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1 FROM EMBODYING INJUSTICE TO EMBODYING EQUITY

EMBODIED TRUTHS AND THE ECOSOCIAL THEORY OF DISEASE DISTRIBUTION

Is it a mystery that people subjected to economic deprivation, discrimination, and hazardous working and living conditions, compounded by histories of enslavement and colonization, typically have worse health, have worse health care, and die younger than people with economic, social, and legal privileges?[1] It shouldn't be. Observations about associations between societal power, position, and health status, that is, the societal patterning of population health, appear in the earliest known medical writings, dating back several millennia—for example, in texts from the ancient Egyptian, Greek, Indian, and Chinese civilizations, to name a few.[2] Systematic documentation of such associations was also central to many of the founding reports, in the mid-19th century CE, of the field of public health in Europe and the Americas.[3]

However, it is one thing to observe an association. It is another to explain it. This is why theory, causal assumptions, and frameworks are key, not just the observable "facts."

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Ecosocial Theory, Embodied Truths, and Health Justice: Parsing Population Health Patterns

The crux of the argument, as conventionally posed, is who bears responsibility for the observed social patterning of population health: individuals or their societal context, past and present?[4]

The stakes in this debate are high since they concern accountability—and these debates repeatedly founder on the ubiquitous individual/population divide that permeates both individualistic and social analyses of health. The standard poles of the argument are as follows:

- If the fault for poor health, or the privilege and praise for good health, lies within individuals, their innate biology, and the social groups with whom they individually and independently choose to affiliate, then, per the dominant status quo framing, social group differences in health are simply a reflection of innate biology, values, and choices.[5] Health, from this standpoint, is an individual resource.
- If, however, responsibility lies within societal systems in which some groups have power at another group's expense, in ways that affect options for living a healthy life, then the social group differences in health constitute health inequities, that is, differences in health status that are unfair, avoidable, and in principle preventable.[6] Health, from this standpoint, is socially contingent, and improving health equity becomes a collective resource.

The rub is that the computation of population rates—be they of birth, health, illness, or death—requires counting individuals in both in the numerator (i.e., the "cases") and denominator (i.e., the population in which the "cases" emerge). Does this mean that population health simply reflects aggregated individual health status? No. But it takes a new way of theorizing health—as *emergent embodied phenotypes*—to understand, explain, and act to change the *embodied truths* of population health.

This book enters these debates with three premises:

- First, the familiar framing of individual versus society is dangerously wrong, especially in relation to health. On our planet Earth, no individual (of any species) ever lives—or ails or dies—separate from this world. Rather, we inhabit a planet in which every living being necessarily (1) is simultaneously an individual and part of a population shaped by its history, and (2) engages dynamically with members of their own and other species in their broader ecological context.[7]
- Second, every living being's body tells stories of its experiences[8]—what I here newly term *embodied truths*—which both reflect and shape its engagement with other organisms and the rest of the biophysical world. Stated another way, all organisms live their phenotype(s), not genotype—and this phenotype is not fixed.[9] What we live is our *emergent embodied phenotype*,[10] one that emerges through engagement with the dynamic social and biophysical features of the dynamic changing world we inhabit and alter. A corollary is that the *embodied truths of individuals' lives are inseparable from the embodied*

truths revealed by analysis of distribution and causes of population rates of health, disease, and well-being.

- Third, the reason to analyze health inequities is not to prove that injustice is wrong, since injustice is wrong by definition.[11] Rather, the point is to illuminate how both injustice and equity can respectively shape people's health and the health of our planet for bad and for good, so as to guide action and allocation of resources for prevention, redress, accountability, and change.[12]

In this first chapter, I accordingly introduce key concepts and arguments concerning embodiment and people's health, as grounded in the ecosocial theory of disease distribution.[13] In Chapter 2, I provide a range of supporting empirical examples. In Chapter 3, I step back and consider the critical challenges and contributions the *ecosocial* constructs of *embodiment*, *embodying (in)justice*, *emergent embodied phenotypes*, and *embodied truths* can offer for sparking new questions and producing new scientific knowledge that can help advance health justice in its myriad forms.

Debating "Individual" Versus "Social" Causes of Health and "Gene-Environment Interaction": "Déjà Vu All Over Again"[14]

One can be forgiven a deep sense of fatigue when jumping into current controversies over causes and patterns of population health. However, some background and context is necessary. Given the stakes, it should be no surprise that current debates still follow contours of contention—individual versus societal responsibility for population health—traced out over two centuries ago in the founding documents of the field of public health.[15] They likewise echo the worldwide arguments over eugenics in the 1920s–1940s

spurred both by US Jim Crow and anti-immigration politics and, related, by Nazi and other fascist regimes.[16] They are once again rehearsed in contemporary clashes over whether racial/ethnic health divides reflect "cultures of poverty" and "Black pathology" versus structural racism.[17]

Nor are these debates unique to public health. Again, not surprisingly, given the stakes, parallel arguments pitting individuals versus society—as causal agents, as units of analysis—are littered across kindred fields, including sociology, anthropology, economics, medicine, medical and health geography, psychology, philosophy, and science and technology studies, to name a few.[18] The ubiquity and persistence of these debates, endlessly updated with the latest evidence afforded by whatever the newest technology permits, attests to relationships between the causal frameworks public health scientists and other scholars use—and contest—and the political and societal systems and issues at stake.[19]

In the case of public health, what specifically is at issue is whether, as noted earlier, social group differences in health status are (1) "natural" and fair, versus (2) societal in origin and unfair. Framed in terms of "bodies," the core causal question is whether causal agency and explanations for population health patterns

1. reside in individuals, by virtue of their innate biology—aka the "body natural"—and their individually chosen or possibly genetically determined behaviors, values, and social group or cultural affiliations,[20] versus
2. reside in the "body politic"—aka the priorities, policies, and practices of the political and economic systems governing the conditions in which individuals live.[21]

In the first case, population patterns of health simply arise from the aggregation of individuals, and the corresponding interventions, whether biomedical or behavioral, are focused on individuals. In the second case, population patterns of health reflect societally structured ways of living, thus requiring interventions focused on equitable societal changes to enable healthier living. While both accounts can (and should) recognize that inherently stochastic random events can affect both individual risk and population rates of disease, they differ in whether they frame these chance occurrences (for good or for bad) as being a matter of private individual luck versus socially structured chance.[22]

Of course, the posing of an "either/or" argument is stark—and can be viewed as a simplistic polemic.[23] The past half-century's conventional "solution" has been to proffer "gene × environment interaction" (GEI) as an alternative.[24] But this "solution" remains vexed by problems it cannot solve. First, contention continues over what and who counts as "the environment"—since entities comprising "not genes" can variously extend anywhere from non-DNA molecules within cells to macroeconomic systems.[25] Second, in the case of living beings, "genes" don't interact with environments: organisms do.[26] While analysis of literally disembodied genes (as well as genes inserted from one type of organism into another) can be designed and executed in laboratories, that is not the same as the lived experience of genomes becoming expressed as emergent embodied phenotypes.[27] The seeming "concreteness" of seemingly apolitical "genes" versus the "fuzziness" and perhaps more readily politicized "environments," and the greater possibilities for the "manipulation" of the former versus the latter by empirically oriented health scientists, means

that "genes" consistently get first seat for funding and causal attention.[28]

Beyond this, GEI founders on the terms of debate set by the first explicit partitioning of "nature versus nurture" as propounded in the late 19th century CE by Sir Francis Galton (1822–1911)—an English Victorian elite investigator who came down squarely on the "nature" side and, related, coined the term "eugenics."[29] Since then, endless debates, in and outside of public health, have vigorously disputed which matters more.[30] One repeated and profoundly erroneous exercise has been to try to apportion the respective causal contributions so that the sum adds up to 100%—for example, 10% genetic, 90% environmental, or 70% genetic, 30% environmental.[31] These exercises, however, profoundly and wrongly ignore what interaction entails. Specifically: interaction—whether between "genes" and "the environment," or between multiple genes, or between different components of "the environment"—by definition means the sums must add up to more than 100%.[32]

It is not a new insight that taking interaction seriously requires understanding that "nature" and "nurture" cannot be neatly partitioned. In the 1930s, Lancelot Hogben (1895–1975), a prominent medical statistician, experimental zoologist, and population geneticist, first formally introduced the fundamental concept of the "interdependence of nature and nurture."[33] He demonstrated mathematically, and with real-world data, that the very question of "which matters more" is at its core fallacious. If, say, a plant and its clones on average grow only 3 inches tall in soil type A, but its numerous clones on average grow 6 inches tall in soil type B, then there is not one answer to how tall a plant will grow, given its genome, because it depends on context. By implication, if two

independent causes contribute to an outcome, and their interaction also contributes, then the causal contribution of the two causes necessarily adds up to more than 100%.[34] This interdependence of nature and nurture, moreover, is built into the very essence of life on Earth, because an organism's gene expression and phenotypic development across the lifecourse necessarily depends on its dynamic interactions with the complex changing biophysical and social world in which it originates (by asexual or sexual reproduction), lives, and dies.[35]

Further complicating the picture, new evidence indicates that an individual organism's biological development (e.g., from zygote to adult) can require both "external cues" and the literal incorporation of other beings (e.g., the microbiome), leading new scholarship to posit that the conventional human construct of the "inside/outside" divide—of individual bodies versus context—may be deeply artificial.[36] The larger point is that simply saying both "genes" and "environment"—or "individuals" and "society"—matter for population health affords little clarity for critically analyzing causes of observed population patterns of health within and across diverse societies, over time.

Embodying (In)justice and Embodied Truths in Context: Critical Ideas in Contentious Times

Still another set of arguments point to why critical engagement with debates over "individual" versus "societal" causes of population health patterns is necessary—and why grappling with embodying (in)justice may be helpful. All involve intensifying conflicts regarding "truth" and science.[37]

I write this book at a time when "dark money" and overt political donations are increasingly funding efforts to seed doubt and deception about scientific findings—especially regarding climate change and COVID-19—that inconveniently challenge current structures of power, both secular and religious.[38] Monetary support and political clout are provided by ultra-rich families and corporations who believe the sole purpose of government is to protect their private property, especially those whose wealth depends on the fossil fuel and petrochemical industries, along with those invested in Big Food and Big Pharma, tobacco, alcohol, weapons, and financial speculation.[39] Meanwhile, religious fundamentalists in the major denominations worldwide—especially Judeo-Christian and Islamic—are ramping up their fight against what they refer to as "gender ideology," with their polemics dismissing if not denouncing any scientific evidence that supports laws and policies that promote gender equality, reproductive rights, or civil and political rights for lesbian, gay, bisexual, and transgender people.[40] Within scientific communities, yet another set of longstanding debates are again heating up over the nature of scientific objectivity and whether or not ideological beliefs can bias who becomes scientists and the science they produce, especially in relation to race/ethnicity and gender.[41]

Tellingly, despite their distinctions, all three sets of controversies strikingly revolve around what I would term *embodied truths*—that is, evidence regarding the people's health.

Why? Because when the impacts of ideas, policies, and laws become measured by metrics of health, especially human health, the evidence crosses over from being a matter of opinion to a matter of life and death. Such evidence has standing not only in the court

of public opinion but also in courts of law (at least in countries not subjected to authoritarian and/or corrupt rule).[42] It is bodily evidence that links the "body natural" to the "body politic" and illuminates the impacts of governments' priorities on both the people's health and planetary health.

Even more bluntly: the evidence afforded by "embodied truths" raises the stakes. Once scientific evidence exists to show that the actions of some are harming the health of others—whether in relation to pollution, climate change, commercial products, infectious disease, second-hand tobacco smoke, or social and economic policies—the grounds shift vis-a-vis issues of liability, prevention, and even reparations.[43] The terrain of debate and action likewise shifts once evidence exists to show how human action can improve population health, planetary health, and health equity.[44]

The fundamental importance of "embodied truths" explains why it is no accident that the emergence of the professional field of public health in the mid-1800s was heralded by a series of pathbreaking landmark governmental reports—and nongovernmental critiques—regarding the health of the population in relation to social and economic conditions. The trigger was the rapid rise in England and other European countries of a new coal- and steam-powered industrial factory system joined with intensified land enclosures and imperial expansions of global commerce and investments.[45] Together these created two enmeshed and co-defining groups: a dominating new political class of self-proclaimed capitalists, coupled with vast new precariously employed and housed sickly urban populations whose terrible health and political unrest posed a challenge to governance, commerce, and investments.[46] Responding to these conditions, the iconic

1842 *Report on the Sanitary Condition of the Labouring Population in Great Britain*, presented by Edwin Chadwick (1800–1890) to both Houses of Parliament, "by Command of Her Majesty,"[47] was the first massive government report of its kind and set the basis for the world's first modern public health laws, agencies, and action. Yet, whereas the official government reports focused principally on the need for better sanitation and better morals, numerous influential nongovernmental exposés laid bare the class politics responsible for these "embodied truths," including Flora Tristan's 1842 *Promenades dans Londres: L'Aristocracie et les Prolétaires Anglais* and Friedrich Engel's 1845 *The Condition of the Working Class in England*.[48]

Such "embodied truths" played a similar role in the United States, albeit in relation to not only class but also racialized patterns of health. In 1845, in a critical work akin to Engel's, John Griscom published *The Sanitary Condition of the Laboring Population of New York with Suggestions for Its Improvement*.[49] In 1847, the American Statistical Association, founded in Boston, Massachusetts, in 1839, issued its first publication, which notably included critical data on the health of American Indians and "Negroes," both enslaved and free, and concluded with a petition to the state of Massachusetts asking for a report on the health of the population.[50] In response, in 1850 the landmark state-commissioned review, the *Report of the Sanitary Commission of Massachusetts*, was published; its authors, led by Lemuel Shattuck (1793–1859), one of the founders of the American Statistical Association, had been "appointed under a resolve of the legislature of Massachusetts."[51] Like the Chadwick report that inspired it, the Shattuck Report shaped the formation of both US state

and national public health agencies and laws.[52] Moreover, challenging government policies, during the 1850s and 1860s the first wave of credentialed US Black physicians—including Dr. James McCune Smith (1813–1865), Dr. John S. Rock (1825–1866), and Dr. Rebecca L. Crumpler (1831–1895)—published powerful critiques, informed by health data, to challenge both slavery and dominant ideologies of scientific racism, white supremacy, and racial inferiority.[53] The history of anti-racist science is long, having long been in contestation with racist science.[54]

Jumping to the late 20th and early 21st century CE, the stakes embroiled in "embodied truths" remain high. In 1977, reflecting growing concerns that universal health care, as epitomized by the United Kingdom's National Health Service (NHS), could not alone secure everyone the right to health, the UK Labor Government commissioned the 1980 *Black Report*, named after its chairman, Sir Douglas Black (1913–2002), and coauthored with Peter Townsend, Jerry Morris, and Cyril Smith.[55] The report's documentation and analysis of profound class gradients in health across the lifecourse sparked new rounds of government-issued reports on social class inequities in health worldwide, setting a model followed by myriad global, state, and local health agencies to this day. Globally, the 1978 Declaration of Alma Ata, cosponsored by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), declared: "The existing gross inequality in the health status of the people particularly between developed and developing countries as well as within countries is politically, socially and economically unacceptable and is, therefore, of common concern to all countries."[56] Together, these influential documents posited that people's health

status reflected and revealed political and economic priorities and conditions, and prescribed societal changes needed to promote equity and well-being.

Their arguments, however, were not heeded—and, rather, were resolutely rejected—by the post-1980 global neoliberal economic policies that imposed austerity budgets, deregulation (including rollbacks of public health regulations), and defunding of the public sector (including public health agencies), while enabling ever greater private concentrations of wealth.[57] Thirty years later, as global evidence of growing health inequities began to mount, the World Health Organization (WHO) issued its landmark 2008 report *Closing the Gap in a Generation: Health Equity Through Action on the Social Determinants of Health*, concerned chiefly with socioeconomic health inequities.[58] In the United Kingdom, the subsequent UK 2010 Marmot Review on *Fair Society, Healthy Lives* and the 2020 update *Health Equity in England: The Marmot Review 10 Years On* documented the worsening inequities resulting from governmental disregard of the evidence.[59]

Subsequently, in 2019, the Commission of the Pan American Health Organization (PAHO) on Equity and Health Inequalities in the Americas published its report *Sociedades Justas: Equidad en la Salud y Viva Digna/Just Societies: Health Equity and Dignified Lives.*[60] Akin to the 2008 WHO document, the PAHO report discussed socioeconomic health inequities.[61] Beyond this, it newly addressed the continued impacts of histories of settler-colonialism and enslavement on current Indigenous and Black health inequities, and likewise newly discussed the impacts of climate change and climate injustice.[62] Related radical civil society critiques bringing together these issues further paralleled

and expanded on the official reports, as illustrated by the *Global Health Watch* series, whose reports have appeared in 2005, 2008, 2011, 2014, and 2017.[63]

As this brief history suggests, the "embodied truths" about the state of people's health thus comprise a unique currency for contesting harms and proposing salutary alternatives. Government and societal responses to these embodied truths—whether their dismissal and denial or embrace and use to inform action—speak deeply about the state of power relations, constituting one variant of "speaking truth to power." Stated another way, what I refer to as "the stories that bodies tell"[64] can reveal powerful truths about the connections between "the body natural" and "the body politic."

The catch is that these "embodied truths" are not self-evident and instead are always shaped and infused by theory. They are not simply "facts" that can be "read off" an individual's literal body or a body of statistical data. Partly tempering claims of truth is the recognition that scientific knowledge is dynamic and reflexive: inevitably, as scientists generate, test, refine, and reject hypotheses, using new and different technologies and analytic methods, both theoretical understanding of disease processes and systems of classifying disease can change, as can nosologies of death.[65] Beyond this, it deeply matters who is telling—and testing—the stories that bodies tell, and doing so from what vantage, about whose bodies, in what historical, societal, and ecological context. It equally matters whose bodies are invisible or ignored.

Calling attention to these assumptions and omissions is core to ensuring scientific rigor: it is about doing correct science, not politically correct science.[66] After all, a cardinal principle of scientific

knowledge—and the basis for claims of valid and reliable evidence and explanations—is that it depends on the public testing of public ideas and data by independent scientists, whose methods, ideas, and data are open for public scrutiny.[67]

Here an aphorism from Donna Haraway (1944–), a renowned biologist and philosopher of science,[68] is useful: science and its evidence "are *made* but not *made up*."[69] Reflecting on contemporary controversies over scientific evidence, which span from outright rejection of science to critical questioning of bias in science, in 2019 she observed that for her and kindred critical scholars who have critiqued simplistic stances about science inherently being "objective" and bias-free:[70]

> Our view was *never* that truth is just a question of which perspective you see it from. . . . The idea that reality is a question of belief is a barely secularized legacy of the religious wars. In fact, reality is a matter of worlding and inhabiting. It is a matter of testing the holdingness of things. Do things *hold* or not?
>
> Take evolution. The notion that you would or would not "believe" in evolution already gives away the game. If you say, "Of course I believe in evolution," you have lost, because you have entered the semiotics of representationalism—and post-truth, frankly. You have entered an arena where these are all just matters of internal conviction and have nothing to do with the world. You have left the domain of worlding.

It is in this very material world, one existing long before humans evolved but now profoundly shaped by human actions informed by

human ideas, for good and for bad, that the realities of embodied truths play out.

On this note, it is now time to review briefly the key features of the *ecosocial theory of disease distribution*. As will become evident, the interlinked ecosocial constructs of *embodiment*, *embodying (in)justice*, and *embodied truths* animate its core.

Ecosocial Theory of Disease Distribution: Situating Embodiment and Embodying (In)justice

In 1994, I introduced the *ecosocial theory of disease distribution*.[71] Its purpose is to explain societal distributions of disease and health and thereby generate knowledge that can inform action to improve both population health and health equity. From the start, and in its subsequent elaborations,[72] this theory has emphasized the importance of engaging with the *multilevel spatiotemporal processes of embodying (in)justice*, across the lifecourse and historical generations, as shaped by the political economy and political ecology of the societies in which people live.

The invitation is to start with our real and material world—and to ask how living beings and the populations of which they are a part reciprocally and dynamically engage with, incorporate, and shape this world, by virtue of the capacities that their biology affords.[73] In the case of people—who are simultaneously, not concurrently, quirky individuals, kin, and members of the population into which they were born and the societies in which they live and engage[74]—these lived realities of embodiment are shaped by interlinked societal and ecological systems, by individual and collective agency, and by structured chance.[75] Embodiment is thus simultaneously a lived reality and a tool for thinking—and

one that can challenge dominant narratives of disembodied genes and decontextualized behaviors.[76] As I will argue here, no other public health construct does so much, so comprehensively, so concisely. It is why the ecosocial construct of *embodiment*—and the ideas of *embodying (in)justice* and *embodied truths*—together have the power they do, to inspire hypotheses, explanations, understandings, and action for the people's health.

Because I have written extensively about the ecosocial theory of disease distribution (or ecosocial theory, for short) in other publications,[77] here I offer a concise recap of the theory's key features, as shown in Figure 1.1—and then focus primarily on why grappling with embodiment in the ways the theory proposes is critical.

Ecosocial Theory of Disease Distribution: Why Every Word in the Name Matters

In brief, the *ecosocial theory of disease distribution* takes its name seriously.[78] Thus:

- *Ecosocial* (a term not used in public health until I introduced it in 1994, nor in any other literature with any elaboration) deliberately conveys, in one word (with no hyphen!), the fundamental interdependence of societal and ecological contexts, whereby societal systems and interactions necessarily depend on, shape, and are shaped by ecological systems—and vice versa. Because this theory is focused on population health and

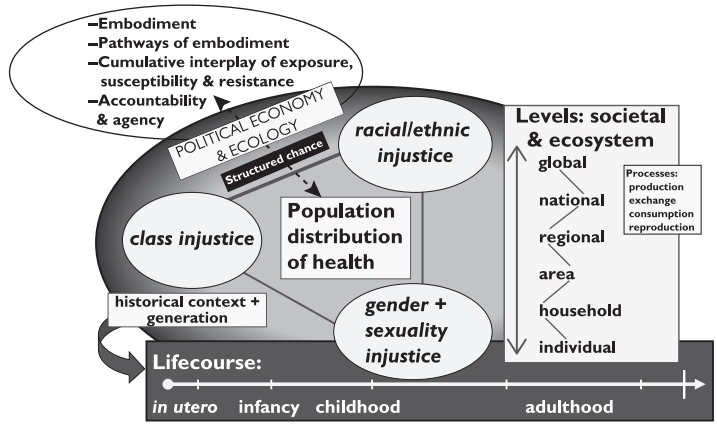


Figure 1.1 Ecosocial theory of disease distribution: levels, pathways, and power.

Sources: Krieger N. Epidemiology and the web of causation: has anyone seen the spider? *Soc Sci Med* 1994;39(7):887–903. doi: 10.1016/0277-9536(94)90202-x; Krieger N. Epidemiology and social sciences: towards a critical reengagement in the 21st century. *Epidemiol Rev* 2000; 22(1):155–163. doi: 10.1093/oxfordjournals.epirev.a018014; Krieger N. Theories for social epidemiology in the 21st century: an ecosocial perspective. *Int J Epidemiol* 2001; 30(4):668–677. doi: 10.1093/ije/30.4.668; Krieger N. A glossary for social epidemiology. *J Epidemiol Community Health* 2001; 55(10):693–700. doi: 10.1136/jech.55.10.693; Krieger N (ed). *Embodying Inequality: Epidemiologic Perspectives*. Amityville, NY: Baywood Publishing Co., 2004; Krieger N. Embodiment: a conceptual glossary for epidemiology. *J Epidemiol Community Health* 2005;59(5):350–355. doi: 10.1136/jech.2004.024562; Krieger N. Proximal, distal, and the politics of causation: what's level got to do with it? *Am J Public Health* 2008; 98(2):221–230. doi: 10.2105/AJPH.2007.111278. Epub 2008 Jan 2; Krieger N. *Epidemiology and The People's Health: Theory and Context*. New York: Oxford University Press, 2011; Krieger N. Measures of racism, sexism, heterosexism, and gender binarism for health equity research: from structural injustice to embodied harm-an ecosocial analysis. *Annu Rev Public Health* 2020;41:37–62. doi: 10.1146/annurev-publhealth-040119-094017. Epub 2019 Nov 25.

health inequities, and because societal systems and issues of injustice and equity are central to evaluating if differences in health status across social groups are unjust, avoidable, and in principle preventable, the "eco" modifies "social" (and not the other way around). Hence:

- ***Eco*** is meant literally, not metaphorically, and refers to the actual ecosystems (i.e., ecologies) that enable life to exist on our planet Earth (and, presumably, any other planet).[79] The construct of "eco" thus encompasses the lives of myriad species in their many evolved, evolving, and endlessly reproducing forms, past, present, and future. At issue are organisms and species, from one generation to the next, and one historical epoch to the next, jointly living and dying in real biophysical places that afford the possibilities for life, and which shape and are shaped by each organism's and each species' interactions with the living and abiotic world around them. The "eco" in ecosocial is not restricted to humans and instead encompasses complex cross-species and cross-level dynamic ecological systems that evolve. That said, ever since *Homo sapiens* evolved some 200,000+ years ago, as one new species joining 4.5 billion+ years of life on Earth, people have shaped and been shaped by their local ecosystems, with rising impacts on regional and increasingly planetary scales, especially since the 15th-century CE rise of global colonialism and commerce on a large scale.[80]
- ***Social*** in turn refers to the sociality of species life, involving the actions and interactions of living beings, within and across species, that affect the terms by which they and others live, reproduce, and die.[81] In the case of people, "social"

additionally encompasses "society."[82] It thus includes both forms of governance and the ideas people generate—and act on (with purpose in mind, and sometimes mindful of possible unintended consequences)—to explain and variously to structure, celebrate, honor, control, denigrate, or challenge their society's formal and informal rules plus impacts on the ecosystems of which they are a part.[83]

- ***Theory*** derives from the Greek word *theoria*, whose original meaning of "looking at," in relation to theater and spectacle, transmuted to mental schemes, and thus inner vision.[84] In the case of science, theory refers, as I have noted previously, to a "coherent and presumptively testable set of inter-related ideas that enable independent scientists to discover, describe, explain, and predict features of a commonly shared biophysical reality in which cause-and-effect exists."[85] Like all thinking, such theories inevitably rely on metaphor, to enable the "unknown" to be conceptualized in relation to the "known"—which is vital, given that our world, indeed universe, is more wonderful, unruly, and stranger than anything we can imagine.[86] Scientific theories are thus more than models; they encompass and spark hypotheses and frame the collection, analysis, and interpretation of data—and they are premised on science being a public way of knowing, involving the public testing of public knowledge.[87]
- ***Disease*** is a term I explicitly meant broadly, to refer not just to specific ailments, but as shorthand to encompass a diversity of somatic and mental phenomena that render an organism ill, disabled, or unhealthy; unable to partake in usual daily activities; and ultimately or immediately dead (whether via sickness, an injury, or an assault).[88] The contrast is thus to being alive, healthy, and in a state of well-being, which the theory also encompasses

(i.e., as health-relevant phenomena with a population distribution). While people have endlessly debated definitions of what constitutes "disease" and "health" (let alone "alive" and "dead"), in both ancient to current texts and oral traditions of diverse societies worldwide,[89] one striking commonality is that life, health, disease, injury, disability, and death are phenomena that manifest within individual organisms. The shorthand of "disease" thus refers to health-related phenomena occurring within individuals, which can then, whether literally or metaphorically, be aggregated to paint a picture of population health. Moreover, while the health status of individuals can depend on interactions between individuals, and also between individuals and their enmeshed societal and ecological systems, and thus be linked to and influenced by population rates of disease, nevertheless the health status experienced occurs within individual bodies.

- ***Distribution*** in turn links individual and population phenomena within a specified time and place. A noun that notably refers to both description and action, *distribution* can describe either (1) the static frequencies or probabilities with which specified characteristics of individual units occurs within a delimited population, and (2) the dynamic processes producing, that is, distributing, this allocation of characteristics.[90] In the case of population sciences, distributions are thus necessarily a multilevel phenomenon, involving individual units and the populations of which they are a part. It follows that description and analysis of distributions at the most abstract level require knowing the bounds of the values (minimum, maximum) and their clustering within these bounds (e.g., normal distribution, bimodal distributions, something else), within the population context in which the distribution occurs.[91]

- In the case of population health, measures of distribution typically are expressed as population rates (cases per total population in a specified place in a specified period of time) or population frequencies (proportions of a population, again in a specified place and time). They also, however, may pertain to frequencies or probabilities of events within an individual (e.g., respiratory rate, or pulse or heart rate, per unit of time).[92]
- No matter what the outcome, for any population distribution, it is critical to know the criteria used to delimit the population in which the distribution occurs, and in the case of population health, this requires characterization in relation to place or institution, social groups, and time.[93] There is, after all, no such thing as one adult human height distribution, even as human adults typically range between 4 feet and 7 feet tall (with, of course, outliers in both directions); the specific distribution depends on population, place, and time, whether 500 BCE or 2021 CE.[94]

Hence the name: the *ecosocial theory of disease distribution*—nothing more, and also, nothing less.

What Ecosocial Theory Is Not

The specifics of what is the *ecosocial theory disease distribution* can also be illuminated by being explicit about ***what it is not***. Thus, the ecosocial theory of disease distribution

- is *not* simply a theory of disease causation—since at issue is not only engaging with the social or biophysical mechanisms involved in the causation (or prevention) of individual cases of disease but also accounting for societal patterns of disease distribution, both present and past;
- is *not* simply a "model"—because it is a theory, and thus (1) presents a coherent and presumptively testable set of interrelated ideas that enable independent scientists to discover, describe, explain, and predict societal patterns of health and disease, and (2) specifies and structures the types of phenomena necessary for developing specific models to analyze particular population distributions and risk;
- is *not* simply a "framework"—because its purpose is not just to "frame" ideas but to generate testable hypotheses, explanations, and predictions about who and what drives population patterns of health and health inequities;
- is *not* simply a "social" theory of disease distribution because it engages with embodiment as a biological phenomenon and engages with the conjoint and temporally dynamic societal, biological, and ecological processes that shape population distributions of disease and health;
- is *not* simply a "social ecological" theory, as per the "social ecological theory" widely used in public health that was developed by Bronfenbrenner, since in this theory "ecology" refers solely to multilevel human phenomena, for example, children nested within families, households, neighborhoods, and schools, with no attention to actual ecosystems or other species;[95] and
- is *not* simply a "biosocial" theory because (1) such a construct ignores ecology, and (2) this term is haunted by its eugenic and

> sociobiological past, whereby many scientists and journal titles still use it as shorthand for asserting biological determinism, even as others in diverse fields are trying to recast it to mean socioculturally shaped biological plasticity.[96]

Hence: the ecosocial theory of disease distribution is what its name says—literally—and its intent is to theorize the profound embodied connections that exist between people, politics, ecologies, and health, so as to understand and alter who and what drive population rates of disease and health inequities. It is an integrative theory, not a theory of "everything," that provides the principles and constructs for analyzing population distributions of health and promoting health equity in societal and ecological context—and stands in direct contrast to dominant theories that are individualistic and essentialist to their core.

Why Bother with Developing Ecosocial Theory?

The spark to my developing the ecosocial theory of disease distribution was my frustration, as I received my training in epidemiology in the mid- to late 1980s, with the narrow, individualistic, ahistorical, and highly biomedical bent of my field (I earned my master's degree in 1985 and my PhD in 1989, having previously obtained a BA in biochemistry in 1980). Noting that arguments can be an especially productive spur for critical thinking, I was at a journal club meeting soon after I received my PhD, and the proverbial "web of causation" was once again invoked to explain

connections between so-called risk factors. I pointedly asked: who is the spider who has made such pernicious webs with such unjust distributions? This nascent crystallization of my argument with the ideas of my field led to my 1994 essay, "Epidemiology and the Web of Causation: Has Anyone Seen the Spider?,"[97] in which I formally introduced the ecosocial theory of disease distribution.

A key challenge, however, was that if the spiderless web of causation didn't cut it for me, what would? Criticism without suggestion of better alternatives is, after all, insufficient, if not irresponsible. What I came up with—which led me to rich theorizing about the idea of embodiment—was a fractal image that metaphorically and materially united the bush of evolution with the scaffolding of society that different social groups seek daily to reinforce or alter.[98] History, historical contingency, and chance are built into this image, as suggested by the branching shapes, as is deliberate social structure (and its intended and unintended consequences), as suggested by the scaffolding.

As I explained in the text, this image dynamically situates both (1) the bush of evolution within the changing ecologies in which evolution occurs, and (2) the scientists who research population health and the questions they do or do not ask. As I wrote then and would still argue now (albeit with greater recognition of the need to be clear that the social and biologic reflect and shape their ecological context):[99]

> This intertwining ensemble must be understood to exist at every level, sub-cellular to societal, repeating indefinitely, like a fractal object. Different epidemiologic profiles at the

> population-level would accordingly be seen as reflecting the interlinked and diverse patterns of exposure and susceptibility that are brought into play by the dynamic intertwining of these changing forms. It is an image that does ***not*** permit the cleavage of the social from the biologic, and the biologic from the social. It is an image that does not obscure agency. And it is an image that embraces history rather than hides it from view. . . . . this image makes clear that although the biologic may set the basis for the existence of humans and hence our social life, it is this social life that sets the path along which the biologic may flourish—or wilt.

I would further add now that another feature of this image is that it recognizes that causal arrows may fly in multiple directions, across and within levels, from macro to micro, but that does not mean they each do so with the same causal strength.[100] Recognition of the levels being considered—and ignored—is a first step to understanding who and what shape population patterns of health and health inequities.

KEY CONSTRUCTS OF THE ECOSOCIAL THEORY OF DISEASE DISTRIBUTION

As shown in Figure 1.1, the ecosocial theory of disease distribution theorizes population health—that is, *population health exposures, processes, and outcomes*—in relation to *levels, pathways, and power*, together situated in their *societal and ecological context,* driving the *processes and pathways of embodiment,* and especially *embodying (in)justice.* Connecting these levels, both societal and ecological,

and also the phenomena occurring within levels, are the *processes of production, exchange, consumption, and reproduction*.

It is not accidental that these latter terms can refer both to biological and societal phenomena. Consider only: producing hormones within the body or producing them in commercial laboratories; exchanging oxygen and carbon dioxide in the lungs or exchanging US dollars for euros; consuming nutrients or consuming products; sexually reproducing or socially reproducing hierarchies of power or daily life in households via cooking, cleaning, and caring. The "eco" in both "ecology" and "economics" can be traced back to the ancient Greek word *oikos*, which refers to "household" generally, and "household management" more specifically.[101] When the biologist Ernst Haeckel (1834–1919) coined the term *ecology* in 1866, he stated his focus was on "the place each organism takes in the household of nature, in the economy of all nature," one in which organisms exist in "infinitely complicated relations" with inorganic and organic conditions of existence, including "among the other organisms its friends and enemies."[102] There is no way to theorize about population distributions of health without attending to *time*, *place*, and *historically structured* relationships, within and across species, and which, for people, includes structurally forged social groups.

From this standpoint, households, whether of humans or other species, are physical places and social spaces, they are units of biological and social reproduction, they require sustenance and produce waste, and in the case of people, their inhabitants and what they do depend on the political, social, economic, and ecologic context in which their households exist. It matters whether and which household inhabitants are—or are descended—from which permutations

of people: enslaved versus free; undocumented versus documented; Indigenous versus immigrant versus "native" born; working class versus professional; impoverished versus wealthy. It matters if they are cis- or transwomen versus cis- or transmen; lesbian or gay or bisexual versus heterosexual; genderqueer or non-binary versus cis-gender. It matters if they are young versus old; disabled versus disability-free; alone or living with others. The various inhabitants of these households—and also homeless people, both sheltered and unsheltered—each and every day integrate, within their very bodies, their daily social and biological exposures and experiences, both in and outside their households. To ask theories of disease distribution to be equally integrative about how these realities are reflected in people's health status is thus to ask such theory to engage with the realities of life, health, disease, and death on Earth.

Engaging with the processes that produce population health requires one additional consideration: time. Processes, by definition, take place over time—and three aspects of time are critical. One is time in relation to an organism's *lifecourse*, including biological development and the constant interplay and modification of phenotype by lived experience, from birth to death. A second is the *historical generation* in which this life is lived (e.g., birth cohort). A third is the *etiologic period* (e.g., incubation period for infectious diseases, latency period for noninfectious chronic diseases), that is, the amount of time causally required from initiation of exposure for pathologic processes to result in change(s) in health status.[103] This etiologic period can range from practically instantaneous (e.g., being shot by a bullet to the head and dying) to a couple of weeks (e.g., the time from exposure to the measles virus to developing measles[104]) to several decades (e.g., from asbestos exposure

to mesothelioma[105]). The chronicity of exposure also matters: both acute traumatic events and prolonged abuse can, over variable time periods, increase risk of subsequent chronic mental and physical health problems,[106] and acute and chronic high alcohol consumption can respectively lead to acute alcohol intoxication and, over decades, to cirrhosis.[107]

A Concrete Example: Who and What Drive Population Distributions of Lead Poisoning? When and Where?

As one example that underscores the centrality of societal and ecological context, including time, place, and social group, to population distributions of health and epidemiologic theorizing, consider the age-old case of lead poisoning, known as early as 4,000 years ago, as described in ancient Egyptian papyri.[108] The population distributions of the health impacts of acute and sustained lead exposure depend in part on the age at exposure (in utero, infancy, early childhood, adolescence, adulthood) as well as on the sources of exposure: leaded water pipes, leaded paint and paint chips, leaded gasoline, lead dust at work, or lead contamination of cosmetics, beverages, food, and medicine.[109] In the case of water and leaded pipes, they depend as well on what else is in the water (e.g., how "hard" or "soft" it is) and what other chemicals, including industrial pollutants, are present.[110] All of these exposures also depend on the technologies available: leaded gasoline for

automobiles, driven by the invention of cars, introduced entirely new ways of widely dispersing lead unrelated to occupational exposures or water pipes.[111] The distributions of exposure and outcomes likewise depend on the state of knowledge about lead poisoning, the existence and enforcement of regulations to prevent lead exposure—and also who benefits from intentional use of lead or from seeking to undercut or ignore these regulations.[112]

Economic, racialized, and gender inequities in population distributions of lead exposure and attendant outcomes have thus varied by time and place, shaped by practice and policies affecting exposures at work, at home, and in the community—of not only people but also pets, other animals, and plants.[113] Within the United States, the distribution of lead poisoning among children has depended on whether they were born before versus after the 20th century CE introductions of leaded gasoline and leaded paint, the fights to ban them, and the passage and enforcement of versus disregard for lead exposure prevention and abatement policies for housing and drinking water.[114] Bringing this home, as it were, is the ongoing recent debacle of the explosive rise of lead contamination of water in Flint, Michigan, a Black-majority city (54%) in which 40% of the population in 2019 was below the poverty line.[115] Lead contamination of its water supply soared in 2014 after state and city officials, in a corrupt cost-cutting measure, switched the water source from Lake Huron to the Flint River without necessary corrosion control treatment, and then denied the severity of the ensuing crisis, leading to extensive litigation, criminal indictments, convictions, and community initiatives to redress the damage.[116]

The example of lead poisoning also illustrates why explanations of disease distribution cannot be reduced solely to biophysical

explanations of disease mechanisms, since the latter do not account for why rates and population patterns of disease change, in complex ways, over time and place. As with any causal analysis, questions of "why" and questions of "how" both matter, so as to understand the causal processes that interventions must address.[117] The biophysical mechanisms of lead toxicity (i.e., the "how") are presumably the same as they were millennia ago, when described in medical texts of antiquity in Egypt, Greece, India, China, and Rome.[118] Enormous expansion of the knowledge of the biophysical mechanisms, facilitated by improved technologies, crucially has enabled detection of harms associated with increasingly detectable very low levels of exposure, and has also improved options for therapies such as chelation.[119] But knowledge about the "how" is not the same as knowledge about the "why." To understand and intervene on the distribution of lead poisoning and prevent its harms, it is also essential to ask and investigate: why is exposure occurring, who is it affecting, and at whose cost and whose benefit? And too: why have some efforts to prevent exposure succeeded and others failed, also at whose cost and whose benefit?[120]

As should be clear, societal and ecological context is key. There is not and can never be one answer to the question: what is, and who and what cause, the epidemiology—that is, the actual population health distribution—of the adverse impacts of lead exposure? But there can be systematic approaches to asking these questions, informed by theory, with due attention to who and what is shaping population health distribution and inequities in health—which are for this reason at the very center, conceptually, of the ecosocial theory of disease distribution—as literally depicted in Figure 1.1.

Delineating Ecosocial Theory's Core Constructs: From Embodiment to Agency and Accountability

Figure 1.1 also shows, in the upper left-hand corner, the four core and conjoined conceptual constructs of the ecosocial theory of disease distribution, whose real-world manifestations are always transmuted, via structured chance (as I explain later), through the extant political economy and political ecology of the population in which disease distribution occurs.[121] In Chapter 2, I use concrete examples to illustrate the utility of these constructs for public health research and practice; here, I briefly delineate the core concepts.[122] They are as follows:

1. *Embodiment*: referring to how we humans, and all other biological organisms, literally biologically incorporate, that is, embody, our societal and ecologic context. While this may seem to be an obvious truism, as noted earlier, this approach to conceptualizing embodiment stands in direct opposition to the dominant frameworks of "nature" versus "nurture" and "gene × environment interaction."
2. *Pathways of embodiment*: referring to the concrete and concurrent social and biophysical processes and mechanisms, from macro to micro, involved in organisms embodying their societal and ecological context, thereby producing population distributions of health, disease, and death. Identification of these pathways is guided by ecosocial theory's other core constructs and consideration of both political economy and

political ecology: both the "why" and "how" of causal processes matter.

3. *Cumulative interplay of exposure, susceptibility, and resistance*: in relation to the pathways of embodiment, at each and every level, and in relation to both lifecourse and historical generation. Social movements resisting injustice and organizing for equity, for example, are every much a part of resistance relevant to shaping population health profiles as are individual-level interactions or resilience.
4. *Agency and accountability*: referring both to who and what, at each and every level, are responsible for health inequities and also for the research to explain population health. Key questions are: who benefits from injustice and from research that ignores injustice, and, conversely, who is harmed by injustice and by the overt suppression, lack of funding, and self-censorship that can limit research on these issues?

As with any theory, none of ecosocial theory's core constructs are "stand alone": they are interdependent and should not be used in isolation.[123] The ecosocial constructs of "embodiment" and "embodying (in)justice" can thus not be invoked on their own, as solely phenomena to explain mechanisms in biophysical or psychosocial terms. Instead, it must engage with the theory's other core constructs—taking into account levels, pathways, and power—with the objective of explaining population distributions of disease, within and across societies and places, at a given point in time and over time, and including but not restricted to health inequities.[124]

Embodiment and the processes of embodying (in)justice, as conceptualized in the ecosocial theory of disease distribution, accordingly are multifaceted, multilevel, temporally dynamic constructs. Embodiment is a noun that conveys a process.[125] It interweaves the links between that which is being embodied and the body doing the embodying. It requires agency and action and engagement. It requires vitality. And it requires context—which is provided by its companion construct "embodying (in)justice."

From an ecosocial public health standpoint, embodiment and embodying (in)justice—in societal and ecological context—are what connect, causally and conceptually, exposures and outcomes, and also individual risk and population rates of health. At issue is who and what is responsible for who is embodying what exposures, with what health consequences, along with (but not solely) the biophysical mechanisms by which such embodiment occurs within individuals. Stated plainly: just as bodies daily integrate organisms' experiences and the individual and collective actions they take to engage with and shape their world, the constructs of embodiment and embodying (in)justice afford a robust integrative way of thinking that can bridge the conceptual divides of individual versus population and societal versus biophysical. In Chapter 3, implications for interventions are considered.

Using Ecosocial Theory to Reject Biological Essentialism and Embrace Embodied Integration

Two key corollaries to the ecosocial constructs of embodiment and embodying (in)justice are (1) *the need to reject biological essentialism* and (2) *the need to embrace, instead, embodied integration*.

A third is to recognize that all living beings on our planet are, in ecosocial terms, *emergent embodied phenotypes.*[126] In this increasingly –omic, nanoscale-centric, and hyper-biomedical research moment, it is critical to emphasize that the drivers of current and changing societal patterns of disease distribution, including health inequities, are exogenous to people's bodies and reside instead in the body politic.

Ecosocial Constructs: Emergent Embodied Phenotypes and Distinguishing Between Biological Expressions of Injustice Versus Unjust Interpretations of Biology

Consider, for example, how the ecosocial theory of disease distribution engages with embodiment and embodying (in)justice by distinguishing between what I newly term, building on earlier work,[127] *biological expressions of injustice* versus *unjust interpretations of biology*. The former refers to the biological consequences of embodying societal injustice and constitutes manifestations of emergent embodied phenotypes. The latter, by contrast, refers to how societal injustice distorts interpretations of biology—and especially how it can lead to "naturalizing" the social phenomenon of health inequities. These constructs build on concepts I introduced to the epidemiologic literature in the mid-1990s, referring then to *biological expressions of racism* and *racialized expressions of biology* and, related, *biological expressions of gender* and *gendered*

expressions of biology.[128] The intent was, and remains, to counter how "race/ethnicity" and "sex/gender" routinely appear in epidemiologic analyses as if self-evident stand-alone ostensibly biological characteristics that were solely individual-level characteristics, and with scant to no attention to how racial/ethnic and gender inequality shape both these very categories and the health of people so categorized.[129]

With regard to "race," the epidemiological, public health, and even more voluminous biomedical literature was—and remains—steeped with the supposition that "race" is an innate biological category, whereby "races" are posited to be distinguished by systematic genetic differences, and these differences give rise to observed racial/ethnic differences in health.[130] Reams of scholarship exist regarding the origins of these ideas, both outside and within medicine and science, as tied to histories of the rise of the European transatlantic slave trade and worldwide colonialism.[131] The upshot has been to racialize biology, via a circular logic that presumes that observed racial/ethnic differences are due to alleged innate differences, and therefore any such observable differences constitute proof of said differences. Missing from the analysis is any consideration of how the very power relations that have constituted and enforced racial injustice and forged the very construct of "race" have durable biological consequences: both for those who have endured racial discrimination and attendant economic deprivation and, conversely, for those who have benefited from racialized economic privilege.

Distinguishing between *biological expressions of racism,* as reflected in racial/ethnic health inequities, versus *racialized expressions of biology,* referring to health status and other bodily

characteristics interpreted as signifiers of alleged innate "racial" differences, has offered new options for addressing links between categories of racialized groups and biology in population health research. After all, if structural racism affects the material and social conditions in which people live, and people embody these conditions, the ensuing biological expressions of this embodiment will be present in individual bodies and manifest in on-average differences in health status across the specified racialized groups. How could it be otherwise?

The analytic implications are twofold.[132] One pertains to the need to develop empirical measures of racial injustice, at multiple levels, that are feasible to use in epidemiologic research, cognizant of cohort effects related to historical events affecting exposure (e.g., imposition of Jim Crow, passage of civil rights acts, etc.). The other concerns the need to become aware, for each outcome studied and its biological features, of the histories of scientific debates over its associations with the assigned race/ethnicity of the racialized groups—that is, as being due to racism or to "race."

Clarity regarding these constructs has critical implications for the rigor and accuracy of *all* population health research—since *no one* is exempt from membership in these types of socially assigned groups. It accordingly is important to underscore the ongoing challenges for improving the methods and intellectual rigor of research on these issues.[133] Current work, increasingly breaking through to being published in prominent medical and public health journals, explicitly challenges the long-dominant framing, where since at least the early 1800s it has been deemed "scientific" to posit "race"—understood as a stand-in for inborn traits—as explanatory, but "ideological" to raise issues of the health impact of

racial injustice.[134] The deeper truth is that it is ideological and intellectually weak to ignore how racial injustice harms health and, in the absence of such considerations, unscientific to make biological claims about "race" being the cause of observed differences in on-average health between racialized groups.[135]

Similar issues in the mid-1990s swirled around the framing of "women's health" in epidemiology and public health (noting that "men's health," as such, was rarely discussed in the public health literature back then, and questioning of the gender binary was virtually nonexistent).[136] As with racism and health, these debates were informed by a long history, easily extending back millennia, regarding the extent to which differences in biology between women and men explained their individual and group differences in power, property, behaviors, and health—both for health outcomes potentially experienced by both sexes and for those uniquely related to reproduction (e.g., birth).[137] Here, however, the challenge was different. In contrast to "race/ethnicity" (and thus racialized groups) being solely a social construct with no legitimate biological basis, for sex/gender, different considerations existed regarding the social and biological issues involved. Specifically, in addition to the social construct of "gender," there were also the realities of humans being a sexually dimorphic species, meaning two different sexes are required for reproduction—which is separate from the question of where any particular individual lies in the distribution of diverse sex-linked biological traits.[138] That said, it is critical to underscore that people, regardless of their sex-linked biology, necessarily and overwhelmingly share a common biology by virtue of being members of the same species.[139]

Distinguishing between the constructs of *biological expressions of gender* and *gendered expressions of biology* likewise has been useful to sharpen analysis within population health science, with embodiment again analyzed in relation to levels, pathways, power, lifecourse, and historical generation.[140] The former construct has encouraged analysis of the impacts of social gender and structural gender inequality on the health of all genders, while the latter has allowed for critical questioning of how scientific sexism has shaped both scientific questions and affected interpretation of biology, including for comparative analysis of sex-linked biology across species.[141] Decentering human biology can be a way of looking again at human biology with fresh eyes—with new insights gained into what have been termed *flexible phenotypes*, as illustrated by how for some types of animals (e.g., teleost fish), individual organisms can change their reproductive sex repeatedly during their lifetime.[142] These biological realities bolster ecosocial theory's focus on population distributions when considering any particular exposure, trait, or health outcome.

As with racism and health, articulation of the ecosocial constructs involving embodying (in)justice, gender, and biology—that is, *biological expressions of gender* versus *gendered expressions of biology*—has likewise underscored how the concepts, methods, and measures for analysis of gender systems, gender inequality, and population distributions of health need to be strengthened.[143] They also led me to cease using the word *sex* by itself, and to refer instead to *sex-linked biology*, for two reasons. One was to avoid the common treatment of biological "sex" as one "thing," which ignores the complex layering of myriad biological characteristics

and systems involved in the capacity to reproduce sexually (including chromosomes, genomes, epigenomes, hormones, and hormone receptors) and the distribution of these characteristics both within and across individuals and populations.[144] The second was because important aspects of sex-linked biology, such as estrogen receptors, can, among humans and other animals, occur in every organ system and can have biological roles not directly tied to sexual reproduction.[145] The larger empirical question could thus be rephrased—and remains—whether gender, sex-linked biology, neither, or both contribute to observed population patterns of specified health outcomes.[146]

More broadly, by hypothesizing that health inequities comprise the *emergent embodied phenotypes*[147] via which injustice is biologically expressed—whether the injustice be in relation to social class, racism, nativity, sexism, heterosexism, gender binarism, ableism, or other types, separately or combined[148]—ecosocial theory invites population health scientists to develop the concepts and methods to put these ideas to the test. It likewise invites critique of population health and biomedical research that neglects to consider how injustice may affect both the population health phenomena under study and the ideas and methods used to study it. And because it is a scientific theory, one that can be studied and applied like any other theory, ecosocial theory clarifies that the knowledge needed to formulate these kinds of hypotheses is possible for anyone who takes the time to learn and acquire the relevant expertise, above and beyond whatever their own lived experience might be.[149]

Ecosocial Theory, Embodying (In)justice, and Intersectionality: Disciplinary Connections and Differences and Contrasts to Metaphors of "Weathering" and "Under the Skin" and the Construct of the "Exposome"

The ecosocial theory of disease distribution and its constructs of embodiment and embodying (in)justice additionally invite integrative thinking about bodily and population health phenomena. By implication, embodiment means we are not a member of a particular racialized or ethnic group one day, have a particular gender identity on another, and on still another day have a particular sexual orientation: we are all of these at once—and the same holds for our social class, nationality, immigration status, and where we live and work.[150] With and within our bodies, people and other organisms daily integrate their experiences and exposures, social and biophysical, in each and every moment. Doing so is literally part and parcel of being alive. Consequently, causal theorizing about these integrative processes needs to be equally integrative, including for such integrative phenomena as embodiment, embodying (in)justice, and population distributions of health.

A recognition that people's experiences are simultaneously shaped by their multiple historically forged social positions and identities is also conveyed by *intersectionality*. This construct first surfaced in the academy in the legal and social sciences in the early 1990s,[151] notably as used by Kimberlé Crenshaw in 1991 in a legal essay on violence against women of color.[152] The construct itself

built on a legacy of activist insights and organizing in the 1970s and 1980s, galvanized by Black feminists, around the interlinked issues and lived realities of sexism, racism, heterosexism, and class injustice.[153] This latter body of work has also aided my development of ecosocial theory.[154]

The construct of *intersectionality,* whose use has dramatically risen in numerous fields over the last 30 years, has given rise to productive discussion and debate as to what it means and what it entails for critical analysis and action, including within public health.[155] In 2020, Patricia Hill Collins, one of the first-wave Black feminist scholars explicitly engaged in developing this framework, writing with her coauthor, Sirma Bilge, noted that while there can be varied and sometimes contradictory answers as to what "intersectionality" means, nevertheless a common working definition would be:[156]

> Intersectionality investigates how intersecting power relations influence social relations across diverse societies as well as individual experiences in everyday life. As an analytic tool, intersectionality views categories of race, class, gender, sexuality, class (*sic*), nation, ability, ethnicity, and age—among others—as interrelated and mutually shaping one another. Intersectionality is a way of understanding and explaining complexity in the world, in people, and in human experiences.

The objective is to foster the ideas and practices that people can use to challenge interlocking and mutually reinforcing distinct systems of power and their impacts on both societies and individuals, with the intent of creating equitable societies.

Or, as Claudia Rankine, an African American poet, stated in her 2014 award-winning prose-poem *Citizen: An American Lyric*:[157]

> The world is wrong, You can't put the past behind you. It's buried in you, it's turned your flesh into its own cupboard. Not everything remembered is useful but it all comes from the world to be stored in you.

As this metaphor suggests, the totality of people's lived experiences, shaped by their societies, lodge and manifest in their bodies, such that to understand the state of the people's health, one must start by grappling with their histories, in societal context, within and across generations.

Thus, like the ecosocial theory of disease distribution, intersectionality is concerned with socially structured entanglements of multiple types of injustice. Where it differs is that intersectionality's intended use is for analysis and action regarding intersecting forms of structural injustice in human societies.[158] It was not and has never been intended to guide theorizing jointly concerned with social, biological, and ecological phenomena and the pathways and processes of literal biological embodiment and their translation, via emergent embodied phenotypes, to patterns of population health and health inequities.[159] Of note, while the ideas and methods of intersectionality have been and can be productively applied in public health research and practice,[160] "intersectionality" by itself is not—nor ever was intended to be—a population health theory. That said, deep resonance exists between the analytic approaches and objectives of "intersectionality" and ecosocial theory.

The same can be said for the sociocultural construct of "embodiment."[161] An old idea long the focus of profound philosophical and theological debates about ties between material existence (i.e., bodies) and consciousness (or spirit or soul),[162] since the 1980s interest in "embodiment" has surged in both the humanities and social sciences. Active discussion about and use of this idea occurs within and between anthropology, ethnography, sociology, history, critical feminist studies, critical race studies, queer studies, postcolonial studies, disability studies, literary and art criticism, and philosophy and theology, to name a few.[163] A primary focus has concerned understanding how, within specified societal contexts and constraints, people's ideas and their power to enact them shape what they and others do with and to their own bodies and the bodies of others—where, when, and with whom.[164] The primary interest is in the body as site of action and contestation in the world, not its biological being. That said, new scholarship in both sociology and anthropology (especially that of Margaret Lock[165]) is addressing biology as it analyzes embodiment in relation to societal systems, power, social and biophysical exposures, health practices, and health status.[166] However, as befitting for the social sciences, this sociocultural scholarship employs chiefly conceptual and qualitative analysis and is not intended to provide quantitative description or analysis of population distributions of health.[167]

So too with the construct of "habitus," a complex concept regarding what the influential French sociologist Pierre Bourdieu (1930–2002)[168] referred to as "the social made body."[169] Although Bourdieu never provided one single definition of "habitus,"[170] sociologically and philosophically he held that social processes

of pedagogy and socialization mediate how the outside world transports itself into and transforms people's bodies, from infancy onward, leading to their internalizing dispositions that shape how they act, feel, think, and talk—which they then bodily manifest as their "habitus."[171] Examples include how people's societal context and their family's standing within it variously affects (consciously or unconsciously) their posture, gestures, facial expressions, and gait; how they dress and adorn their bodies; how and what they eat and drink; how they stimulate or dull their senses (including via recreation and cultural activities); and how they have sex and with whom.[172] Moreover, although Bourdieu recognized that "habitus" had health implications, his focus as a sociologist was on cultural and social phenomena, not disease distribution, epidemiology, or public health.

Precisely because of their different emphases, ecosocial and sociocultural understandings of "embodiment" can enrich each other in complementary ways.[173] The sociocultural analyses can provide rich or thick information regarding the ways in which people describe, interpret, and shape their lived experiences,[174] providing clues that ecosocial theory can use to delineate and test hypotheses about potential literal "pathways of embodiment" connecting this lived experience to population distributions of health outcomes. Conversely, ecosocial theory, attuned to the context-dependent population distributions of the stories that bodies tell—both separate from and in conjunction with what people are willing or able to self-report about their lives[175]—can reveal context-specific patterns of designated health outcomes and test hypotheses about the historically shaped experiences and exposures that produce them. Together, the distinct but related ecosocial and sociocultural

approaches to analyzing "embodiment"—along with ecosocial theory's explicit focus on embodying (in)justice—can generate insights relevant to understanding the people's health and guiding action for health justice.

Three additional public health concepts concerned with exposures' impacts on bodies and health status are *weathering*,[176] *get under the skin,*[177] and the *exposome*.[178]

- The first, "weathering," is a metaphor introduced by Arline Geronimus in 1992 as part of a novel hypothesis about why "the black-white infant mortality differential is larger at older maternal ages than at younger ages."[179] It evokes how weather (i.e., wind, precipitation, temperature, etc.) can physically sculpt and also disintegrate substances, whether inorganic (e.g., rocks), dead (e.g., timber), or alive (e.g., skin);[180] by association, it conveys how people's social context affects their biological aging and risk of disease and death.[181]
- The second, "get under the skin," construed as a metaphor (and as opposed to literal use describing skin-penetrating parasites[182]), emerged in psychosocial epidemiology in the late 1990s;[183] rooted in health psychology and neurobiology, it serves as shorthand for biological mechanisms by which psychosocial stressors affect disease risk.[184]
- The third, "exposome," a term coined in 2005 by Christopher Wild to capture the "nongenetic" complement to "genome,"[185] refers to biological markers of environmental exposures (initially biophysical, then expanded to include psychosocial) whose "footprints" can be measured within individuals.[186]

While none of these three concepts by themselves constitute theories of disease distribution or explicitly focus attention on who (and not just what) drives health inequities, all attest to the growing interest in understanding how people's psychosocial and biophysical exposures affect their biology and disease risk.

Finally, starting in the early 2010s, several social worker scholars and practitioners have called for their field to adopt an "ecosocial" approach to their work, prompted by the growing crisis of climate change.[187] What this entails is for social workers to be more engaged with how people's ecological context affects their societies, their social welfare systems, and the hardships they face. Responding to kindred societal and ecological contexts that spurred my introducing the ecosocial theory of disease distribution back in 1994, the social work approach, however, is fundamentally more akin to a "social-ecological" approach (as described earlier), with the added component of a nonhuman ecological context. As befitting for its focus, the social work approach does not address analysis of disease distributions or biological embodiment of societal and ecological context; it should not be confused with the ecosocial theory of disease distribution.

Embodiment: Producing Population Distributions of Disease in Societal and Ecological Context, and a Causal Challenge to the Proximal/Distal and Upstream/Downstream Divides

The notion that biology is expressed in societal and ecological context, is sensuous, and is structured by history is not unique to the ecosocial theory of disease distribution. It is, rather, core to analysis of biology, development, and evolution for all species.[188] As emphasized in the collaborative work of the evolutionary biologist

and paleontologist Niles Eldrege (b. 1943) and Marjorie Grene (1910–2009), a major 20th-century CE philosopher of biology, all living beings on Earth are always and inseparably social beings and biological organisms and members of species whose lives reflect and create entwined histories of ecologies, genealogies, and social interactions.[189] This is why the lives of all living beings, from start to end, necessarily are *emergent embodied phenotypes*.[190]

To this mix, humans have distinctively expanded modes of inheritance from being first and foremost biological (what is passed from parents to progeny via sexual or asexual reproduction, including but not limited to DNA and RNA[191]) to societal rules about passage of property from one generation to the next.[192] The relationship of people to place—understood socially and ecologically—and what this entails for the health of people and other living beings is likewise core to such disciplines as critical health geography[193] and political ecology.[194]

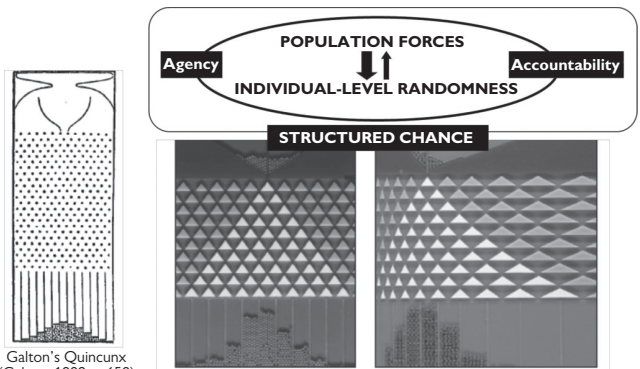
Ecosocial theory's focus on population distributions of disease and embodying (in)justice, however, entails specific theorizing about populations, distributions, exposures, and health outcomes, and the causal processes underlying their existence and relationships. To close this chapter, and as a segue to the concrete work of using ecosocial theory in Chapter 2, I accordingly address the interrelated concepts and realities of *populations* and *structured chance*, and why their embodied connections refute the misleading characterization of "distal" versus "proximal" and "upstream" versus "downstream" causes of health.[195] These are topics I have written about at length in other publications,[196] informed by the work of scholars in diverse disciplines, so my presentation here is telescoped to bring key points into clear view.

In brief, the ecosocial theory of disease distribution recognizes that the construct of "populations" is complex, with profound implications for causal analysis of "population distributions." At the crux are (1) who and what define the "population" and delimit who and what it includes *and* excludes, (2) whether these defining characteristics are viewed as fixed versus dynamic, and (3) whether populations comprise entities from which random samples of individuals can be taken to estimate population characteristics.[197] Deeply entangled in all of these considerations are issues of structure, agency, and chance—and, related, whether health inequities are analyzed as embodied biological expressions of injustice versus unjustly interpreted as resulting from innate biological differences or flawed versus virtuous individual or cultural choices.

Stated bluntly, the embodied stance of ecosocial theory rejects biological essentialism and strict determinism. It instead embraces historical contingency, structured chance, and possibilities of change—including for the very definitions of populations and diseases, as brought about by people debating ideas and seeking to alter how they live within their societies.[198] The contrast is to the dominant view, aptly captured by the famous apparatus of the Quincunx (Figure 1.2), designed in 1889 by Sir Francis Galton (1822–1911).[199] As noted earlier, Galton infamously coined the term *eugenics* in 1893 and he also invented the correlation coefficient in his quest to prove that population distributions, including of intelligence, were a product of "heredity," not "environment."[200]

Galton designed his Quincunx to be "an apparatus . . . that mimics in a very pretty way the conditions on which Deviation depends."[201] The device consisted of pegs placed on a vertical board and was designed so that identical pellets poured through

a funnel that randomly bounced off the carefully placed pins would fall into different bins and produce a normal distribution, with the height of the column reflecting the probability of different pathways of descent (Figure 1.2). To Galton, the device beautifully demonstrated the properties of what he called the "Law of Frequency of Error," a "law" that he claimed "would have been personified by the Greeks and deified, if they had known of it. . . . each element, as it is sorted into place, finds, as it were, a pre-ordained niche, accurately adapted to fit it."[202] From this standpoint, the placement and shape of the pins and funnels



Galton's Quincunx (Galton, 1889, p.658)

Physical models demonstrating the genesis of normal and log-normal distributions (Limpert el at, *Biosci* 2001, p.343)

Figure 1.2 Producing population distributions: structured chances as represented by physical models.

Sources: Krieger N. "Who and what is a "population"? Historical debates, current controversies, and implications for understanding "population health" and rectifying health inequities". *Milbank Q* 2012; 90(4):634–681; figure: p. 658; Galton F. *Natural Inheritance*. London: Macmillan, 1889; p. 63, which is freely available at: https://galton.org/books/natural-inheritance/index.html; Limpert E, Stahel WA, Abbt M. Log-Normal distributions across the sciences: keys and clues. *BioSci* 2001;51:341–352; figure: p. 343.

were a given in the background—and the resultant distributions were simply preordained.

Galton's fundamental assumption—common to the political elites of his time, and still influential to this day[203]—was that the global political, economic, and intellectual dominance of white Anglo-Saxon men of rank and means simply reflected their innate superiority, as a natural group.[204] This superiority was to women in their own "race" and class; men in their own "race" but who were working class; and men and women in all other "races," regardless of class. A second assumption, based on scant, biased, or otherwise dubious data,[205] was that variation in characteristics between these populations vastly exceeded within-group variation.[206]

Yes, outliers existed, but the average and distribution told the "real" story; in Galton's own words:[207]

> Let us then compare the negro race with the Anglo-Saxon, with respect to those qualities alone which are capable of producing judges, statesmen, commanders, men of literature and science, poets, artists, and divines. . . .
>
> First, the negro race has occasionally, but very rarely, produced such men as Toussaint L'Overture. . . .
>
> Second, the negro race is by no means wholly deficient in men capable of becoming good factors, thriving merchants, and otherwise considerably raised above the average of whites . . . a result which again points to the conclusion, that the average intellectual standard of the negro race is some two grades below our own.

Toussaint L'Overture notably commanded Galton's attention because of his leadership role in the first successful anti-colonial and

anti-slavery revolution, which liberated Haiti from French rule (1791–1804), with enormous implications for not only France but also Great Britain and other European colonial powers and their reliance on slavery, as well as the US anti-slavery struggle.[208]

Innate difference, to Galton, is what also explained group differences in age at death, despite flux of individuals.[209] To convey the idea that populations' stability arose from the common essence of each transient member, he reached for a celestial metaphor: "The cloud and the population are composed of elements that resemble each other in the brevity of their existence, while the general features of the cloud and of the population are alike in that they abide."[210] This perspective clearly was indifferent to changes wrought by the wind (how long have you seen a cloud hold its shape?). Instead, to Galton, inner properties determined outer essence—and the external context was of secondary or no importance.

However, consider the alternative mechanical device also shown in Figure 1.2. It was built by several late 20th-century CE physicists, who altered the shape of the funnel and pins to generate a log normal curve (i.e., the logarithm of the values has a normal distribution).[211] Juxtaposing these two figures enabled me to introduce the ecosocial idea of *structured chance*,[212] via use of an illuminating mechanical metaphor for showing how altered structures can change population distributions, including of identical balls, by altering the probabilities or chances of what pins they will hit, what angle they will bounce off, and where they will end up. This concept recognizes that while randomness, or stochasticity, is integral to disease distributions and the outcomes for individuals, at the same time, the population distributions themselves are not simply random, but reflect the societal and ecological contexts that create the populations and structure exposure and risk.[213]

One implication is that observed embodied differences between populations are simply that: observed embodied differences in a given context, not clear-cut indicators of "innate difference," with structuring of chance playing out over time and different spatial scales as well. In the case of population health, what matters is not only time reckoned in terms of seconds, minutes, or people's lifecourse but also the historical time period in which they live.

Are comparisons of, say, Black versus white health status carried out when racialized slavery is legal, when formal legal equality exists but without reparations for enslavement, or (as is yet to be the case anywhere) when equity has existed for generations, in all domains of human rights (social, economic, civic, political, and cultural)?[214] Is Indigenous health analyzed and compared to that of other groups (e.g., settler-colonialists and their descendants, other immigrants) at a time of forcible expropriation of territory and forced settlement on reservations, when formal legal equality and formal recognition of sovereign treaties exist but without reparations for colonization, or, again, when equity and respect for human rights has existed for generations? Are comparisons of health status across categories of gender and sexual identities conducted when women as a class are denied suffrage and property rights, when homosexuality or same-sex marriage is illegal, when transgender as a category is denied legal recognition, or when equality in legal recognition and rights exist?

The juxtaposition of structures and distributions in Figure 1.2, when combined with the ecosocial approach to analyzing embodiment, additionally underscores problems with the conventional causal divides, in public health and other literatures, of "proximal" versus "distal," and "upstream" versus "downstream."[215] Levels coexist, interact, and exert their influence

simultaneously: the so-called distal policies that affect, say, population distributions of wealth and impoverishment, or subsidies for fossil fuels or deregulation of environmental protections, are as directly embodied by individuals as are the more specific so-called proximal exposures these policies engender. Moreover, the embodied impacts can last long after the policies change, across the lifecourse and across generations. Reckoning with these cross-level temporal realities is what the daily embodied integration of societal and ecological context entails. Additionally, individuals (typically construed as "downstream") can engage in collective action to change so-called upstream systems and policies, a possibility obscured if causal power flows solely from "upstream" to "downstream." Indeed, only collective organizing by individuals has ever had the strength to change societal structures.[216] A frank reckoning with levels, pathways, and power, as articulated by the ecosocial theory of disease distribution, makes these connections and possibilities clear.

In sum: people and other living beings live in socially, spatially, and temporally structured multilevel realities—history and context always matter, as do the lived realities of embodying (in)justice. How could they not? The privileging of individual-level phenomena by dominant theories, at the heart of the "individualistic fallacy," flies in the face of actual lived experience, as has its denigration of use of contextual data as mere "ecological fallacy."[217] Rather, as I wrote when reflecting on being at the first People's Climate March in 2014: "Indeed, the real 'ecological fallacy' is to think epidemiologists or others could ever understand the people's health except in societal and ecological, and hence historical, context."[218] Putting these ideas to work is the task of Chapter 2.