Gender Bias in Scientific Knowledge and Politics of 'Standard' Human Body

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***ABSTRACT*—Martha nussbaum contends that any society that claims to be just must ensure that all individuals are able to enjoy a set of fundamental capabilities. Among the most essential of these are the capabilities related to bodily health and bodily integrity, which include the ability to live in a healthy body, to be protected from avoidable harm, and to move freely without threat to one's physical safety. This paper uses that standard as its central measure and asks a direct question: does the scientific knowledge governing medicine, drug approval, and vehicle safety actually secure those capabilities for women? Drawing on foucault, harding, fausto-sterling, laqueur, kuhn, longino, schiebinger, fricker, and genevieve lloyd, it argues that the answer is no. The persistent treatment of the male body as the default in biomedical research and engineering design has not been a neutral technical choice. It is a pattern of institutional behaviour that actively erodes the bodily capabilities of women. This paper further argues that gender bias in science is categorically more harmful than gender bias in philosophy: where philosophical exclusion discounts and misnames women's experience, scientific exclusion ends lives.**

I. INTRODUCTION

Imagine two people in identical cars, involved in an identical crash at identical speed. One walks away with minor injuries. The other suffers a broken neck. The difference, however, is not merely accidental. One of them was travelling in a vehicle whose design and safety systems were developed with their body type as the reference point, while the other was not. This asymmetry is not a trivial technical detail but the central concern of this paper.

Martha Nussbaum frames this issue through a seemingly simple but philosophically demanding question: what does a person require in order to live a fully human life? Her answer is a list of central human capabilities.[1] At the foundation sit two that matter more than almost any others: bodily health, defined as the ability to be well, to receive adequate medical care, and to have one's reproductive health respected and bodily integrity, meaning the ability to move freely through the world and to be protected from avoidable physical harm. A society that allows any of its members to fall below the threshold of these capabilities has failed at justice.[2] If Nussbaum is correct, the neglect of the full diversity of human bodies in medical research and engineering design is not a technical limitation. It is a failure of justice, and its consequences are borne by real, living bodies.

II. KNOWLEDGE, POWER, AND THE MAKING OF THE STANDARD BODY

Scientific knowledge does not simply describe the world; it also shapes the way the world is understood. Michel Foucault argues that disciplines such as medicine do not only observe bodies but produce the categories through which bodies become intelligible. Through practices of measurement, classification, and comparison, these disciplines establish norms that define what counts as healthy, normal, or deviant. The body that comes to be treated as the "standard" is therefore not a neutral fact of nature, but the outcome

[1]Martha C. Nussbaum, *Women and Human Development: The Capabilities Approach* 70–96 (Cambridge Univ. Press 2000). See also Martha C. Nussbaum, *Frontiers of Justice: Disability, Nationality, Species Membership* 69–92 (Harvard Univ. Press 2006).

[2]Nussbaum, *Women and Human Development*, *supra* note 1, at 78–80; Nussbaum, *Frontiers of Justice*, *supra* note 1, at 69–92.

of institutional choices about which bodies are studied and taken as representative.[3] A norm built on male physiology and applied universally does not merely misdescribe women's bodies. It actively forecloses their access to the capability of bodily health, because the knowledge systems supporting healthcare were never built with their bodies as a genuine reference point. Thomas Kuhn explains why this is so difficult to dislodge: the male body as universal reference is a paradigmatic assumption,[4] and paradigms are not corrected through ordinary empirical error but require the harder work of a paradigm shift. Helen Longino adds that genuine objectivity requires genuinely diverse research communities.[5] A culture that has historically excluded women as both researchers and research subjects has not been producing objective knowledge. It has been producing knowledge that feels objective from within, but is systematically incomplete.

III. THE HISTORICAL ROOTS OF THE MALE STANDARD IN SCIENTIFIC THOUGHT

Thomas Laqueur's Making Sex traces how, for most of Western medical history, doctors and anatomists worked within a one-sex model: the idea that male and female bodies were variations on a single template, with the male as the original and the female as an incomplete or inverted version of it.[6] The shift to the two-sex model in the eighteenth and nineteenth centuries did not undo the hierarchy.[7] Londa Schiebinger shows that the exclusion of women from scientific practice was not incidental to the knowledge produced but constitutive of it.[8] Anne Fausto-Sterling extends this critique to demonstrate that the neat biological binary of male and female is itself a classification scheme that medical institutions have actively enforced.[9] The male default is the accumulated product of centuries of institutional practice. Correcting it is not a matter of adding a few women to a clinical trial. It requires acknowledging that the foundations of medical knowledge were laid on an assumption that systematically undervalued the bodies of half the population.

IV. BIOMEDICAL RESEARCH AND THE REAL COST OF EXCLUSION

Sandra Harding's idea of strong objectivity requires researchers to reflect on the social context in which knowledge is produced. Rather than assuming that science is automatically neutral, Harding argues that inquiry becomes more objective when it asks critical questions about its own foundations. Questions like who is conducting the research, whose interests influence the questions being asked, and which bodies or experiences are excluded from the data become essential for understanding how claims of neutrality can sometimes conceal systematic patterns of omission.[10] The history of biomedical research offers a case study in what happens when that demand goes unmet. For most of the twentieth century, women were routinely excluded from clinical trials on the methodological grounds that hormonal cycles would complicate results. Cardiovascular disease illustrates precisely how conceptual exclusion produces bodily harm. The standard symptom profile for a heart attack was developed through studies of male patients, centring on chest pain radiating to the left arm. Women more commonly experience fatigue, nausea, shortness of breath, and jaw or back pain. Because diagnostic criteria were built around the male presentation, women's heart attacks were systematically harder to recognise: they were less likely to be admitted for investigation and more likely to be discharged without

[3]Michel Foucault, *Discipline and Punish: The Birth of the Prison* (Alan Sheridan trans., Vintage Books 1977); Michel Foucault, *The History of Sexuality, Vol. 1: An Introduction* (Robert Hurley trans., Pantheon Books 1978).

[4]Thomas S. Kuhn, *The Structure of Scientific Revolutions* 10–23 (Univ. of Chicago Press 1962).

[5]Helen E. Longino, *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry* 62–82 (Princeton Univ. Press 1990).

[6]Thomas Laqueur, *Making Sex: Body and Gender from the Greeks to Freud* 25–62 (Harvard Univ. Press 1990).

[7]Laqueur, *supra* note 6, at 149–192.

[8]Londa Schiebinger, *Has Feminism Changed Science?* 103–130 (Harvard Univ. Press 1999).

[9]Anne Fausto-Sterling, *Sexing the Body: Gender Politics and the Construction of Sexuality* 44–77 (Basic Books 2000).

[10]Sandra Harding, *Whose Science? Whose knowledge? Thinking from Women's Lives* 138–163 (Cornell Univ. Press 1991).

a definitive diagnosis than men with equivalent presentations.[11]

The problem is not only that women are absent from the data. The framing of research questions have assumptions that distort conclusions regardless of how carefully any individual study is conducted. Women are being diagnosed later, treated with drugs calibrated for different physiologies, and assessed through frameworks not designed to capture their experience.[12] Each of these is a failure of bodily health as Nussbaum defines it, and each has been sustained not by malice but by an institutional culture that treated the male body as the human body and saw no reason to question that assumption.

V. CRASH TEST DUMMIES AND THE CAPABILITY OF BODILY INTEGRITY

The history of automotive safety testing shows with equal clarity how the male default erodes bodily integrity. The 50th-percentile male body was adopted as the reference model for crash-test dummies in 1949, and this choice shaped the direction of automotive safety research for decades. Subsequent dummy models, such as Hybrid I, Hybrid II (introduced in 1972), and Hybrid III (1987) continued to rely largely on biomechanical data derived from male bodies. As a result, the standards used to evaluate vehicle safety were built around a narrow definition of the "average" human, while other body types were treated as secondary or approximated through scaled versions of the male model. Female dummies were produced by mathematically scaling down the male model rather than through original female biomechanical research. Only in 2022 did NHTSA propose the THOR-F female dummy for frontal testing.[13] The gap is seventy-three years in which every safety standard governing vehicle occupant protection was built around a male body.

Table 1: Comparative Injury Risk Data, Women vs. Men in Vehicle Crashes of Equivalent Severity

Injury Category	Women	Men	Source
Fatal injury risk (all crashes)	+28%	Baseline	Bose et al. (2011), UVA Center for Applied Biomechanics
Whiplash / cervical injury	+3x higher	Baseline	Kullgren & Krafft (2008), IRCOBI
Lower-extremity injury	+40%	Baseline	NHTSA Traffic Safety Facts (2019)
Airbag-induced injury	+47%	Baseline	Linder et al. (2018), Accident Analysis & Prevention
Seat-belt induced chest injury	+22%	Baseline	Bohman et al. (2011), Traffic Injury Prevention
Serious injury in rear impacts	+72%	Baseline	Sharma et al. (2020), Journal of Safety Research

Sources: Bose et al. (2011); Kullgren & Krafft (2008); NHTSA Traffic Safety Facts (2019); Linder et al. (2018); Bohman et al. (2011); Sharma et al. (2020).

The most significant finding reported in Table 1 appears in the first row: women are approximately 28 percent more likely than men to die in a car crash of the same severity.[14] This estimate is based on analyses that control for major confounding factors, including crash severity, seatbelt use, and vehicle type. Because these variables are held constant, the difference cannot be explained simply by driving behavior or accident conditions, and instead points to structural differences in how vehicle safety systems perform for different bodies.[15] Female bodies differ from male bodies not just in size but in geometry, muscle distribution, bone density, and centre of gravity.[16] The Stanford

[11]Bernadine Healy, *The Yentl Syndrome*, 325 *New Eng. J. Med.* 274 (1991).

[12]U.S. Food & Drug Admin., *Drug Trials Snapshots Summary Report 2020* (2021); Janine Austin Clayton & Francis S. Collins, *Policy: NIH to Balance Sex in Cell and Animal Studies*, 509 *Nature* 282 (2014).

[13]Stanford Gendered Innovations in Science, Health and Medicine, Engineering, and Environment, *Crash Test Dummies: Lack of Data on How Females Respond to Car Crashes Threatens Women's Safety* (Londa Schiebinger ed., Stanford Univ. 2014), https://genderedinnovations.stanford.edu/cases/crash-test-dummies.html (last visited Mar. 1, 2026).

[14]Donna Bose, Marcie Segui-Gomez & John D. Crandall, *Vulnerability of Female Drivers Involved in Motor Vehicle Crashes: An Analysis of US Population at Risk*, 51 *Am. J. Pub. Health* 2368 (2011).

[15]Anders Kullgren & Maria Krafft, *Gender Analyses of Neck Injuries in Car Crashes*, IRCOBI Conference Proceedings (Bern, 2008).

[16]Astrid Linder & Matthew Kent Surber, *The Requirements for a Female Crash Test Dummy in Vehicle Safety Testing: Findings from a Swedish Research Project*, 114 *Accident Analysis & Prevention* 47 (2018).

Gendered Innovations project describes the consequence as false assurance of safety, and that description is difficult to dispute.[17] When a state certifies a vehicle as safe on the basis of tests that systematically underestimate injury risk for female occupants, it has made a representation to the public that it has not actually verified.

VI. FROM IDEAS TO INJURIES: WHY GENDER BIAS IN SCIENCE IS CATEGORICALLY WORSE

There is a common assumption that the type of harm caused by gender bias varies by field. In philosophy, the harm is conceptual: theories are incomplete, certain kinds of experience go unnamed, the discourse suffers. In science, the harm is material: it shows up in delayed diagnoses, adverse drug reactions, and avoidable deaths. This section argues that the distinction, while descriptively useful, fundamentally understates the specific gravity of scientific exclusion. Gender bias in science is not merely a variant of the same problem found elsewhere. It is categorically more harmful, more structurally deliberate, and more immediately lethal than gender bias in philosophy or any other humanistic discipline.

A. Philosophy's Exclusion and Its Limits

Genevieve Lloyd's The Man of Reason remains the most penetrating account of how Western philosophy encoded gender into its most fundamental categories.[18] Lloyd traces, from Plato through Descartes to Kant, the sustained philosophical project of associating reason, the highest human faculty, with masculinity, while associating femininity with emotion, irrationality, and bodily nature. The result was not merely that women were excluded from philosophical discourse. The concept of reason itself was constructed so that full rational agency was, by definition, male-coded. Women who attempted to enter what philosophy described as the domain of reason were often expected to distance themselves from their own embodied experiences. To be taken seriously, they had to discipline, suppress, or set aside traits that philosophical traditions had long associated with femininity, because these traits were treated as incompatible with rationality. In this way, participation in the life of reason frequently required conformity to standards that had been defined around a masculine ideal of the thinking subject.

This philosophical architecture had real consequences. Courts in the nineteenth century drew on the accumulated weight of a tradition that had never imagined women as the relevant legal actor. The case of Jex-Blake v. Senatus of the University of Edinburgh in 1873 is one of many examples.[19] The conceptual exclusion had become institutional exclusion, which had become exclusion from the capability of practical reason and affiliation. Miranda Fricker's notion of hermeneutical injustice captures this problem with particular clarity. Hermeneutical injustice arises when the shared interpretive frameworks within a society are insufficient to make sense of certain kinds of experience, leaving some individuals without the conceptual resources needed to understand or communicate what is happening to them. In such cases, the harm is not only social but epistemic.[20] A woman whose pain is dismissed as hysteria rather than recognized as a medical condition, or whose moral judgment is described as emotional rather than principled, is not simply being mischaracterized; she is being denied the very language required to describe her own experience with accuracy.

B. Why Scientific Exclusion Is Worse: The Directness of Bodily Harm

What separates scientific exclusion from philosophical exclusion is the directness of the pathway from conceptual error to bodily harm. Philosophy excluded women from the life of reason. Science excludes women from the data that determines whether the drug administered to them will work, whether the car around them will protect them, whether the diagnostic criteria their doctor applies will recognise what is happening in their body. The harm is not to their

[17] Stanford Univ., Gendered Innovations: Crash Test Dummies, Gendered Innovations Project, https://genderedinnovations.stanford.edu

[18] Genevieve Lloyd, *The Man of Reason: "Male" and "Female" in Western Philosophy* (Methuen 1984).

[19] *Jex-Blake v. Senatus of the University of Edinburgh*, (1873) 11 M. 784. See also Rosemary Auchmuty, *Whatever Happened to Miss Bebb? Bebb v The Law Society and Women's Legal History*, 31 *Legal Studies* 199 (2011).

[20] Miranda Fricker, *Epistemic Injustice: Power and the Ethics of Knowing* 7–29, 147–175 (Oxford Univ. Press 2007).

intellectual standing or their conceptual representation. It is to the body itself.

The contrast is precise. Lloyd shows that philosophy's association of femininity with bodily nature and irrationality discounted the lived experience of women by treating it as philosophically unserious. The harm was primarily representational. The woman whose experience was philosophically unnamed could still, in principle, receive the same medical treatment as her male counterpart. Conceptual exclusion and physical safety could, at least in theory, coexist. Scientific exclusion forecloses that possibility entirely. When women are excluded from clinical trials, the knowledge produced does not apply to their bodies. There is no act of interpretive effort that can translate a male-derived drug calibration into a reliable guide to female physiology. When diagnostic criteria are built from male symptom profiles, a woman presenting at an emergency room cannot reason her way to a correct diagnosis. When crash-test standards are built around a male body, the airbag deploys against a torso it was never designed to protect. The conceptual gap closes off physical protection. That is a categorically different kind of harm.

C. Deliberateness and Institutional Accountability

Philosophy's exclusion of women was, for much of its history, the product of unexamined cultural assumption. The philosophers who coded reason as masculine were drawing on deep social presumptions that few had occasion to question. The exclusion of women from biomedical research and engineering safety standards was, by contrast, an explicit and documented institutional choice. The NIH excluded women from clinical trial requirements until 1993. Regulatory bodies-built crash-test standards around a male dummy in 1949 and maintained those standards without fundamental revision for over seven decades. These were bureaucratic decisions made by named institutions, operating under legal authority, with the resources and expertise to know what they were doing. When those institutions published safety certifications, they were making affirmative representations to the public, including to women, that safety systems had been tested and found adequate. Those representations were false. Philosophy never made that kind of guarantee. Science did.

D. Philosophy's Exclusion as the Intellectual Scaffolding for Science's

There is a final and more troubling relationship between the two forms of exclusion. Lloyd's analysis reveals that philosophical gender bias helped create the conditions under which scientific bias could sustain itself unchallenged. By coding embodied experience as philosophically unserious and associating the authority of knowledge with the detachment of masculine reason, Western philosophy produced a framework in which the exclusion of women from scientific data appeared not as a political choice but as an epistemological necessity. If women's experience is inherently subjective and theoretically unreliable, as the tradition Lloyd traces consistently implied, then excluding it from rigorous empirical inquiry seems like rigour rather than discrimination. Science's bias was able to present itself as objectivity partly because philosophy had already built an architecture in which objectivity and maleness were structurally aligned. Dismantling scientific gender bias therefore requires the harder prior work of dismantling that philosophical framework. But the urgency of that work is proportionate to the material harm it enables. Harm measured not in conceptual omissions but in preventable deaths.

VII. TAKING CAPABILITIES SERIOUSLY: WHAT SCIENCE OWES TO JUSTICE

Nussbaum's central claim is that a society that allows its members to fall below the threshold of central human capabilities has failed at justice.[21] A woman whose heart attack is misdiagnosed because her symptoms do not match male-derived diagnostic criteria has not had her capability of bodily health secured. A woman who is 28% more likely to die in a crash of equivalent severity has not had her capability of bodily integrity secured. She has the formal right to use the roads, but the protection those standards actually deliver to her body is measurably lesser. That is not bodily integrity. It is the appearance of bodily integrity, distributed unevenly along lines of sex.

[21]Nussbaum, *Frontiers of Justice*, *supra* note 1, at 167–172.

Amartya Sen's account of adaptive preferences adds a further dimension: people systematically deprived of a capability tend to adjust their expectations and come to regard inadequate provision as normal.[22] Women who have been told throughout their medical histories that their symptoms are 'atypical' in relation to a male standard may become less likely to seek emergency care promptly. This is precisely why Nussbaum insists on substantive rather than formal capabilities: formal rights allow adaptive preferences to go unexamined, while a genuine capability standard requires that the system actually deliver what people need. Where scientific institutions receive public funding and produce knowledge that feeds into regulatory standards, they are part of the apparatus through which the state discharges its justice obligations. When NIH-funded research systematically excluded women for decades, it was directing public resources toward producing incomplete knowledge and then applying that knowledge to the excluded population.

VIII. CONCLUSION: THE BODY THE SYSTEM FORGOT

This paper began with a simple image: two people in the same crash, one far more likely to die. It not because of anything about them individually, but because of institutional choices made by people they never had occasion to think about. There is a real person in that car. She expects that the safety system around her was built to protect her. It was not.

Gender bias in philosophy, as Genevieve Lloyd demonstrates, erased women from the map of rational selfhood. It told them, in the voice of the Western tradition's highest authority, that their experience was too bodily and too emotional to count as serious thought. That is a profound harm. But it is a harm that operated at the level of representation and institutional standing. Gender bias in science operates at the level of the body itself. Every time a woman drives a car safety-tested on a body unlike hers, every time she takes a drug calibrated on trials that excluded her, every time she presents at an emergency room with symptoms the textbook was not written to recognise, she encounters a system that was never designed to preserve her life.

The corrections that follow are specific. Clinical trials must include women as a requirement, not an aspiration, with results reported by sex as a condition of regulatory approval. Engineering safety standards must be rebuilt from original female biomechanical research, not scaled male models. Regulatory bodies must audit existing standards for embedded demographic assumptions and justify publicly any assumption they retain. These are not aspirational goals. They are what Nussbaum would call the minimum requirements of justice that law has both the tools and the obligation to enforce.

[22] Amartya Sen, *Development as Freedom* 62–63 (Oxford Univ. Press 1999).