the biological sciences, have also explored complexity as a macro theoretical project in an effort to more fully account for the complex dynamics of contemporary social systems. As noted by John Urry (2005), this involves a shift away from "reductionist analyses" to an understanding of systems as "irreducible to elementary laws or simple processes" (pp. 1-3). For example, Sylvia Walby (2007) draws on complexity theory to conceptualize the macro dynamics of intersectional forms of inequality and difference. Her complex model of social systems as overlapping, non-nested, and non-saturating offers an alternative to the "flattening" of social relations to a single underlying dimension, such as class. The purpose here is to provide a complex ontology of how social relations exist and interact at the macro level, with implications for how such inequalities are then studied by social scientists.

A complexity approach can also aid in developing more holistic accounts of how social and biological systems interact, complicating the artificial division between "nature" and "culture" (Capra 2005). The analytic framework of Developmental Systems Theory (DST), pioneered by Susan Oyama, offers an alternative to dualistic constructions of nature and culture as representing fundamentally distinct processes. Oyama describes a developmental system as "a heterogeneous and causally complex mix of interacting entities and influences that produces the life cycle of an organism" (2000, p. 1). Feminist biologist Anne Fausto-Sterling has further refined the DST framework as it applies to gendered/sexed bodies. Preferring the term Dynamic Systems Theory, Fausto-Sterling (2000) argues that sexual variation in brain development, cognitive skills, and hormone fluctuations can be understood at least in part as accumulated or momentary responses to the social inputs and stimuli that humans encounter over their lifetime. This approach is distinct from that of postmodern feminist theorists, such as Judith Butler (1990) and Judith Lorber (1993), in that it understands physiological processes as interacting with—rather than reducible to—social processes.

Parallel efforts to promote complex ontologies of the body are found in critical race scholarship. In addition to problematizing racial categories themselves (Fujimura et al. 2014), social scientists have sought to empirically document how racist social systems and environments "get under the skin" and re-emerge in the body in the form of race-related health disparities (Diez Roux 2011; King 1996; Krieger et al. 1993; LaVeist 1993; Williams 1997). For example, higher rates of poor metabolic outcomes in older black versus white men in the US can be explained by their higher exposure to stress-inducing social inequalities, the effects of which accumulate over their lifetime, rather than "irresponsible" individual behaviors (Das 2013). Abigail Sewell (2016) has shown how patterns of home financing reflect the racial and economic

characteristics of mortgage applicants, leading to lower quality housing for non-white individuals and neighborhoods, which in turn has health effects.

Projects aimed at shifting how social and biological systems are conceptualized and studied reveal the pluralization of both *ontologies* and *epistemologies* of the body. As Annemarie Mol (2003) argues, different medical and scientific practices of the body can produce multiple realities, which rarely align as a single, cohesive ontology. The condition of lower limb atherosclerosis, for example, presents to clinicians as pain on walking, to radiographers as x-ray views of narrowed or blocked vessels, to surgeons as white paste scraped from blood vessels. These multiple practices produce multiple ontologies, or the "body multiple." The relationship between ontology and practice is important here. As Mol writes, "*ontology* is not given in the order of things … instead, ontologies are brought into being, sustained, or allowed to wither away in common, day-to-day, sociomaterial practices (p. 6, emphasis in original).

Mol's insights are relevant beyond the scientific study of the body. Karin Knorr Cetina's (1999) classic account of epistemic cultures documents the different knowledge practices that explain "*how* we know what we know" (p. 1, emphasis added), the heterogeneity of which contribute to the "disunity" of the sciences more broadly (Galison and Stump 1996). Knorr Cetina compares high energy physics and molecular biology, with high energy physics characterized by a reduction of the empirical world to an alternative reality of signs and simulations and a focus on the limits of knowing, or "negative knowledge," while molecular biology is committed to embodied experience and the principles of "blind" variation and "natural" selection, with experimental settings reorganized until they "work" and little concern for understanding when they don't (p. 12). As Knorr Cetina explains, this variation in scientific knowledge practices reflects underlying differences of ontology, or different approaches to "the

kinds of entities, the forms of being, or the structures of existence in an area … the [particular] way the empirical universe happens to be configured into entities or properties" (p. 253).

The approach of scientists to addressing the complexity of a research object, or the extent to which they reduce or maintain a given level of system complexity, has frequently been highlighted in STS scholarship as a dimension that distinguishes different cultures of knowledge (and nonknowledge) (see Frickel and Vincent 2007; Kleinman and Suryanaranan 2012). As characterized by Böschen and colleagues (2010) in their analysis of risk debates in agri-biotechnology and mobile phoning, scientists adhering to a control-oriented epistemic culture may seek to reduce complexity in order to maintain the integrity and reproducibility of their experimental conditions, but produce findings that fail to account for crucial contextual factors or real-world uncertainties. In a complexity-oriented culture, scientists may be open to unanticipated events and uncontrollable or contextual factors but produce results with limited generalizability or predictive power.

The regulatory environments of sport and biomedicine encompass multiple scientific understandings of gender/sex and its relationship to experiences of health and athletic ability. A key axis of variation amongst these heterogeneous approaches to gender/sex is their orientation towards complexity, which shapes claims about both the nature of gender/sex and how it can best be studied. The extent to which an epistemic culture of gender/sex embraces complexity also has institutional implications. As I explore in the following section, rule-makers may prefer regulatory approaches that reduce complexity *despite* their recognition of complex approaches to gender/sex. In both US biomedicine and international sport, rule-makers have preferred to regulate in ways that define sex in binary, reductionist terms.

From Gender/Sex to Sex Difference in Biomedicine

Complex ontological and epistemological approaches to gender/sex have important implications for the scientific investigation of health. A recent pharmaceutical controversy illustrates this point. In late 2013, the Food and Drug Administration (FDA) in the US announced that they were cutting by half the recommended dose for women of Ambien (Zolpidem), a popular sleep aid, following the discovery that they were experiencing higher rates of adverse reactions to the drug (FDA 2013). According to ORWH policy-makers, this outcome reflects fundamental biological sex differences that impact how drugs are metabolized in men versus women (Collins 2017). The case was used to illustrate the consequences of not attending to sex differences in preclinical research (Clayton and Collins 2014). As several FSS scholars have since pointed out, however, women's higher rates of adverse reaction to Zolpidem may in fact reflect average differences in body mass between men and women rather than a fundamental effect of biological sex (Eliot and Richardson 2016; Richardson et al. 2015). Additionally, women may experience higher rates of adverse drug reactions than men since they are generally more likely to be taking multiple medications at one time. Here the cause would be at least partially social, rather than purely biological. In other words, a complex orientation towards gender/sex can result in quite different assumptions about the extent and nature of differences between women and men.

In the late 1990s and early 2000s, policy-makers and biomedical scientists aligned with the women's health movement made it a central project to introduce a discursive distinction between sex and gender into the language of the biomedical sciences. Such efforts were deemed a necessary corrective to the tendency of researchers to use the terminology of gender and sex interchangeably and unreflexively. However, in opting to differentiate gender from sex, the definitions advanced by policy-makers obscured concepts of gender/sex as a complex

entanglement, while simultaneously positioning "social" gender as secondary to or deriving from "biological" sex. Thus, the first insight from the NIH case is that *efforts to regulate inclusion in US biomedicine rely on maintaining the ontological independence of sex from gender, despite recognition of their entanglement*.

In 1999, for example, the NIH released an expansive six-volume report documenting the proceedings of four workshops held in 1996 and 1997 and involving 1500 scientists, policy-makers, and other stakeholders, which were aimed at charting a strategic agenda for women's health research over the proceeding decade (NIH 1999a). The closing volume of the report offered the following hierarchical distinction between gender and sex:

> Sex refers to the classification of living things, generally as male or female, according to their reproductive organs and functions assigned by their biological make-up. Gender refers to a person's self-representation as male or female, or how society responds to that person based on the individual's gender presentation. *Gender is rooted in biology* and shaped by environment and experience. (NIH 1999b, p. 1, emphasis added)

This distinction was offered despite an earlier chapter emphasizing that "although there is the desire to separate that which is biologically determined about sex differences and that which is social, cultural, and environmental, scholars have since argued that neither sex nor gender—nor the relationship between them—can be understood so simplistically" (Fishman et al. 1999, p. 17). The NIH distinction between gender and sex was carried forward over the subsequent two decades and has appeared in various publications, most notably an influential 2001 report by the Institute of Medicine on sex differences (Wizemann and Pardue 2001). As emphasized in the primary message to emerge from the report, "every cell has a sex." Current Director of the NIH Office of Research on Women's Health (ORWH), Janine Clayton, recently reiterated:

> Sex and gender inform various levels of research distinctly. Although sex is a biological attribute relating to genetics, physiology, or anatomy and defines cells and organisms as "male" or "female," gender references behavioral, social, and cultural domains relevant to humans. (Clayton 2016, pp. 519-520)

Sex difference researchers writing in support of the SABV policy have similarly emphasized "the distinction between sex and gender," describing sex as "the biological result of interplay between sex chromosomes and gonadal hormones" and gender as combining "self- and societal perceptions of a person's sex" (McCollough et al. 2014, p. 340). This ontological distinction enables NIH policy-makers to justify their primary investment in the biomedical sciences, as distinct from more interdisciplinary or social scientific approaches to understanding gendered health experiences.

This leads to a second insight, namely: *policy-makers acknowledge the importance of more complex research forms yet promote the pursuit of scientific knowledge forms that affirm sex as distinct from rather than fundamentally entangled with gender*. In their 1999 strategic report for women's health research, for instance, NIH policy-makers referred to the "unquestionable" importance of social and behavioral science to research on women's health (NIH 1999b, 14). They also recognized the importance of research addressing the entanglement of gender/sex. As stated by in the report's opening chapter, "if we do not explore the complex relationship between "nature" and "nurture," how can we conduct appropriate research into health and disease in women and treat them fairly?" (Fishman et al. 1999, 19). Yet, the report ultimately prioritized preclinical research and particularly genomic technology as holding "particular" potential "for uncovering the mechanisms of disease that underlie many women's

health disorders" (NIH 1999b, 31). Two years later, the 2001 IOM report stated the importance of expanding "the direct and intentional study of [sex] differences at the basic cellular and molecular levels" (Wizemann and Pardue 2001, p. 21). Listed first amongst the report's recommendations concerning future research on gender/sex were: to promote research on sex at a cellular level; and second, to study sex differences over the life course, but to do so specifically by "relying on animal models of disease and including sex as a variable in basic and clinical research designs" (p. 5).

Following the announcement of the SABV policy in 2014, statements by NIH policy-makers similarly acknowledged the importance of studying gender as part of translating basic and clinical research findings into specific interventions. However, as stated by Janine Clayton, "much of this research extends beyond the direct reach of NIH funding" (Clayton 2016, 522). In sum, NIH policy-makers have promoted a research agenda that ensures the scientific reproduction of sex as a biological variable whose effects occur separately from those of gender, in the process slowing the advancement of knowledge about the complexities of gender/sex and their entanglement, which is relegated to the realm of a known-but-not-prioritized "unknown" (Gross 2007).

Third, *while policy-makers and biomedical scientists understand that gender/sex is characterized by similarity and overlap between men and women, they overwhelmingly construct sex-based variation in terms of binary differences*. Over the past two decades, there have been frequent references to sex as involving both differences *and* similarities. For example, the 2001 IOM report stated its purpose was to "take stock of what is known about differences and similarities in the basic biology of the sexes" (Wizemann and Pardue 2001, p. ix). Yet the study of *difference* was presented as having the greatest potential for the advancement of the scientific

study of health. As stated, “there are multiple, ubiquitous differences in the basic cellular biochemistries of males and females that can affect an individual’s health” (p. 4). And, “understanding these differences makes it possible to design health care more effectively for individuals, both males and females” and “can offer important insights into underlying biological mechanisms” that influence health (p. ix-x). Similarly, former ORWH Director, Vivian Pinn, wrote in 2005 that “[t]oday’s approach to research on women’s health is to investigate sex/gender differences *or* similarities between women and men” (p. 1407, emphasis added). Yet she also noted that the purpose of NIH inclusion policies was specifically to “determine if *differences* do exist for women, thereby providing information that can be used in sex/gender-specific health care” (p. 1407, emphasis added).

In a 2013 article written by Janine Clayton and Stephanie Joseph (US Food and Drug Administration), these policy-makers described the importance of “understanding the similarities and differences among the sexes that affect health” (p. 2). Despite containing two other references to similarities, the article primarily focused on explaining the importance of “sex differences research” as reflected in the 2010 *NIH Strategic Plan for Women’s Health and Sex Differences Research*. They described the plan’s two central goals as “to increase sex differences research in basic science studies” and “to incorporate findings of sex/gender differences in the design and application of new technologies and medical products” (p. 2). As explained by Clayton four years later at a workshop on the SABV policy, “we know that women and men are both the same and different at the same time [but] knowing when they are different can make all the difference in the world.”

This is not an exhaustive account of the steps taken by policy-makers to reduce the complexity of gender/sex as a focus of biomedical and health research. For instance, feminist

scholars have also highlighted the perils of assuming that gender/sex findings from animal research can simply be translated to humans (Fine et al. 2014; Gungor Duchesne and Bluhm 2019; Richardson et al. 2015), a point that has received little engagement from NIH policy-makers. A key fourth point, however, is that *binary and biological constructions of sex inclusion in biomedicine have been resisted*. For each of the three points elaborated above, policy-makers are aware of more complex constructions of gender/sex and alternative approaches to its scientific study. For example, when the NIH announced the SABV policies in 2014, several prominent FSS scholars and feminist biologists sought to contact policy-makers at the ORWH but found themselves limited to formal channels of mass inclusion with limited impact. As one feminist biologist recalled in an interview, "I reached out to Janine Clayton and we had some e-mail exchanges, I sent her a paper, she said 'oh I already have it, it's actually on our website as a reference for people.' And she let me know at that point they were going to be issuing a call for feedback." As directed, she formally submitted her comments, in which she stated:

> I do not believe that simply comparing male and female cells or animals is an adequate means for understanding the influence of sex/gender on the outcomes of interest, and in fact, I am very concerned that an approach involving male-female comparisons will actually *hamper* our ability to understand these issues in a nuanced and sophisticated way, and will perpetuate unhelpful notions of biological determinism and essentialism.

However, as she reflected, "I don't know to what extent my own comments were influential … I didn't get any specific or direct feedback myself or response to my own comments." Another feminist biologist, who believed that the SABV policy promoted a simplistic approach to sex that may do little to address health outcomes, had similarly sought to communicate with the ORWH. However, she recalled being "very involved [in debates over the SABV policy] in the beginning

and then I felt that I wasn't really listened to and it was just wasting my energy and it was frustrating. So, I am doing my research and showing what I can show." In sum, while the NIH has moved over time towards privileging the preclinical study of sex differences, presumed to be biological and distinct from gender, this trajectory has been contested on multiple occasions since the mid-1990s. However, efforts to redirect policy have often been limited to formal avenues of consultation and stakeholder input, which give the appearance of inclusion and influence—and hence offer legitimacy to policies that result—but in practice have been merely symbolic (Böschen et al. 2010).

Reducing the Female Athlete to Testosterone

In addition to promoting an ontology of gender/sex based on the principle of entanglement, a second way that feminist scholars have sought to reveal the complexity of the gendered/sexed body has been to reveal how binary female/male categories are an inaccurate reflection of how sexual variation actually occurs, particularly by problematizing medical constructions of intersex bodies as pathological (Davis 2015; Fausto-Sterling, 2000; Hird, 2000; Kessler, 1990). As shown by Susan Kessler in her classic study of intersex case management (1990), physicians "hold an incorrigible belief in and insistence upon female and male as the only 'natural' options" for human expressions of biological sex, despite their exposure to intersex bodies providing "incontrovertible evidence" that sex is far from binary (p. 4). The clinical construction of intersex as pathological, which derives from cultural ideologies of sex rather than how sexed bodies *actually* occur, serves to reduce complexity and stabilize the notion that sexual dimorphism is the "natural" state of human variation (Preves 2002). In addition to pushing for changes in the clinical management of intersex variation, which currently promotes involuntary

and irreversible "corrective" surgeries during infancy and childhood, intersex rights movements have pushed for bureaucratic changes across a range of institutional settings to enable the broader recognition and legitimacy of nonbinary gender/sex categories.

In international sport, the struggle to maintain the myth that binary female/male categories are rooted in biology and can be scientifically defined has taken the form of regulating women's participation, specifically by targeting specific biological traits believed to indicate male-like and hence "unfair" advantage. Beginning in the late 1950s, formal regulations began with mandatory genital examinations for all women athletes in Olympic sports and track-and-field in particular, followed by chromosome-based testing from the late 1960s into the 1990s, and most recently, regulations focused on functional naturally occurring testosterone levels. In this area of gender/sex regulation, the reduction of complexity occurs in relation to both sex and athletic ability: first, that the female sex can be determined using a singular biological marker, even for those women with differences of sexual development whose bodies deviate in some way from medical/scientific constructions of binary female/male categories; and, second, that a singular biological marker can be relied upon to explain average differences in the athletic ability of female and male athletes, even though there is considerable overlap between the groups and many factors are known to influence athletic performance.

When the IAAF and IOC formally turned their focus to testosterone in 2011, it was necessary to differentiate the regulations from earlier "gender verification" regimes, since it was widely acknowledged that sports governing bodies could neither scientifically nor ethically make a determination of sex, or in other words, provide a clear answer to the complicated question of which social and biological characteristics constitute a woman (Henne 2014; Karkazis et al. 2012). The IAAF and IOC have thus sought to *avoid the complexity of sex by defining their*

regulatory approach in terms of "unfair" advantage rather than sex determination. As stated by the IOC in 2012, "[n]othing in these [Hyperandrogenism] Regulations is intended to make any determination of sex" (IOC 2012, p. 1). Similarly, when the IAAF released their revised Eligibility Regulations for Female Athletes in 2018, they described them as intended "solely to ensure fair and meaningful competition within the female classification … [and] in no way are they intended as any kind of judgement or questioning of the sex or the gender identity of any athlete" (IAAF 2019, p. 4).

Yet despite this stated commitment, the categorization of women with high testosterone as "female" or "male" does indeed occur under these regulatory regimes. The IOC regulations, for instance, stated that if "[a female] athlete has been declared ineligible to compete in the female category [and does not want to undergo medical treatment to lower her testosterone], the athlete may be eligible to compete as a male athlete" (IOC 2012, p. 1). Similarly, the most recent IAAF Regulations specify that a female athlete who refuses to lower her testosterone may compete in the male category or, when offered, in an "intersex or similar classification" (IAAF 2019, p. 4). In this instance, reference to the possibility of a third category still assumes a straightforward sex determination process and ignores the fact that women in question are clinically classified as female, rather than "intersex" or "male" (Hughes et al. 2006). In other words, the medical construction of the female category is sufficiently complex to incorporate women with naturally high testosterone, a complex categorization rejected by the IOC and IAAF.

The approach of the IOC and IAAF to justifying their categorization efforts in terms of "fairness" rather than "sex" has received quasi-external legitimation from the CAS. In 2015, the CAS accepted that excluding certain women from the female category on the basis of their

biological profile did not constitute a determination of their sex. As stated, “endogenous testosterone … is not being used to determine whether an athlete should compete either as a male or as a female. Instead, it is being used to introduce a new category of ineligible female athletes within the female category” (pp. 147-148). When Semenya brought an appeal to the CAS in 2019, and critiqued IAAF experts for referring to her as a “biological male,” the adjudicating panel responded that it was not their responsibility to assess “the validity of these concepts and the appropriateness of the IAAF's terminology.” Rather, their focus was on whether women with high testosterone “have an athletic advantage over other female athletes” (CAS 2019, p. 133). In other words, the CAS, too, avoided the complexity of sex by focusing on “unfair” advantage, which was effectively sex determination in all but name.

Second, *single-trait approaches to defining the female athlete category have been repeatedly deployed despite the knowledge that they are questioned by scientists*, including those trained in the biology of gender/sex. In other words, rule-makers in international sport impose regulations on female athletes, and often describe their approach as “scientific,” despite their awareness of resistance from scientists. From 1968 until the early 1990s, both the International Olympic Committee (IOC) and IAAF relied on a chromosome test, called the Barr body test, to determine eligibility for female athletes. Over the 1970s and into the 1980s, it became broadly recognized within the scientific community that the technology was being inappropriately applied, since its purpose was not sex determination. In 1972, a group of five Danish researchers working in various medical and scientific fields at the University of Aarhus released a memorandum in which they called for the IOC to stop their use of the sex chromatin test for the purposes of femininity control, arguing that the method was “open to severe criticism for scientific reasons” (p. 6). A geneticist, Dr. Albert de la Chappelle ,wrote repeatedly to the IOC

Medical Commission throughout the 1980s, arguing in 1983 that "the present screening method [was] scientifically unfounded, nearly totally ineffective and sometimes harmful." In a 1988 review of their female eligibility protocol, the IOC Medical Commission acknowledged that "the Barr test with X and Y chromatin has since been widely criticized for its inaccuracies, but although the test was not 100 per cent sure … it was to date the most feasible method available" for regulating the female athlete category.

Scientists have similarly expressed concern about more recent regulatory efforts focused on testosterone. Here scientists have debated whether the IAAF can statistically demonstrate that naturally occurring testosterone *alone* explains performance advantage across female athletes as well as the *average* group differences between male and female athletes. In addition to athletic performance being complex, the complexity of testosterone itself is debated: does the body respond similarly or differently to artificial versus naturally occurring testosterone levels (Pape 2019a)? In other words, do cases of doping—or hormone replacement therapy in transitioning athletes—provide evidence of testosterone's performance enhancing effects, or should normal ranges of testosterone be conceptualized as having a less dramatic effect on the body? Such concerns are known to governing bodies like the IAAF. For instance, following the 2019 ruling by the CAS that the IAAF could continue to rely on testosterone screening to exclude certain women from competing, the World Medical Association (WMA) urged its member physicians to "take no part in implementing [the] regulations" since they were "based on weak evidence from a single study" and are "contrary to a number of key WMA ethical statements and declaration" (WMA 2019). In response, the IAAF rejected the WMA's concerns and argued that the organization ought to endorse medical interventions that are "gender affirming" for women with high testosterone, even when such interventions are not medically necessary (IAAF 2019). In

other words, the IOC and IAAF are committed to regulating female eligibility on the basis of a single biological trait regardless of scientific and medical resistance based on recognition of complexity.

When the CAS ruled in Chand's favor in 2015 by suspending the IAAF's Hyperandrogenism Regulations for two years on the basis that there was *as yet* insufficient evidence to support the exclusion of women with high testosterone, they nevertheless agreed that it would *become possible* to scientifically demonstrate the performance enhancing effects of naturally occurring testosterone. Put differently, the relationship between testosterone and athletic ability was taken as a "known unknown:" a presumed effect that was "merely not yet known" and therefore did not require any fundamental rethinking of the IAAF's regulatory approach (Böschen et al. 2010, p. 786). Not recognized was the possibility of pursuing alternative research agendas that might advance more complex understandings of testosterone, with such questions instead relegated to the realm of the "unknown unknown." The CAS preference for the pursuit of a research agenda that would confirm testosterone as having a straightforward effect on athletic ability occurred despite the adjudicating panel hearing evidence from scientific experts advocating for more complex approaches. Thus, and as in the case of gender/sex inclusion in biomedicine, *the scientific investigation of the complex dynamics of gender/sex and athletic ability does not receive institutional support*.

Critical reflection on the complex institutional dynamics that enable certain areas of scientific research to be "done" while others are left "undone," which has so frequently been the project of STS scholars, was generally missing from the CAS rulings in 2015 and 2019. Instead, an assumption that all science is equal and objective prevailed. In both instances, the Panel presumed that scientific data collection and analysis were being conducted on a fair and level

playing field on which all experts have equal opportunity to pursue research questions driven solely by scientifically derived and politically neutral hypotheses (Pape 2017). However, the institutional position of the IAAF offers both political authority and material resources that give their experts a head start in defining the research questions that will actually get "done." In both 2015 and 2019, concerns were raised about the lack of independent analyses of the data that the IAAF has relied on to justify their regulatory approach, which is the private property of the IAAF and has not been shared so that other researchers can attempt to replicate their findings (or look for alternative relationships) (Pielke 2019). When these concerns were brought to the attention of the CAS in 2019, the adjudicating panel responded that they were, quite simply, "not required to appraise the adequacy of the IAAF's policy-making process" (CAS 2019, p. 145).

While many additional forms of complexity characterize the regulation of women with high testosterone have been denied by the IAAF and IOC and dismissed by the CAS, the final dimension highlighted in this chapter is that *sports governing and adjudicating bodies continue to justify their regulatory approach as nondiscriminatory by failing to recognize how its implementation is influenced in complex ways by the intersection of race, nation, and gender*. In recent years, feminist critiques of these regulatory regimes have expanded to draw attention to the role of race and nation in the regulation of women athletes, particularly in the sport of track-and-field. This is because those women athletes in track-and-field who have been publicly accused in the media over the past decade of having naturally high testosterone have primarily been women of color from India and Sub-Saharan Africa. The over-representation of such women amongst those singled out for scrutiny warrants critical examination, since their achievements in track-and-field events are not particularly exceptional when compared to dominant male athletes or current women's world record holders (Karkazis et al. 2012). Feminist

and critical race scholars have questioned whether race and nation are mediating constructions of "biological femininity" in international sport, with particular implications for the development of women's sport in contexts outside of the Global North (Bohoun, 2015; Cooky, Dycus & Dworkin, 2013; Henne and Pape 2018; Karkazis and Jordan-Young 2018; Nyong'o, 2010).

Feminist social scientists have shown that both the experts involved in drafting the 2011 and 2019 Regulations, and many track-and-field stakeholders, believe that women of color from Global South nations are the legitimate targets of these regulatory efforts. Amongst doctors affiliated with the IAAF, the dominant (and unsubstantiated) narrative is that women with high testosterone are over-represented in Global South nations (Karkazis and Jordan-Young 2018). Elite athletes and coaches have also been found to subscribe the widespread rumor that women with high testosterone from sub-Saharan African nations will be intentionally groomed by national teams and managers in order to dominate international women's track-and-field (Henne and Pape 2018). Since not all women athletes are subjected to testosterone screening—with only those deemed "suspect" subjected to an investigation—such constructions of women of color from the Global South, and Sub-Saharan Africa in particular, greatly increases the chances that the successful athletes amongst them will be targeted under the regulations. However, when such evidence was brought before the CAS in 2015, it was dismissed as "sociological opinion, which does not equate to scientific and clinical knowledge and evidence" (CAS, 2015, p.134). For their part, the IAAF has denied that race and nation play any role in their regulatory approach. As one IAAF witness simplistically stated during the 2019 Semenya appeal, "it's about sex, not race" (CAS 2019, p. 102).

Gendering Institutional Responses to Complexity

The above analysis reveals that regulatory approaches to gender/sex inclusion in US biomedicine and international sport that promote sex as a pure, biological, and binary form of embodied difference are not inevitable. Rather, these institutions are characterized by resistance to efforts to promote an ontological and epistemological shift in how rule-makers think about the nature of and scientific approaches to gender/sex. In the case of US biomedicine, the reduction of complexity enables a particular form of scientific knowledge to remain authoritative—one that understands biological sex as determining health from the cellular level upwards, and thus basic and preclinical science as the most important unexplored frontier for advancing the health of women and men. While feminist critics of this approach are not opposed to these forms of scientific investigation, they urge biomedical scientists and policy-makers to adopt a more nuanced understanding of gender/sex, since failure to do so may result in incomplete knowledge that is ineffective in addressing women's and men's health concerns, and on a broader level, may exacerbate essentialist ways of thinking about biological sex.

The trajectory of gender/sex inclusion pursued by the NIH since the early 1990s is consistent with epistemological shifts in the women's health movement and biomedicine more generally. As various women's health scholars have demonstrated, the women's health movement in the US became increasingly depoliticized and professionalized in the early 1990s, particularly as women increased their presence and training within biomedical fields and their associated paradigms (Clarke and Olesen 1999; Morgen 2002; Ruzek and Becker 1999; Worcester and Whatley 1988). Concurrently, and as Clarke and colleagues theorize (2003), an era of "biomedicalization" was unfolding in which health itself was increasingly being reduced to basic science, supported by the vast political economy of biomedicine. Various social groups have sought to be included in biomedical research under this paradigm (Epstein 2007), making it

yet more difficult to show how (and why) a more complex inclusion paradigm might be institutionalized.

In both sport and biomedicine, resistance to complexity has broader political effects, reflecting the deeply gendered nature of these institutions (Henne 2014; Lorber 1994; Pape 2017). In the case of international sport, rule-makers resist complex accounts of the female athlete body, and testosterone's role within it, for fear that accepting a complex approach to gender/sex categorization will undermine women's sport. In other words, resistance to complexity is driven by a desire to protect existing ideological investments, a move alleged to be in the interests of women who meet normative criteria of biological femininity, in the process concealing the reality that the female category is biologically heterogeneous. The reduction of athletic ability to a single biological trait—testosterone—advances this larger gendered purpose. The legitimating actions of the CAS, which affirm the authority of a "control-oriented" science to define restrictive boundaries for the female category (Böschen et al. 2010), are particularly significant at a time when the boundaries of sex and gender are in flux. In this context, and as IOC and IAAF advisors Eric Vilain (endocrinology) and Maria José Martînez-Patiño (sports science) have argued (2019), sports governing bodies may well have ideological commitments that lead them to prefer reductive rather than complex accounts of gender/sex. However, it is critical that biomedical scientists trained in the complexities of gender/sex make it known that such regulatory efforts are driven by ideology, rather than science.

Beyond gender/sex, STS scholars provide evidence that institutional resistance to complexity is a broader trend. In the case of bee colony collapse in the US, for instance, Kleinman and Suryanarayanan (2012) find evidence of strategic epistemic alliances between honey bee scientists, government regulators, and agrochemical industry officials. In deciding

what counts as evidence of the relationship between toxic chemicals and bee health, these actors ignore and marginalize the anecdotal accounts of beekeepers, which seek to highlight the complex ecological effects of toxic chemicals (p. 509). Agrochemical industry interests are protected as a result, as are the epistemic commitments of academic toxicologists, who retain authority and avoid having to reconfigure the knowledge forms valued by their profession. Similarly, Frickel and Vincent (2007) suggest a need for entirely "new knowledge institutions" that "embrace, rather than deny, the complexity of ecological and social systems in interaction" (p. 187). They use the example of Hurricane Katrina to demonstrate that the Environmental Protection Agency's (EPA) current testing practices for environmental contamination ignore ecological and social complexity, with the result that risks to health may be vastly underestimated. Importantly, when institutions privilege a "control-oriented" approach over the recognition of complexity, there are often benefits for major corporate and industry interests (Böschen et al. 2010).

These political dimensions of complexity warrant further examination from STS scholars, with particular attention to the diverse ways that institutions may seek to avoid ontological and epistemological reordering. The regulatory bodies examined in this chapter are characterized by an unwillingness to consider the opportunities represented by complex approaches to gender/sex. The ongoing international controversy surrounding the IAAF effort to exclude Caster Semenya from competing in the women's 800m suggests has called into question the legitimacy of regulating female eligibility on the basis of their biological characteristics. In this context, governing bodies like the IAAF ought to give serious consideration to how they might establish more transparent, pluralistic, and unbiased approaches to rule-making that make room for more complex orientations towards gender/sex to be institutionalized. While gender/sex inclusion in

biomedicine has not attracted the same level of public scrutiny, the growing field of feminist biology is increasingly presenting policy-makers with empirical evidence that a complexity approach to health is productive for both women and science. It is thus consistent with—rather than counter to—the priorities of the NIH to open up the rule-making process in more meaningful ways and ensure the variety of different epistemic approaches to gender/sex are represented and acknowledged.

CONCLUSION

Institutional actions, rather than nature, produce sex as a biological and binary form of embodied difference. As this dissertation has shown, it is not simply the case that scientists working in laboratory settings produce accounts of sex that affirm their ideological and paradigmatic assumptions, which they acquire through their training and social environment and then re-enact through their practice (Fujimura 2006; Haraway 1988; Lorber 1993; Martin 1991; Nelson 2016; Pitts-Taylor 2016). While this insight from FSS remains critically important, the empirical cases presented in this dissertation show that there are also alternative accounts of gender/sex—as a complex, dynamic entanglement—being produced by biological scientists with different ontological and epistemological commitments. Here the question becomes: why is it the former perspective, and not the latter, that has underpinned and gained institutional support from the regulatory approaches of governing bodies in US biomedicine and international sport? Drawing on both feminist and STS theories of the body, knowledge, and regulation, the four empirical chapters of this dissertation offer explanations focused on the institutional dimensions that differentiate the scientific knowledge about gender/sex that is produced and legitimated from that which remains more marginal.

First, institutional designations of expertise function to reassert the expected boundaries of the female body even when the scientific evidence is contested and inconclusive. In the case of Dutee Chand's appeal to the CAS in 2015, the adjudicating body endorsed in principle the use of testosterone to determine eligibility for the female athlete category, even while acknowledging the complexity of both sex and athletic ability and the presence of unanswered questions about the precise relationship between testosterone and performance. The findings presented in this chapter extend STS accounts of the institutional production of expertise, particularly as it unfolds

in legal settings, by theorizing the role of the body. In addition to the binary sexed body itself emerging from battles to gain epistemological ascendancy in debates over expertise, the achievement of expertise relies on representing the body in politically expedient ways.

Second, the legitimacy of regulatory regimes focused on particular scientific accounts of the gendered/sexed body relies not only on stakeholder buy-in, but also on *stakeholder avoidance* of alternative perspectives that might destabilize existing institutional and ideological commitments. Much of the dynamics of institutional ignorance—the process of turning away from what could otherwise be known about gender/sex—unfold at the ground level via the everyday interactions and actions of stakeholders. This conceptualization stems from sociological approaches to institutions, which focus not only on the formal actions and policies of decision-makers and governing entities, but also on the everyday work of diverse stakeholders in enacting and endorsing a given institutional norm, value, or rule. This everyday work is important, since it grants legitimacy to the regulatory actions of governing bodies and ensures their compliance on the ground. Thus, it is not only the case that regulations shape broader understandings of embodied difference (Epstein 2007). The broader popular forum in which regulatory regimes are legitimized is also characterized by strong attachments to particular notions of embodied difference. Of course, this forum is plural, and the views of the international track-and-field community may not be shared by those outside of the sport (Fraser 1997). Nevertheless, the willingness of these core stakeholders to *turn away from* or *ignore* complex accounts of the sex, testosterone, and the female athlete body is revealed in this dissertation as a key factor enabling the regulatory regimes of the IAAF. Indeed, this is a broader insight that carries across the dissertation: that governing bodies do not operate in a vacuum, and rely on

external validation to institutionalize particular notions of gender/sex through their rule-making practices (Parker and Braithwaite 2003).

Third, different forms of feminism have experienced uneven influence over the regulatory actions of institutions. It is not the case that either the exclusion of women athletes with high testosterone, or the push to produce knowledge about sex differences in biomedicine, are "anti-feminist." Rather, both cases of gender/sex regulation examined here are carried out first and foremost in the name of women's interests, with the interests of science a close second. In the case of US biomedicine, the version of feminism that has become institutionalized and represented in rule-making circles and funding structures is that which does not seek to fundamentally challenge the ascendancy of biomedical models of sex, health, and science, under which the pursuit of scientific knowledge is presumed to be objective and unbiased, particularly when it is uncovering fundamental mechanisms untainted by the influence of social context and gender. Thus, alongside the "disunity of science" explored in the fourth chapter, this dissertation reveals the "disunity of feminism" and its implications for the inclusion of women and their interests within US biomedical institutions. By placing gender/sex inclusion in US biomedicine in historical perspective, and tracing how particular ontological and epistemological commitments have developed over time, it becomes possible to see how current regulatory outcomes were not inevitable but rather were contingent on specific decisions and mobilizing actions, much of which emerged from and remain aligned with a particular form of feminism. As I describe in further detail below, however, for these same historical reasons the US context serves as a very specific example of gender/sex inclusion in biomedicine, and it should be expected that different trajectories unfold in other national contexts with their own histories of feminism, science, and healthcare.

Fourth, regulation in US biomedicine and sport is approached as a process of simplification. In other words, the complexity of gender/sex is approached by decision-makers as something that must be tamed. The reduction of gender/sex complexity becomes a necessary step for women's sport to survive, or for women's bodies and health experiences to be fully understood. In the absence of such steps, gender/sex becomes so unwieldy as to create chaos for the practice of sport and science. This institutional aversion to complexity mirrors the response of medical professionals when they encounter differences of sexual development in infants or young children: natural variation is unsettling for institutions committed to a female/male binary believed to *emerge* from nature rather than being *imposed* upon it. The potential consequences, however, are that biomedical research produces findings with little practical relevance to complex experiences of health or, at the very least, that interdisciplinary and social science research that might make gender/sex complexity an empirical reality remains under-realized. In international sport, resistance to complexity allows investments in particular ideas about sex and testosterone to remain intact, while turning a blind eye other less politicized sources of advantage. For example, the advantages of being a female athlete in a resource-rich nation, which might include access to sports medicine, sports science, and a lucrative college-based sports development system, have avoided scientific measurement and restriction. Women with high testosterone—who are raised women, identify as women, and want to compete as women—are the collateral damage in an institution that is nostalgic about a fictional "simpler time" when the politics of gender/sex were not so complex.

While these four insights are not an exhaustive account of the institutional mechanisms explored in the preceding four chapters, let alone those contained within the large body of data collected for this dissertation project, they point to the productive ways that the insights of FSS,

STS, and sociology of gender can be combined to advance feminist understanding of the ascendancy of certain scientific knowledge claims about gender/sex.

The Future of Feminism, Sport, and Biomedicine

As explored throughout this dissertation, the regulation of gender/sex in biomedicine and sport raises fundamental questions for feminist scholars and movements. Under what circumstances is it advantageous—politically or scientifically—to claim the distinctiveness of women's bodies? For those feminists who adhere to a complex orientation towards gender/sex, how might they better influence regulatory institutions and promote broader shifts in popular understanding of the nature of sex and its relationship to gender?

Both of the cases examined in this dissertation point to the particular difficulty of institutionalizing complex accounts of gender/sex in institutional settings where the inclusion of women has been won on the presumption of biological difference (Epstein 2007). In the case of international sport, women were historically excluded because of an ideology that constructed their bodies as physically inferior and vulnerable. When inclusion was gradually won over time, it was under conditions of segregation that affirmed their inherent inferiority relative to men and the necessity of "protecting" this fragile category (Pape 2019b). In the case of US biomedicine, women were also often excluded as research subjects in clinical trials because of fears about potential harm during pregnancy and the assumption that their hormone cycles were too complex to accommodate within a control-oriented biomedical approach. In both sport and biomedicine, women were ultimately incorporated not because they had proven their similarity to men, but because they had asserted their fundamental difference. In the case of sport, the notion of "protection" has underpinned exclusionary regulations for the female athlete category since their

formal adoption in the late 1950s. In US biomedicine, proponents of "sex difference research" have seen the pursuit of binary differences at the cellular level as beneficial rather than problematic. The challenge for complexity-leaning feminist scholars is to communicate their ontological, epistemological, and political vision in ways that emphasize opportunities and benefits for a diversity of women, rather than appear as threatening hard-fought gains for women in sport and biomedicine.

How might more complex ontologies and epistemologies of the body be incorporated into the regulatory regimes of sport and biomedicine? Future research could investigate variation in institutional approaches to the regulation of gender/sex. In 2015, for instance, Canadian trans athlete Kristen Worley succeeded in challenging the transgender eligibility regulations of the IOC and International Cycling Union by pursuing an appeal through the Human Rights Tribunal of Ontario (HRT). How do human rights proceedings differ from sports arbitration as legal routes for pursuing institutional recognition of complex approaches to gender/sex and female athlete eligibility? Though not the focus of this dissertation, the issue of regulating trans women in international sport has often accompanied public discussions of the place of women with high testosterone. This is despite trans women and women with high testosterone being subject to distinct forms of regulation, revealing that both groups of women unsettle dominant ideas about the female athlete in international sport. While a number of influential women's sports organizations, such as the International Working Group on Women and Sport and the Women's Sports Foundation, have declared their support for Semenya, their position towards trans women remains unclear. Feminist scholars could explore fruitful ways to engage with the regulation of trans participation and support informed and inclusive dialogue amongst stakeholders.

Additionally, studies examining how the regulation of female athlete eligibility intersects with race and nation are few in number. Future research might consider how athletes, coaches, and other stakeholders in targeted nations, such as India and South Africa, experience this issue. Particular efforts should be made to support the scholarship of feminist researchers located in these countries, rather than this topic being monopolized by feminists located in the global "metropole" (Connell 2007; Henne and Pape 2018).

In the case of gender/sex inclusion in biomedicine, future research could consider how the Canadian Institutes of Health Research (CIHR) has come to adopt a more complex regulatory approach. As explored in Chapter Three, US policy-makers have increasingly moved towards defining sex as a binary and biological variable that determines health in fundamental ways at the cellular level. By contrast, Canadian policy-makers take a more balanced approach to the study of gender and sex, including support for interdisciplinary collaboration to better understand how gender and sex interact to influence health outcomes (Clow et al. 2009; Health Canada 2017; Sharman and Johnson 2012). This holistic stance is further underpinned by a commitment to understanding how the health experiences of women, men, and nonbinary people are also influenced by other forms of difference and inequality, such as ethnicity and class (CIHR 2018; Status of Women Canada 2017).

The approach of the CIHR is further distinguished by its Institute of Gender and Health (IGH), established in 2000, which remains the world's only federal research institute of its kind. Moreover, and unlike the NIH, Canadian policy-makers have aligned their regulatory efforts with international policy recommendations and "mainstreaming" discourses on gender and health, even recruiting representatives of the World Health Organization (WHO) to serve on the IGH Advisory Board (Schiebinger 2014; Sen and Östlin 2010; Stewart et al. 2013). Few federal

funding agencies have advanced as far as Canada in the implementation phase (Johnson and Beaudet 2013). As such, the Canadian case offers a rare opportunity to study whether and how a more holistic and internationally recognized approach to the regulation of gender and sex inclusion in biomedical and health research materializes in practice.

Questions to be asked about the Canadian case include: in what ways do the specific organizational structures, processes, and institutional history of the CIHR help to explain its approach to gender and sex inclusion? How has mobilization by external stakeholders mattered to policy development and implementation in Canada? How have Canadian policy-makers sought to mobilize specific external actors—such as international partners and journal editorial boards—in aid of their implementation efforts, and to what effect? On paper, Canadian policy-makers support social, biological, and interdisciplinary research that recognizes intersections with other forms of socially meaningful difference. How have these holistic goals been translated into specific actions, such as funding provisions? Finally, how have different research communities responded to the call for gender and sex inclusion? To what extent have the stated inclusion goals of the CIHR impacted scientific practice, particularly in terms of research agendas, methods, and actual knowledge produced about gender and sex?

Finally, feminist biology is emerging as a growing field, offering an alternative for biomedical scientists who understand the relationship between gender/sex, health, and science in more complex ways. Future research could chart how this field has developed since the 1970s and 1980s, where and how institutional gains have been won, and the actual effects of knowledge emerging from feminist biology on lived experiences of gender/sex embodiment, health interventions, and popular ideas about gender/sex.

REFERENCES

Acker, J. 1990. Hierarchies, jobs, bodies: A theory of gendered organizations. Gender & Society, 4, 139-158.

Azocar, M.J. and M.M. Ferree. 2015. Gendered expertise. Gender & Society 29(6): 841–62.

Beery, A. and I. Zucker. 2011. Sex bias in neuroscience and biomedical research. Neuroscience and Biobehavioral Reviews 35(3): 565-572.

Berg, M. and M. Akrich. 2004. Introduction–Bodies on trial: Performances and politics in medicine and biology. Body & Society 10(2-3): 1–12.

Berman, P.S. 2005. From international law to law and globalization. Columbia Journal of Transnational Law 43(2): 485–556.

Berman, P.S. 2009. The new legal pluralism. Annual Review of Law and Social Science 5: 225–42.

Bermon, S., P.Y. Garnier, A.L. Hirschberg, N. Robinson, S. Giraud, R. Nicoli. . . M.E. Ritzen. 2014. Serum androgen levels in elite female athletes. The Journal of Clinical Endocrinology and Metabolism 99(11): 4328–35.

Bermon, S. and P.Y. Garnier. 2017. Serum androgen levels and their relation to performance in track and field: Mass spectrometry results from 2127 observations in male and female athletes. British Journal of Sports Medicine, 51, 1309-1314.

Birrell, S. and C.C. Cole. 1990. Double fault: Renee Richards and the construction and naturalization of difference. Sociology of Sport Journal, 7, 1-21.

Bleier, R. 1984. Science and Gender: A Critique of Biology and its Theories on Women. New York: Pergamon.

Bleier, R. 1986. Feminist Approaches to Science. New York: Pergamon.

Bohuon, A. 2015. Gender verifications in sport: From an East/West antagonism to a North/South antagonism. The International Journal of the History of Sport 32(7): 965–79.

Böschen, S., K. Kastenhofer, I. Rust, J. Soentgen, and P. Wehling. 2010. Scientific nonknowledge and its political dynamics: The cases of agri-biotechnology and mobile phoning. Science, Technology, & Human Values 35(6): 783–811.

Boston Women's Health Book Collective. 1971. Our Bodies, Our Selves. Boston: New England. Free Press.

Broom, D. 1991. Damned if we do: Contradictions in Women's Health Care. North Sydney: Allen & Unwin.

Butler, J. 1990. Gender Trouble: Feminism and the Subversion of Identity. New York: Routledge.

Cahill, L. 2014. Equal does not equal the same: Sex differences in the human brain. Cerebrum: The Dana Forum on Brain Science, April 1, 2014. Available at: http://dana.org/Cerebrum/2014/Equal_%E2%89%A0_The_Same__Sex_Differences_in_the_Human_Brain/

Canadian Institutes of Health Research (CIHR). 2018. How to integrate sex and gender into research. Accessed June 20, 2018. http://www.cihr-irsc.gc.ca/e/50836.html

Capra, F. 2005. Complexity and life. Theory, Culture & Society 22(5): 33-44.

Cavanagh, S.L and H. Sykes. 2006. Transsexual bodies at the Olympics: The International Olympic Committee's policy on transsexual athletes at the 2004 Athens summer games. Body & Society 12(3): 75–102.

CBS News. 2011. Sex matters: Drugs can affect sexes differently. 60 Minutes, Febuary 9. Available at: https://www.cbsnews.com/news/sex-matters-drugs-can-affect-sexes-differently/

Charles, M. and K. Bradley. 2009. Indulging our gendered selves? Sex segregation by field of study in 44 countries. American Journal of Sociology 114(4): 924-976.

Charmaz, K. 2006. Constructing Grounded Theory: A Practical Guide Through Qualitative Analysis. London: Sage.

Clarey, C. 2009. Gender test after a gold-medal finish. New York Times August 19, 2009. Accessed June 28, 2017. http://www.nytimes.com/2009/08/20/sports/20runner.html

Clarke, A.E. and V.L. Olesen. 1999. Revisioning Women, Health, and Healing: Feminist, Cultural, and Technoscience Perspectives. New York: Routledge.

Clarke, A.E., J.K. Shim, L. Mamo, J.R. Rosket and J.R. Fishman. 2003. Biomedicalization: Technoscientific transformations of health, illness, and U.S. biomedicine. American Sociological Review 68(2): 161-194.

Clayton, J.A. 2016. Studying both sexes: A guiding principle for biomedicine. FASEB 30(2): 519-24.

Clayton, J.A. 2018. Applying the new SABV (Sex as a Biological Variable) policy to research and clinical care. Physiology & Behavior 187: 2-5.

Clayton, J.A. and F.S. Collins. 2014. Policy: NIH to balance sex in cell and animal studies. Nature 509(7500): 282-283.

Clayton, J.A. and S. Joseph. 2013. Why research sex differences and similarities? Medical Physics 40(4).

Clow, B., A. Pederson, M. Haworth-Brockman, and J. Bernier. 2009. Rising to the Challenge: Sex- and Gender-Based Analysis for Health Planning, Policy, and Research in Canada. Halifax, NS: Atlantic Centre of Excellence for Women's Health.

Cole, S.A. 2007. Where the rubber meets the road: Thinking about expert evidence as expert testimony. Villanova Law Review 52(4): 803–42.

Cole, S.A. and A. Bertenthal. 2017. Science, technology, society, and law. Annual Review of Law and Social Science 13: 351–71.

Collins, F.S. and L.A. Tabak. 2014. Policy: NIH plans to enhance reproducibility. Nature 505(7485): 612-613.

Connell, R. 1987. Gender and Power: Society, the Person, and Sexual Politics. Palo Alto, CA: Stanford University Press.

Connell, R. 2007. Southern Theory: The Global Dynamics of Knowledge in Social Science. Cambridge, MA: Polity Press.

Cook, J.A and M.M. Fonow. 1986. Knowledge and women's interests: Issues of epistemology and methodology in feminist sociological research. Sociological Inquiry 56: 2–29.

Cooky, C., R. Dycus and S.L. Dworkin. 2013. "What makes a woman a woman?" versus "our first lady of sport:" A comparative analysis of United States and the South African media coverage of Caster Semenya. Journal of Sport and Social Issues 37(1): 31–56.

Court of Arbitration for Sport (CAS). 2015. CAS 2014/A/3759 Dutee Chand v. Athletics Federation of India (AFI) & The International Association of Athletics Federations (IAAF). Lausanne: Court of Arbitration for Sport.

Court of Arbitration for Sport (CAS). 2019. Semenya, ASA and IAAF: Executive Summary. Lausanne: Court of Arbitration for Sport.

Das, A. 2013. How does race get "under the skin?" Inflammation, weathering, and metabolic problems in later life. Social Science and Medicine 77: 75-83.

Davis, G. 2015. Contesting Intersex: The Dubious Diagnosis. NYU Press: New York.

Diez Roux, A.V. 2011. Complex systems thinking and current impasses in health disparities research. American Journal of Public Health 101(9): 1627–34.

Echols, A. 1989. Daring to be Bad: A History of Radical Feminist Movement in America, 1967-1975. Minneapolis: University of Minnesota Press.

Eisenstein, H. 1996. Inside Agitators: Australian Femocrats and the State. Philadelphia, PA: Temple University Press.

Eliot, L. and S. Richardson. 2016. Sex in context: Limitations of animal studies for addressing human sex/gender neurobehavioral health disparities. Journal of Neuroscience 36(7): 11823-11830.

England, P. 2010. The gender revolution: Uneven and stalled. Gender & Society 24(2): 149-166.

Epstein, S. 2004. Bodily differences and collective identities: The politics of gender and race in biomedical research in the United States. Body & Society 10(2-3): 183–203.

Epstein, S. 2007. Inclusion: The Politics of Difference in Medical Research. Chicago: University of Chicago Press.

Ewig, C. and M.M. Ferree. 2015. Feminist organizing: What's old, what's new? History, trends, and issues. In G. Waylan, K. Celis, J. Kantola, and L. Weldon (eds.) Oxford Handbook of Gender and Politics, pp. 437-461. New York, London: Oxford University Press.

Fausto-Sterling, A. 2000. Sexing the Body: Gender Politics and the Construction of Sexuality. New York: Basic Books.

Fausto-Sterling, A. 2003. Science matters, culture matters. Perspectives in Biology and Medicine 46(1): 109-124.

Fausto-Sterling, A. 2012. The dynamic development of gender variability. Journal of Homosexuality 59(3): 398–421.

Fausto-Sterling, A., C. Garcia Coll, and M. Lamarre. 2012. 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): 1693-1702.

Federal Drug Agency (FDA). 2013. FDA approves new label changes and dosing for zolpidem products and a recommendation to avoid driving the day after using Ambien CR. May 14. Available at: https://www.fda.gov/drugs/drug-safety-and-availability/fda-drug-safety-communication-fda-approves-new-label-changes-and-dosing-zolpidem-products-and

Fine, C. and R.M. Jordan-Young. 2017. We've been labelled 'anti-sex difference' for demanding greater scientific rigour. The Guardian April 6, 2017. Accessed February 11, 2019. https://www.theguardian.com/commentisfree/2017/apr/06/anti-sex-difference-scientific-rigour-gender-research-feminism

Fine, C., D. Joel, A. Kaiser, and G. Rippon. 2014. Reaction to "Equal is not the same: Sex differences in the human brain. Cerebrum: The Dana Forum on Brain Science, December 15. Available at: http://dana.org/Cerebrum/2014/Reaction_to_%E2%80%9CEqual_%E2%89%A0_The_Same__Sex_Differences_in_the_Human_Brain%E2%80%9D/

Fishman, J.R., J.G. Wick and B.A. Koenig. 1999. The Use of 'Sex' and 'Gender' to Define and Characterize Meaningful Differences Between Men and Women. Pp. 15-22 in Agenda for Research on Women's Health for the 21st Century, Volume 1. Bethesda, MD: National Institutes of Health.

Francis, C. and L.A. Tabak. 2014. NIH plans to enhance reproducibility. Nature 505(7485): 612-613.

Fraser, N. 1997. Justice Interruptus: Critical Reflections on the "Postsocialist" Condition. New York, London: Routledge.

Frickel, S., S. Gibbon, J. Howard, J. Kempner, G. Ottinger, and D.J. Hess. 2010. Undone science: Charting social movement and civil society challenges to research agenda setting. Science Technology & Human Values 35(4): 444-473.Frickel, S. & Vincent, M.B. (2007). Hurricane Katrina, contamination, and the unintended organization of ignorance. Technology in Society, 29, 181-188.

Fujimura, J. 2005. Postgenomic futures: Translations across the machine-nature border in systems biology. New Genetics and Society 24(2): 195-225.

Fujimura, J. 2006. Sex genes: A critical sociomaterial approach to the politics and molecular genetics of sex determination. Signs 32(1): 49–82.

Galanter, M. 1975. Afterword: Explaining litigation. Law and Society Review 9(2): 347–68.

Galison, P. and D.J. Stump. 1996. The Disunity of Science: Boundaries, Contexts, and Power. Palo Alto, CA: Stanford University Press.

Gieryn, T. 1999. Cultural Boundaries of Science: Credibility on the Line. Chicago: University of Chicago Press.

Glass, J.L., S. Sassler, Y. Levitte, and K.M. Michelmore. 2013. What's so special about STEM? A comparison of women's retention in STEM and professional occupations. Social Forces 92(2): 723-756.

Gross, M. 2007. The unknown in process: Dynamic connections of ignorance, non-knowledge and related concepts. Current Sociology, 55, 742-759.

Gross, M. & McGoey, L. (2015). Routledge international handbook of ignorance studies. Abingdon, New York: Routledge.

Grosz, E. 1994. Volatile Bodies: Toward a Corporeal Feminism. Bloomington, IN: Indiana University Press.

Hammonds, E. and B. Subramaniam. 2003. A conversation on feminist science studies. Signs 28(3): 923-944.

Haraway, D. 1988. Situated knowledges: The science question in feminism and the privilege of partial perspective. Feminist Studies 14(3): 575–599.

Harding, S. 1986. The Science Question in Feminism. Ithaca, NY: Cornell University Press.

Health Canada. 2017. Health portfolio sex and gender-based analysis policy. Accessed June 20, 2018. https://www.canada.ca/en/health-canada/corporate/transparency/corporate-management-reporting/heath-portfolio-sex-gender-based-analysis-policy.html

Henne, K. 2010. WADA, the promises of law and the landscapes of antidoping regulation. Political and Legal Anthropology Review 33(2): 306–25.

Henne, K. 2014. The 'science' of fair play in sport: Gender and the politics of testing." Signs, 39, 787-812.

Henne, K. 2015. Testing for Athlete Citizenship: Regulating Doping and Sex in Sport. New Brunswick, NJ: Rutgers University Press.

Henne, K. and M. Pape. 2018. Dilemmas of gender and global sports governance: An invitation to Southern theory. Sociology of Sport Journal 35(3): 216-225.

Hess, D. J. 2007. Alternative pathways in science and industry: Activism, innovation, and the environment in an era of globalization. Cambridge, MA: MIT Press.

Hubbard, R. 1983. Have only men evolved? In S. Harding and M.B. Hintakka (eds.) Discovering Reality: Feminist Perspectives on Epistemology, Metaphysics, Methodology, and Philosophy of Science, pp. 45-69. Dordrecht: Kluwer Academic.

Hubbard, R. 1990. The Politics of Women's Biology. New Brunswick, NJ: Rutgers University Press.

Hubbard, R., M.S. Henifin, and B. Fried. 1979. Women Looking at Biology Looking at Women: A Collection of Feminist Critiques. Cambridge: Schenkman.

International Association of Athletics Federations (IAAF). 2011a. IAAF Regulations Governing Eligibility of Females with Hyperandrogenism to Compete in Women's Competition. Appendices. Monaco: IAAF.

International Association of Athletics Federations (IAAF). 2011b. HA Regulations: Explanatory Notes. Monaco: IAAF.

International Association of Athletics Federations (IAAF). 2016. IAAF commitment to healthy and drug-free athletics. Accessed February 20, 2016. http://www.iaaf.org/about-iaaf/medical-anti-doping

International Association of Athletics Federations (IAAF). 2018. IAAF introduces new eligibility regulations for female classification. Accessed April 27, 2018. https://www.iaaf.org/news/press-release/eligibility-regulations-for-female-classifica

International Olympic Committee (IOC). 2012. IOC regulations on female hyperandrogenism. Retrieved from: https://stillmed.olympic.org/Documents/Commissions_PDFfiles/Medical_commission/2012-06-22-IOC-Regulations-on-Female-Hyperandrogenism-eng.pdf

International Olympic Committee (IOC). 2015. Consensus Meeting on Sex Reassignment and Hyperandrogenism. November 2015. Accessed February 20, 2016.

http://www.olympic.org/Documents/Commissions_PDFfiles/Medical_commission/2015-11_ioc_consensus_meeting_on_sex_reassignment_and_hyperandrogenism-en.pdf

Jasanoff, S. 1990. The Fifth Branch: Science Advisers as Policymakers. Cambridge, MA: Harvard University Press.

Jasanoff, S. 1995. Science at the Bar: Law, Science, and Technology in America. Cambridge, MA: Harvard University Press.

Jasanoff, S. 2005. Designs on Nature. Princeton, NJ: Princeton University Press.

Johnson, J.L. and A. Beaudet. 2013. Sex and gender reporting in health research: Why Canada should be a leader. Canadian Journal of Public Health 104(1): 80-81.

Jordan-Young, R.M and K. Karkazis. 2012. Some of their parts: “Gender verification” and elite sports. Anthropology News 53: S1–41.

Kane, M.J. 1995. Resistance/transformation of the oppositional binary: Exposing sport as a continuum. Journal of Sport and Social Issues 19(2): 191–218.

Karkazis, K. and R.M. Jordan-Young. 2018. The powers of testosterone: Obscuring race and regional bias in the regulation of women athletes. Feminist Formations, forthcoming.

Karkazis, K., R.M. Jordan-Young, G. Davis and S. Camporesi. 2012. Out of bounds? A critique of the new policies on hyperandrogenism in elite female athletes. American Journal of Bioethics 12(1): 3–16.

Keller, E.F. 1977. The anomaly of a woman in physics. In S. Ruddick and P. Daniels (eds.) Working it Out: 23 Women Writers, Artists, Scientists and Scholars Talk about Their Lives and Work, pp. 77-91. New York: Pantheon.

Keller, E.F. 1985. Reflections on Gender and Science. New Haven: Yale University Press.

Keller, E.F. 1983. A Feeling for the Organism: The Life and Work of Barbara McClintock. New York: W. H. Freeman and Company.

Keller, E.F. 1987. Women scientists and feminist critics of science. Daedalus 116(4): 77–91.

Keller, E.F. and H. Longino. 1996. Feminism and Science. London, New York: Oxford University Press.

Kempner, J., J.F. Merz and C.L. Bosk. 2011. Forbidden knowledge: Public controversy and the

production of nonknowledge. Sociological Forum, 26, 475-500.

Kessler, S.J. 1990. The medical construction of gender: Case management of intersexed infants. Signs 16(1): 3-26.

King, G. 1996. Institutional racism and the medical/ health complex: A conceptual analysis. Ethnicity & Disease 6(1–2): 30–46.

Kleinman, D.L and S. Suryanarayanan. 2012. Dying bees and the social production of ignorance. Science, Technology, & Human Values 38(4): 492–517.

Kolker, E.S. 2004. Framing as a cultural resource in health social movements: Funding activism and the breast cancer movement in the US 1990-1993. Sociology of Health & Illness 26(6): 820-844.

Knorr-Cetina, K. 1999. Epistemic Cultures: How the Sciences Make Knowledge. Cambridge, MA: Harvard University Press.

Krieger, N., D.L. Rowley, A.A. Herman, B. Avery, and M.T. Phillips. 1993. Racism, sexism, and social class: Implications for studies of health, disease and well-being. American Journal of Preventative Medicine 9: 82-122.

Kuhlmann, E. and B. Babitsch. 2002. Bodies, health, gender—bridging feminist theories and women's health. Women's Studies International Forum 25(4): 433-442.

LaVeist, T.A. 1993. Segregation, poverty, and empowerment: Health consequences for African Americans. Milbank Quarterly 71(1): 41–64.

Lenskyj, H. 1986. Out of Bounds: Women, Sport, and Sexuality. Toronto, Ont: Women's Press.

Lentsch, J. and P. Weingert. 2011. The Politics of Scientific Advice: Institutional Design for Quality Assurance. Cambridge: Cambridge University Press.

Longino, H.E. and E. Hammonds. 1990. In M. Hirsch & E.F. Keller (eds.) Conflicts in Feminism, pp. 164-183. New York: Routledge.

Lopez, J. and J. Scott. 2000. Social Structure. Buckingham, Philadelphia: Open University Press.

Lorber, J. 1993. Believing is seeing: Biology as ideology. Gender & Society 7(4): 568–81.

MacKinnon, C. 1987. Feminism Unmodified: Discourses on Life and Law. Cambridge, MA: Harvard University Press.

Magubane, Z. 2014. Spectacles and scholarship: Caster Semenya, intersex studies, and the problem of race in feminist theory. Signs 39(3): 761–85.

Martin, E. 1991. The egg and the sperm. Signs 16(3): 485–501.

Martin, P.Y. 2005. Rape Work: Victims, Gender and Emotions in Organization and Community Context. New York: Routledge.

Mazure, C. and D.P. Jones. 2015. Twenty years and still counting: Including women as participants and studying sex and gender in biomedical research. BMC Women's Health 15: 94.

McBride, D. and A. Mazur. 2010. The Politics of State Feminism: Innovation in Comparative Research. Philadelphia: Temple University Press.

McCullough, L.D., M.M. McCarthy, and G.J. de Vries. 2014. NIH policy: Status quo is also costly. Nature 510: 340.

McGoey, L. 2007. On the will to ignorance in bureaucracy. Economy and Society 36(20: 212–235.

McGoey, L. 2012. The logic of strategic ignorance. The British Journal of Sociology, 63, 553-576.

Meadow, T. 2010. A rose is a rose: On producing legal classifications. Gender & Society 24(6): 814–37.

Merry, S.E. 1984. Anthropology and the study of alternative dispute resolution. Journal of Legal Education 34: 227–283.

Merry, S.E. 1988. Legal pluralism. Law & Society Review 22(5): 869–896.

Meyerowitz, J. 2002. How Sex has Changed: A History of Transsexuality in the United States. Cambridge, MA: Harvard University Press.

Mol, A. 2003. The Body Multiple: Ontology in Medical Practice. Durham, NC: Duke University Press.

Mol, A. and J. Law. 2004. Embodied action, enacted bodies: The example of Hypoglycaemia. Body & Society 10(2-3): 43–62.

Montini, T. 1996. Gender and emotion in the advocacy for breast cancer informed consent

legislation. Gender and Society 10(1): 9–23.

Morgen, S. 1986. The dynamics of cooptation in a feminist health clinic. Social Science & Medicine 23(2): 201-210.

Moscucci, O. 1990. The Science of Woman: Gynaecology and Gender in England: 1800–1929. New York: Cambridge University Press.

National Institutes of Health (NIH). 2015. "NIH Request for Information: Consideration of Sex as a Biological Variable." Analysis of Public Comments. May 19, 2015. Available at: https://orwh.od.nih.gov/resources/pdf/RFIFinalReport20150520.pdf [Accessed August 12, 2017]

Nelson, L.H. 1995. Preface: Feminism and Science. Synthese 104(3): 329-330.

Nelson, R.L, E.C. Berrey, and L.B. Nielsen. 2008. Divergent paths: Conflicting conceptions of employment discrimination in law and the social sciences. Annual Review of Law and Social Science 4: 103–22.

Nichols, F.H. 2000. History of the women's health movement in the 20th century. Journal of Obstetric, Gynecologic & Neonatal Nursing 29(1): 56-64.

Oakley, A. 1972. Sex, Gender, and Society. New York, NY: Colophon Books.

Offen, K. 1988. Defining Feminism: A Comparative Historical Approach. Signs 14(1): 119-157.

Office of Research on Women's Health (ORWH). 1999. Agenda for Research on Women's Health for the 21st Century. Bethesda, MD: National Institutes of Health.

Office of Research on Women's Health (ORWH). Highlights of NIH Women's Health and Sex Differences Research: 1990-2010. Bethesda, MD: National Institutes of Health.

Oudshoorn, N. 1994. Beyond the Natural Body: An Archeology of Sex Hormones. New York and London: Routledge.

Oyama, S. 2000. Evolution's Eye: A Systems View of the Biology-Culture Divide. Durham, London: Duke University Press.

Pape, M. 2017. The fairest of them all: Gender-determining institutions and the science of sex testing. In: Demos, V.P and M.T. Segal (eds.) Advances in Gender Research 24: Gender Panic, Gender Policy, 177–202. Bingley, UK: Emerald Books.

Pape, M. 2019a. Expertise and Non-Binary Bodies: Sex, Gender and the Case of Dutee Chand. Body & Society. Available at: Available at: https://journals.sagepub.com/doi/10.1177/1357034X19865940

Pape, M. 2019b. Gender segregation and trajectories of organizational change: The underrepresentation of women in sports leadership. Gender & Society. Available at: https://journals.sagepub.com/doi/full/10.1177/0891243219867914

Parker, C. and J. Braithwaite. 2003. Regulation. In: Tushnet, Mark and Cane, Peter (eds) The Oxford Handbook of Legal Studies, 119–145. Oxford: Oxford University Press.

Pieper, L. 2016. Sex testing: Gender policing in women's sports. Urbana, IL: University of Illinois Press.

Pinn, V. 2005. Research on women's health: Progress and opportunities. JAMA 294(11): 1407-1410.

Pinn, V., J.A. Clayton, L. Begg, and S.E. Sass. 2010. Public partnerships for a vision of women's health research. Journal of Women's Health 19(9): 1603-1607.

Pitts-Taylor, V. 2016. The Brain's Body: Neuroscience and Corporeal Politics. Durham, NC: Duke University Press.

Proctor, R. N. & Schiebinger, L. (Eds.) (2008). Agnotology: The making & unmaking of ignorance. Stanford, CA: Stanford University Press.

Rajagopalan, R., A. Nelson, and J.H. Fujimura. 2016. Race and science in the twenty-first century. In U. Felt, R. Fouché, C.A. Miller and L Smith-Doerr (eds.) The Handbook of Science and Technology Studies, pp. 349-378. Cambridge, MA: MIT Press.

Rapp, R. 1999. Testing Women, Testing the Fetus: The Social Impact of Amniocentesis in America. New York: Routledge.

Rhoton, L.A. 2011. Distancing as a gendered barrier: Understanding women scientists' gender practices. Gender & Society 25(6): 696-716.

Richardson, S. 2010. Feminist philosophy of science: History, contributions, and challenges. Synthese 177(3): 337-362.

Richardson, S. 2013. Sex itself: The search or male and female in the human genome. Chicago: University of Chicago Press.

Richardson, S.S., M. Reiches, H. Shattuck-Heidorn, M. Lynne Labonte, and T. Consoli. 2015. "Focus on Preclinical Sex Differences Will Not Address Women's and Men's Health Disparities." Proceedings of the National Academy of Sciences 112(44): 13419-13420.

Rippon, G., R. Jordan-Young, A. Kaiser, and C. Fine. 2014. Recommendations for sex/gender neuroimaging research: Key principles and implications for research design, analysis, and interpretation. Frontiers in Human Neuroscience 8: 650.

Ritz, S. A. 2018. Complexities of addressing sex in cell culture research. Signs, 42, 307-327.

Ritz, S.A., D.M. Antle, J. Côté, K. Deroy, N. Fraleigh, K. Messing, L. Parent, J. St-Pierre, C. Vaillancourt, and D. Mergler. 2014. First steps for integrating sex and gender considerations into basic experimental biomedical research. The FASEB Journal 28(1): 4-13.

Roberts, C. 2007. Messengers of Sex: Hormones, Biomedicine and Feminism. Cambridge: Cambridge University Press.

Roberts, D. 2012. Fatal Invention: How Science, Politics, and Big Business Re-Create Race in the Twenty-first Century. New York: The New Press.

Rosser, S.V. 1988. Women in science and health care: A gender at risk. In S.V. Rosser (ed.) Feminism within the Science and Health Care Profession: Overcoming Resistance, pp. 3-15. New York: Pergamon.

Rubin, G. 1975. The traffic in women: Notes on the 'political economy' of sex. In R. Reiter (ed.) Toward an Anthropology of Women, pp. 157-210. New York: Monthly Review Press.

Ruskai, M.B. 1990. Why women are discouraged from becoming scientists. The Scientist, March 1990.

Ruzek, S.B. and J. Becker. 1999. The women's health movement in the United States: From grassroots activism to professional agendas. JAMWA 54(1): 4-8.

Ruzek, S.B., V.L. Olesen and A.E. Clarke. 1997. Women's Health: Complexities and Differences. Columbus: Ohio State University Press.

Sanz, V. 2017. No way out of the binary: A critical history of the scientific production of sex. Signs 43(1): 1–27.

Schiebinger, L. 2014. Scientific research must take gender into account. Nature 507(7490): 9.

Scott, W. 2014. Institutions and Organizations: Ideas, Interests, and Identities. Fourth Edition. Thousand Oaks, CA: SAGE Publications.

Sen, G. and P. Östlin. 2010. Gender Equity in Health: The Shifting Frontiers of Evidence and Action. New York: Routledge.

Sewell, A.A. 2016. The racism-race reification process: A meso-level political economic framework for understanding racial health disparities. Sociology of Race and Ethnicity 2(4): 402-432.

Sharman, Z. and J.L. Johnson. 2012. Towards the inclusion of gender and sex in health research and funding: An institutional perspective. Social Science & Medicine 74(11): 1812-1816.

Smart, C. 2002. Feminism and the Power of Law (2nd ed.). Hoboken: Taylor and Francis.

Snitow, A. 1990. A gender diary. In M. Hirsch & E.F. Keller (eds.) Conflicts in Feminism, pp. 9-43. New York: Routledge.

Spanier, B. 1995. Im/Partial Science: Gender Ideology in Molecular Biology. Bloomington, IN: Indiana University Press.

Springer, K.W., J.M. Stellman and R.M. Jordan-Young. 2012. Beyond a catalogue of differences: A theoretical frame and good practice guidelines for researching sex/gender in health. Social Science and Medicine 74(11): 1817-1824.

Status of Women Canada. 2017. GBA: Gender-based analysis plus. Accessed June 20, 2018. https://www.swc-cfc.gc.ca/gba-acs/index-en.html

Stewart, M., K.E. Kushner, J. Gray, and D.A. Hart. 2013. Promoting gender equity through health research: Impacts and insights from a Canadian initiative. Global Health Promotion 20(1): 25-38.

Stimpson, C. 1980. The new scholarship about women: The state of the art. Annual Scholarship 1(2): 2-14.

Stimpson, C. and J.N. Burstyn. 1978. Editorial. Signs 4(1): 1-3.

Straubel, M. 2005. Enhancing the performance of the doping court: How the Court of Arbitration for Sport can do its job better. Loyola University of Chicago Law Journal 36(4): 1203–72.

Subramaniam, B. 2009. Moored metamorphoses: A retrospective essay on feminist science

studies. Signs 34(4): 951-980.

Sullivan, C.F. 2011. Gender verification and gender policies in elite sport: Eligibility and “fair play.” Journal of Sport & Social Issues, 35, 400-419.

Suryanarayanan, S. and D.L. Kleinman. 2013. Be(e)coming experts: The controversy over insecticides in the honey bee colony collapse disorder. Social Studies of Science 43(2): 215–40.

Tacke, V. 2001. BSE as an organizational construction: A case study on the globalization of risk. The British Journal of Sociology, 52, 293-312.

Tannenbaum, C. and S. Bekker. 2019. Sex, gender, and sports. British Medical Journal 364(8192): 1120.

Timmermans, S. and T. Iddo. 2012. Theory construction in qualitative research: From grounded theory to abductive analysis. Sociological Theory 30(3): 167–186.

Tuana, N. 1988. The weaker seed: The sexist bias of reproductive theory. Hypatia 3(1): 35–60.

Tuana, N. 2004. Coming to understand: Orgasm and the epistemology of ignorance. Hypatia 19(1): 194–232.

Tuana, N. 2006. The speculum of ignorance: The women’s health movement and epistemologies of ignorance. Hypatia, 21, 1-19.

Urry, J. 2005. The complexity turn. Theory, Culture & Society 22(5): 1-14.

van Anders, S.M. 2012. Testosterone and sexual desire in healthy women and men. Archives of Sexual Behavior 41(6): 1471–84.

van Anders, S.M., J. Steiger, and K.L. Goldey. 2015. Gendered behavior modulates testosterone in women and men. PNAS: Proceedings of the National Academy of Sciences 112: 13805-13810.

Wackwitz, L. 2003. Verifying the myth: Olympic sex testing and the category woman. Women’s Studies International Forum, 26, 553-560.

Wade, L. 2013. The new science of sex difference. Sociology Compass 7(4): 278-293.

Walby, S. 2007. Complexity theory, systems theory, and multiple intersecting social inequalities. Philosophy of the Social Sciences 37(4): 449-470.

West, C. and D.H. Zimmerman. 1987. Doing gender. Gender & Society 1(2): 125-151.

Westbrook, L. 2016. Transforming the sex/gender/sexuality system: The construction of trans categories in the United States." In N. Fischer and S. Seidman (Eds.), Introducing the New Sexuality Studies (pp. 33-42). New York: Routledge.

Westbrook, L. and K. Schilt. 2014. Doing gender, determining gender: Transgender people, gender panics, and the maintenance of the sex/gender/sexuality system. Gender & Society 28(1): 32–57.

Williams, D.R. 1997. Race and health: Basic questions, emerging directions. Annals of Epidemiology 7(5): 322–33.

Wilson, R.A. 2016. Expert evidence on trial: Social researchers in the International Criminal Courtroom. American Ethnologist 43(4): 730–44.

Wizemann, T.M., and M.L. Pardue. 2001. Exploring the Biological Contributions to Human Health: Does Sex Matter? Washington, DC: National Academy Press.

Woodruff, T., M.R. Kibbe, A.S. Paller, F.W. Turek, and C.S. Woolley. 2014. Commentary: "Leaning in" to support sex differences in basic science and clinical research. Endocrinology 155(4): 1181–1183.

Worcester, N. and M. Whatley. 1988. The response of the health care system to the women's health movement: The selling of women's health centers. In S.V. Rosser (ed.) Feminism within the Science and Health Care Profession: Overcoming Resistance, pp. 117-51. New York: Pergamon.

World Anti-Doping Agency (WADA). (2018). Athlete Biological Passport Operating Guidelines. Version 6.1, July 2018. Retrieved from: https://www.wada-ama.org/sites/default/files/resources/files/guidelines_abp_v61_2018_jul_en.pdf

World Medical Association (WMA). 2019. WMA reiterates advice to physicians not to implement IAAF rules on classifying women athletes. Accessed May 3, 2019 at: https://www.wma.net/news-post/wma-reiterates-advice-to-physicians-not-to-implement-iaaf-rules-on-classifying-women-athletes/

Wynne, B. 1992. Misunderstood misunderstanding: Social identities and public uptake of science. Public Understanding of Science 1(3): 281–304.

Wynne, B. 2008. Elephants in the rooms where publics encounter "science"? A response to

Darrin Durant, “Accounting for expertise: Wynne and the autonomy of the lay public.” Public Understanding of Science 17(1): 21–33.

Zippel, K. 2017. Women in Global Science: Advancing Academic Careers through International Collaboration. Palo Alto, CA: Stanford University Press.

Zucker, I. and A.K. Beery. 2010. Males still dominate animal studies. Nature 465(7299): 690.