POWER AND THE ENVIRONMENT IN TYPE 2 DIABETES SCIENCE

By

Jennifer Carman Lai

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

Sociology—Doctor of Philosophy

2021

ABSTRACT

POWER AND THE ENVIRONMENT IN TYPE 2 DIABETES SCIENCE

By

Jennifer Carman Lai

In this dissertation, I use three conceptual frameworks from science and technology studies – political sociology of science, boundary objects, and actor-network theory – across three studies to examine how relations of power engender the production of environmental knowledge within type 2 diabetes science. In the first study, I examine how discourse on environmental factors related to type 2 diabetes have been distributed across time, journal venues, and research institutions within the United States. This in response to "who" produces knowledge in Western science being chronically understudied. Post-war depictions of science have only reinforced its reputation as an objective endeavor, where the chance to engage in knowledge production is equally shared among all who participate in the scientific process. Within type 2 diabetes science, such a reputation is upheld by a clear increase in engagement with environmental risk factors across a greater breadth of medical experts. However, based on a critical content analysis of scientific literature on environmental factors related to type 2 diabetes (160 research articles from 20 medical journals, published from 1990 to 2019), I show how such diversification of expertise associated with environmental knowledge production has been consolidated among a handful of scientific journals and institutions. When fitted to a political sociology of science framework, my findings lend further weight to the critique that the privilege and power – in other words, the sheer momentum – built up behind some research institutions and not others greatly influences who can capitalize on topics of scientific salience.

In the second study, I investigate how environmental factors have inadvertently facilitated the production of interdisciplinary discourse on type 2 diabetes. Within the context of Western science, there is a stereotype that knowledge production is siloed, that is, confined to discipline-specific paradigms. The assumption is that maintaining disciplinary boundaries lends itself to more sophisticated levels of expertise. Yet the idea of scientific siloes contradicts knowledge being produced on salient research topics – such as health and medicine – in which such topics are actually shared by multiple disciplines.

Based on a critical discourse analysis of scientific literature on environmental factors related to type 2 diabetes (160 research articles from 20 medical journals, published from 1990 to 2019), I show how environmental factors themselves act as a boundary object that links multiple groups of scientists under the same intellectual effort. In this case, the vague etiologies suggested by environmental factors within type 2 diabetes discourse allows groups of scientists to ensure that the production of knowledge does not cease. Such groups coast on its neutral connotation and conserve space within its interpretive flexibility to engage with pastiche science, where explanations of disease turn speculative and limited by scientists' positionalities. As such, in likening environmental factors to boundary objects, I shows how such object can facilitate a collective process of knowledge production that is nevertheless imbued with scientists' best-guesses rather than the results of rigorous empirical investigation.

Finally, in the third study, I examine how medical experts define and make sense of the environmental factors that they perceive are relevant to the lives of people living with type 2 diabetes. Within critical studies, the position of "expert" is a contentious one, since who is considered an expert largely depends on the social systems and knowledge infrastructures in place that provide credibility to such expertise. Within Western contexts, medical expertise is distinct in that it a site of tremendous prestige and authority. Thus the interpretation of environmental factors by medical experts are an important baseline to acquire, since it is their interpretations that are likely the most mainstream. By applying an abductive analysis to 24 in-depth interviews with medical experts located in the United States, I show how such experts perceived environmental factors as being one and the same as structural constraints that can prevent the pursuit of a healthy life for people living with type 2 diabetes. Further, I show how medical experts discussed environmental factors in tandem with what they perceived were structural constraints regarding *their* ability to provide effective interventions. Fitting these findings to actor-network theory, these findings suggest that for medical experts, environmental discourse within type 2 diabetes science is shorthand for relations of power that reproduce unjust distributions of disease.

For Wai Wong-Lai, Wing Tak Lai,
and Chelsia Lai, who is the sparkle in my universe.

ACKNOWLEDGMENTS

Thank you to my committee, stef shuster, Sandy Marquart-Pyatt, Cathy Liu, and Sean Valles, for seeing me through everything.

Thank you to Naomi Grobstein and her colleagues, and to all who agreed to be interviewed, for sharing their time, compassion, and wisdom. Your generosity made this project possible.

Thank you to the members of Sociology Students of Color, especially Angélica Ruvalcaba, Jihan Mohammed, Madeline Nash, and Praveena Lakshmanan; the PhD Job Club; and the Sociology Collective, especially Katrina Groeller and Kristina Beethem, for being there, beginning, middle, and end. I am excited to continue looking for third doors with you.

Thank you to Katie Cook and Monique Byas. Your love and generosity carried me through my program, and have impacted many lives beyond mine.

Thank you to Brittany Tucker and Chloe Qian. Your friendship is the most important thing I have earned.

Thank you to my family members for the red envelopes that accompanied me every time I left home.

Finally, thank you to Sam Lipschutz, for sharing the labor, and for making me laugh all this time.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

When it comes to knowledge production, embodied forms of knowledge seem to lie on the periphery of sociology. Sociology is a field that examines forces associated with the collective, while embodied knowledge suggests a focus on the individual. And yet I still have a sense that embodied knowledge is key for radical forms of care and the provision of services that constitute a just society. Embodied knowledge locates expertise on health and illness *at* the individual. This seems contradictory to a sociological approach, since focusing on individual experiences feels dangerously close to pathologizing. As such, the radical potential of embodied knowledge also hinges on the sharing of such knowledge across multiple people so that the most resilient conditions that shape health and illness can be identified. Engaging with such an approach, however, would require a major shift in regards to who we see as legitimate knowledge producers in society, and whose knowledge do we allow to shape society itself.

In this dissertation, I examine knowledge as a form of power that can be redistributed in order to meet multiple needs, and perhaps, achieve multiple forms of justice. I do this by following an approach that feels contradictory: I focus on the knowledge production processes of medical experts who work with people living with type 2 diabetes. My topic of interest is environmental factors, a term that has increased in appearance within medical discourse since the 1970s. There are several important puzzles associated with environmental factors in the context of medicine. One involves deciphering claims of ontological difference between “the body” and “the environment.” Since both the body and the environment are concepts that imply some form of materiality, discursive force is needed to make the corporeality of the body distinct from the “not corporeal, but still material” status of the environment. The second, and perhaps more pressing puzzle involves the extent to which the body, and embodied health, is an indicator for the unjust distribution of environmental factors. If environmental factors shape health outcomes that occur at the level of the body, why are the individual people who are constitutive of those bodies not perceived as knowledge producers?

This second puzzle taps into well-established debates regarding the efficacy of hierarchical forms of medical expertise. One problem with maintaining hierarchical forms of expertise is that such expertise is very difficult to access. This reserves medical knowledge, and its accompanying services and resources, to those most privileged. The second problem is that hierarchical forms of expertise assume that some types of expertise are more valuable than others, hence the hierarchical structure. In the United States, the most valued forms of medical expertise require years of education, training, and practice. There are high stakes with maintaining such expertise, and the work is not easy. Part of this project, then, suggests that one way to ease the burden on experts placed at the top of the hierarchy is to adopt a more flexible approach regarding who is seen as a credible knowledge producer of health, illness, and diseases like type 2 diabetes. People living with type 2 diabetes, who directly engage with any and all challenges related to health maintenance, are themselves experts in regards to what is needed to overcome those challenges. And there are signs that their expertise is sorely needed; type 2 diabetes incidence continues to increase worldwide (World Health Organization 2021). This implies that hierarchical forms of medical expertise are not enough to reduce the number of cases. Perhaps a combination of diverse forms of expertise would work better.

To follow an approach that combines multiple forms of expertise, however, would require not only a redistribution of power in regards to who is allowed to produce knowledge, but also the recognition that the perpetuation of health disparities is itself a *political* project. A central tenet of sociology is that no outcome is inevitable; by extension, health disparities do not have to happen. But they do, and the production of knowledge as a practice of power has a role in maintaining such injustices. By investigating how knowledge on environmental factors are produced within type 2 diabetes discourse, I show that even those at the top of the hierarchy, medical experts, perceive the ability to induce environmental change as a key mechanism for ameliorating health disparities in the United States. However, they also reveal that they do not have access to such power themselves; that power lies with someone or something else.

Below, I provide a brief history of the sociology of scientific knowledge in the West, noting how scholars have conceptualized power in tandem with classifying who is and is not perceived as a credible knowledge producer. I then discuss a small collection of environmental epistemologies that have been developed and applied in the social sciences, and how such epistemologies can provide a theoretical foundation to the consideration of environmental factors related to illness and disease. I then provide a summary of three studies that use conceptual frameworks from science and technology studies to reveal how relations of power shape the production of environmental knowledge within type 2 diabetes science.

POWER AND KNOWLEDGE IN WESTERN SCIENCE

In Western canon, social studies of science have moved along several major threads – or more specifically, along the scholarship of several major actors. For example, investigations of normative practices within clearly bounded scientific institutions is often associated with Robert Merton (Merton 1968; Merton 1973). In a similar vein, Thomas Kuhn's work evokes ideas about the maturation of scientific disciplines; indeed, Kuhn's description of non-linear consolidations of scientific expertise that engendered not only highly specialized knowledge production but also the occasional disruption of foundational concepts within a scientific field was a paradigm shift unto itself (Kuhn 1962). Importantly, Mertonian and Kuhnian examinations of scientific knowledge production took for granted the legitimacy of Western science's truth-seeking abilities, and likewise assumed that there were clear boundaries around where this work occurred. Within these narratives, post-war investigations of scientific knowledge production leaned heavily on the organizational consequences accompanying the transformation of scientific spaces from assembly-line laboratories run by charismatic and competitive innovators such as Thomas Edison, to sprawling, decentralized bureaucracies that belied its confinement to a strict chain of command (Hughes 2004). As such, scholars who studied how science was produced tended to fixate on how consensus was achieved among disparate organizational components, including funding, physical space, or competing interactions between groups of scientists (Cole 2004; Merton 1973).

Power was likewise explored as an organizational mechanism, but in a way that raised scientific institutions to the status of a cohesive, self-contained social actor. In other words, scientific institutions were treated empirically at the same level of corporations or the state. Thus when it came to explaining the origins of power, prestige, authority, and legitimacy in scientific settings, such concepts were typically described as nearly quantifiable resources wielded by scientific institutions in slow-moving but mighty battles with other public, state-adjacent, and private actors for opportunities to accumulate more of the same (Collins and Evans 2002; Shapin 1995). Importantly, throughout this work, the intellectual and often physical separation between science – that is, what was deemed scientific complexes and scientific experts – and society was thoroughly maintained (Hughes 2004). Scholars studying science from an institutional or organizational perspective during this era tended to uphold the assumption that scientists who carefully followed the scientific process were capable of making objective claims about the material world in a way that discarded any intervening effects from social contexts.

It took social scientists encroaching upon the laboratory and placing scientists' subjectivities under scrutiny to disrupt the assumption that the configurations of existing institutions reflected some kind of natural order (Shapin 2012). Early-career writings from Bruno Latour and Karin Knorr Cetina showed in detail the ad hoc incidents, judgment calls, and contingencies that aided – or indeed, constituted – the construction of "scientific facts" (Latour and Woolgar 1986; Knorr Cetina 2005). Knorr Cetina's work in particular demonstrated the processes by which "nature" was brought into scientific spaces and transformed via human interpretation into empirical objects imbued with scientific purpose and meaning (Knorr Cetina 1992; Knorr Cetina 2005). Latour's work in the laboratory only just preceded his work on actor-network theory, under which power was conceptualized as emergent of social relations between human and non-human actors rather than as a discrete, external resource (Callon 1984; Baron and Gomez 2016; Prasad 2017). The implications on institutional investigations of scientific knowledge production were groundbreaking. Under a social constructionist or post-structural conceptualization of science, institutions and the scientists who operated within them were figuratively dragged back into society, where they were susceptible, like everything else, to social forces that bred and maintained notions of difference and systems of inequalities. Likewise, in the years following this "cultural turn," the term "science" has, for some, implied the collective activities of uncritical experts whose work, produced in inefficient and often contradictory ways, concede to their desire to maintain their purpose and social authority. Such interpretations point to the tension that emerges around contested "expert" statuses

(Cable, Shriver, and Mix 2008; Morris-Suzuki 2014) and ongoing debates on the pursuit of “pure” versus “applied” science.

Outside of Western canon, stories about why Western science emerged the way it did were centered elsewhere. For feminist scholars of science, the social activities that constituted “science” were no less than a collective imposition of a hierarchical set of relations in which the oppression of nature and women occurred simultaneously. For example, Carolyn Merchant offered an expansive discussion on how conventional classification systems emerged in conjunction with the transformation of European feudal society into capitalist society (Merchant 1990). Such classification systems condensed around dichotomous descriptions of material and social reality, with ensuing concepts constructed such that they a) directly opposed one another and b) assumed a superior-to-subordinate orientation. Merchant, Val Plumwood, and others thus argued that key notions of social difference, such as “gender,” not only emerged from this era of global social transformation but have continued to underwrite present-day systemic inequalities (Merchant 1990; Plumwood 1993).

Accompanying this work were critiques by the likes of Donna Harding, Sandra Haraway, William Cronon, and others who further questioned scientific delineations between humans and non-humans. Their work demonstrated that the “nature/society divide” was deeply embedded in Western science and acted as an unexamined sorting mechanism that nevertheless determined whose perspectives, lived experiences, and social contributions were deemed scientific, and whose were not (Cronon 1996; Escobar 1999; Haraway 1999; Haraway 2017; Harding 1991). Haraway’s work was particularly instrumental in “troubling” the assumed “objective” status of scientists and their ability to hold themselves apart from their contextual embeddedness (Haraway 1999). The notion of partial perspectives, social situatedness, hybridity, and standpoint theory are all tools for articulating the limits of human knowledge within complex assemblages of humans, non-humans, space, and time (Haraway 1999; Harding 1991). Likewise, both Star (1991) and Haraway (2017) pushed back against the notion that science was inherently competitive and innovative, showing instead the painstaking labor and collaborative, interdependent, and affective relations between diverse entities of human and non-human actors that collectively shored up empirical findings (Star and

Griesemer 1989). Thus the major intervention of feminist scholars within the study of scientific knowledge was to model an acceptance that science was organized around intransigent ideas of social difference, while also accepting that science as a social project was far more complex, contingent, and uncertain than the myths surrounding Western science claimed.

Even feminist scholars of science who produced work with the intention to disrupt the gendered, classist, and racial hierarchies that underwrote conventional Western science were, as a majority, white. Thus it is imperative to note that decolonial, Black, and Indigenous scholars have been critiquing Western scientific canon and methodologies for centuries. Consequently, their work has been relegated to the margins of mainstream knowledge and pedagogical practices for just as long. Nevertheless, scholars like Ruth Wilson Gilmore, Aileen Morton-Robinson, Katherine McKittrick, Shatema Threadcraft, Linda Tuhiwai Smith, Harriet Washington, and Sylvia Wynter have produced countless volumes detailing how the production of Western science, law, civil society, and "normal" ways of being were founded upon – indeed, contingent upon – the overlapping oppression, enslavement, and continued colonization of racial bodies outside of Europe. Their work rejected the expectation of providing abstracted arguments that were the standard for objective, generalizable, "scientific" knowledge that could encompass a specified number of empirical cases. Rather, decolonial counter-narratives to the Western canon made space for the discussion of racist, capitalist, and colonial practices of establishing scientific outposts and "field" locations in order to gather exotic specimens, of both the human and non-human variety, that were the basis for Western scientific "discoveries" and imaginaries (Jasonoff and Kim 2015; Smith 1999). Thus decolonial scholars critiqued, decentered, and expanded upon white feminist arguments that Western science was solely organized around the oppression of women, wrenching open the discussion to also include the histories and lived experiences of Black, Brown, Indigenous, and Asian bodies.

ENVIRONMENTAL EPISTEMOLOGIES

As an environmental concept, materiality brings attention to the material presence of "things" (Ingold 2012) and how "things" have a part in shaping social relations. Oyěwùmí (1997) has commented on how the body has been treated as a separate site of scientific investigation in Western science, with scientists downplaying its materiality in lieu of more isolated and abstracted depictions. Yet the body remains the the material core of society (Oyěwùmí 1997). For the purposes of this project, the body is also where material dimensions of knowledge emerge from. Knowledge developed at the scale of the body is imbued with intangibles, such as emotions, that are often ignored within the scientific process. Yet material, emotional, and ultimately embodied forms of knowledge are highly relevant to discussions on health and illness, specifically regarding how subjective experiences of health compare with established medical science. While many scholars have written about political movements initiated to shift embodied knowledge into the "non-expert" side of medical knowledge (Monteleone 2018), sociology continues to perpepuate a contradiction regarding the measurement of disease prevalence relying on embodied indicators *without* acknowledging the embodied status of disease. Conversely, to acknowledge the embodied status of disease would be to acknowledge the agency and humanity of bodies living with disease, and their expertise regarding these experiences.

The ontological status of the body sits within a larger discussion of how to incorporate material dimensions of reality into social analyses. In sociology, much of this discussion takes place in environmental sociology, where material dimensions of reality are likened to "the environment." Here, scholars have debated about whether the environment should be treated as a venue upon which social change occurs, or whether the environment can also interact with, and therefore shape, social change. In other words, this debate is about how to position the environment as a social actor. Within environmental sociology specifically, there are two major positions.

The first position assumes that there is a strict boundary between humans and the environment and their respective contributions to social change; this is also known as the "nature-society divide" (Freudenberg, Frickel, and Gramling 1995). The second position rejects this boundary by arguing that humans and nonhumans are not ontologically distinct (Freudenberg et al. 1995; Ingold 2012). Instead, humans and nonhumans alike contribute to a reality constituted by relationships, with relations between material or semiotic things forming what we call “society” (Bakker and Bridge 2006; Banerjee and Bell 2007; Lloro-Bidart 2017).

Under a “nature-society divide” epistemology, ontological separation of society and the environment is key. Such an epistemological perspective includes environmental determinism, cultural determinism, and a specific rendition of cultural determinism involving the social construction of nature. Under environmental determinism, scholars place humans as one of many species contained within the same ecological system. Here, humans are situated in a passive position where their control and impact on the environment is limited. Conversely, under a cultural determinist paradigm, humans have supremacy over the environment in that they delineate what the environment is, define it, assign meaning to it, consume it, and use it as a political resource to impose specific forms of social order (Molnar 2016). Here, humans are responsible for social change, and the environment is the medium through which they can extend their political intentions.

As mentioned, a prominent example of a cultural determinist application to the environment involves the social construction of nature, in which it is assumed that all that we know about “the environment” is filtered through human interpretation. In other words, the physical dimensions of the environment can be interpreted multiple ways across individuals. Different “landscapes” (Greider and Garkovich 1994) are constructed by different symbolic and cultural frameworks, even though each framework might reference the same physical, material features. Taken to the extreme, privileging local or individual interpretations of nature under a strict interpretation of social constructionism (Brown 1995) assumes that nature is entirely subsumed by society. Thus knowledge produced under a constructionist outlook reflects a “staunch commitment” (Catton and Dunlap 1978:43) to socionature relationships being a result of human-centered social work.

A nature-society divided epistemology also accommodates the idea of reciprocal effects exchanged between nature and society, or what Freudenberg et al. (1995) call a “balanced dualism.” Under a reciprocal effects perspective, society and the environment impact each other as separate, independent entities. In particular, the environment is regarded as part of an objective reality composed of strictly nonhuman, material, and biophysical entities. Human beings thus have a certain latitude to enact their intentions and actions, but the environment can also act back. Under certain conceptual frameworks, particularly ecofeminism and risk society, the environment is a source of unpredictability and unknowability (Cable et al. 2008; Plumwood 1993).

A third perspective rejects the ontological divide between nature and society and instead depicts reality as following a "socionature" configuration. Rather than referring to nature and society as separate domains, a socionature epistemology conceptualizes nature and society as co-constituted and mutually contingent (Freudenberg et al. 1995). Under anti-essentialist interpretations of socionature, the analytical focus is less on what things "are," and more on the processes by which things come to be (Swyngedouw 1999; Escobar 1999; Rice 2013). Thus socionature is not a singular concept, but has instead been described as material and semiotic hybrids, dialectical formations, and evolving configurations of "matter and energy" (Ingold 2012:431).

In recent decades, discussions of socionature have taken the form of scrutinizing nonhuman agency and materialism. Both concepts are interrelated. To evoke materialities is to attend to a rich world of nonhumans and nonliving matter that simultaneously occupies both tangible and social worlds, and is therefore embedded with contradictions, conflicts, and power struggles (Bakker and Bridge 2006). While it is impossible to avoid human projections and interpretations of nonhuman agency, the point is that nonhuman actors produce political effects – that is, they assert power – in our social reality.

Such interpretations tip over into "mundane" (van Koppen 2017), everyday processes of materiality that are hyper-localized in terms of time and space (Sorenson 2007; Rice et al. 2015). For some scholars, even the body can be interpreted as a form of materiality that is privy to critical analysis. Under this paradigm, the body is both a site of inscription and interpretation, and thus an extension of metabolic processes and social inequalities (Bruun and Langlais 2003; Escobar 1999). It is due to the major specificity of their origins that embodied knowledge and embodied health conditions emerge from the everyday to become a political resource (Rice et al. 2015; Molnar 2016), most often drawn into counter-narratives that inform environmental justice movements (Taylor 2000; McCormick 2003; Brown Zavestoski, McCormick, Mayer, Morello-Frosch, and Gasior-Altman 2004; Klawiter 2008; Brown, Morello-Frosch, and Zavestoski 2011; Tironi and Rodrigeuz-Giralt 2017).

NATURE, BODIES, AND DISEASE

With this in mind, the extent to which Western canonical practices continue in medicine, even in the context of science that ostensibly examines health impacts from structural inequalities, is one of the major motivations of this study. I take a critical stance on an assumption that I believe is central to the perpetration of these practices: nature is likened to the material basis of society, and is therefore likened to physical, living bodies (Gilmore 2018; Oyěwùmí 1997). It is also my belief that what Oyěwùmí (1997) calls the biological determinism underwriting Western scientific endeavors has not been reconciled in social studies of scientific knowledge, even among works that accept the existence of hybrid, complex, monstrous beings and worlds between humans and non-humans (Haraway 2017). It almost seems as if admitting that social actors engage with some form of embodiment is perceived as endangering the social dimensions of our analyses.

The consequences of omitting discussions about the slippery slope between “nature” and “bodies” are especially serious in studies of health disparities, where bodies, usually *embodying* an adverse health condition (e.g., disease, illness, injury), are positioned as subjects of urgent scientific study. The situation is made even more complex due to the recent enrollment of “environmental factors” into epidemiological studies of chronic diseases such as type 2 diabetes. Certainly consideration of environmental factors conveys an authentic desire by scientists to engage with the contextual and structural mechanisms that make the development of disease more likely. As such, at one level, their inclusion almost feels like a weak form of justice: focusing on contextual factors pushes against the narrative that disease is a product of individual choices or behaviors. At another level, feminist and decolonial scholars would still feel compelled to carefully scrutinize the *characterization* of environmental factors within these studies in order to determine the extent to which “environmental factors” contributing to disease and illness can actually be addressed in the context of clinical practice.

In other words, until quite recently, any likeness with nature, even the bodies that humans were beholden to, were perceived as subordinate to science and thus subject to empirical inquiry. Nature was positioned as both the object and subject of science, though both terms implied a lesser agency than the initiator of the studies themselves (Escobar 1999; Harding 1991; Baron and Gomez 2016). Studies of health disparities deal directly with bodies, and with bodies clustered according to the presence of disease across both space and time. Bodies, then, are used to justify scientific research, but are these bodies also perceived as knowledge producers? Within Western science, only some bodies are, while others are firmly designated as subjects-objects. What then are the relations of power that hold these bodies in their place? How do different types of bodies – sometimes labeled “expert” bodies versus “subject-object” bodies – reproduce injustice within processes of knowledge production in type 2 diabetes science?

The logical flow is thus: Science is not removed from society, and cannot be separated from the lived experiences, or positionalities, of scientists themselves. Unlike 20th century mythical depictions of science, scholars in science and technology studies have shown how scientists’ subjectivities bleed in, or altogether inform, the scientific process being followed for empirical investigation (Knorr Cetina 2005). Indeed, scholars like Sandra Harding would argue that acknowledging scientists’ lived experiences enables a stronger form of objectivity. However, if lived experiences are considered an important source of knowledge in health and medicine, then the lived experiences of those who embody indicators of disease are an inextricable part of medical science. When it comes to environmental factors, it can be argued that such bodies constitute the expertise needed to ameliorate unjust distributions of disease, since it is such bodies who are encountering environmental factors directly. At minimum, such embodied knowledges trouble the notion of traditional medical expertise.

In the following chapters, I use three conceptual frameworks from science and technology studies to draw out specific pieces of this central contradiction between embodied knowledge and the hierarchical structure of conventional medical expertise. In the first chapter, I draw on Frickel and Moore's (2006) "political sociology of science" to consider why more diverse forms of expertise participating in environmental knowledge production does not preclude the consolidation of knowledge by a handful of institutional actors. In the second chapter, I use Star and Griesemer's (1989) boundary objects framework to show how knowledge production has collectively progressed among disparate groups of scientists who only marginally share similar conceptualizations of "the environment" in the context of type 2 diabetes. In the third chapter, I examine how medical experts use "environmental factors" as a shorthand to refer to relations of power that reproduce material barriers to type 2 diabetes management, while simultaneously reproducing constraints in the provision of services such that experts feel limited in their ability to effectively intervene. I end by considering how the redistribution of knowledge-power to people whose bodies are highly relevant to any disease of interest, not just type 2 diabetes, was cited by multiple medical experts as a worthy pursuit because, quite simply, doing so would help them do their jobs better. Nevertheless, the option was framed as infeasible, though the reasons were not named. I argue that it is incumbent on sociologists of science and scientific knowledge production to name the reasons.

DOMINANCE AND DIVERSIFICATION OF EXPERTISE IN TYPE 2 DIABETES SCIENCE

INTRODUCTION

In recent decades, type 2 diabetes prevalence has increased so dramatically, public health scholars have started calling it an "epidemic" (Hu 2011). The Centers for Disease Control and Prevention (CDC) estimates that around 10.5% of the United States population has type 2 diabetes; this is both diagnosed and undiagnosed cases (CDC 2020). Meanwhile, its designation as a "multifactorial" disease – that is, a disease that develops after a convergence of multiple risk factors – hints at some of the challenges that both practitioners and people living with type 2 diabetes face regarding its prevention and treatment. Its widespread prevalence also points to our failure to stop its spread. Despite its high impact on the body over time – some complications include long-term damage to the heart, blood vessels, eyes, kidneys, and nerves, and diabetes is also linked to other noncommunicable diseases like cardiovascular disease (World Health Organization 2021) – its commonplace status lends itself to the perception that type 2 diabetes is a disease that people just have to live with.

It is against this backdrop that a surge of interest in environmental factors associated with chronic diseases, including type 2 diabetes, have emerged. Numerous environmental justice and health justice movements have paved the way for framing "the environment" as a potential source of harm to human health (Brulle and Pellow 2006; Taylor 2000). Notably, within these movements, "the environment" has been positioned as a more or less neutral venue in which potential harm can occur as a consequence of anthropogenic activities. Technological disasters, non-point source pollution, and the uneven distribution of environmental "bads" (Cable et al. 2008; Elliot and Frickel 2005; Grant, Trautner, Downey, and Thiebaud 2011) – all have been perceived as downstream of *human*-led decisions. Thus concepts like "environmental justice" and "environmental health" – terms that were eventually enfolded into formal initiatives backed by state agencies – suggest that "the environment" absent of human intervention has a role beyond causing harm to health. As a neutral actor, the environment can also offer resources and embodied experiences that can motivate, maintain, or improve healthy living.

Because it is considered a multifactorial disease – that is, the causes of disease are multiple and disparate – type 2 diabetes is also vulnerable to this discourse. In recent decades, a number of potential risk factors related to type 2 diabetes have been framed as environmental factors. But the appearance of "environmental factors" in type 2 diabetes etiology lends itself to additional questions about the accessibility of medical knowledge production, specifically regarding whether embodied experiences with disease are perceived as legitimate medical expertise. Intended or not, to claim that environmental factors could potentially contribute to the development of type 2 diabetes is to engage with the implications of environmental knowledge in the vein of environmental and health justice. Environmental knowledge produced under a health justice paradigm prioritizes situated, subjective, and embodied experiences of health. This knowledge is subsequently shared and synthesized among other individuals looking for answers to their health issues, and can eventually spur collective action (McCormick 2003; Tironi and Rodriguez-Giralt 2017). Sharing and consolidating knowledge within these movements is slow work that is nonetheless pursued by individuals because they no longer trust medical, government, or corporate authorities (Taylor 2000). Thus environmental and health justice movements operate on processes of knowledge production that are highly accessible to numerous actors – or at least, they are intended to be (Brown et al. 2011). Applying these principles to type 2 diabetes, there is additional motivation to enroll previously-unconsidered forms of expertise into its prevention and treatment, since, as discussed, its widespread prevalence suggests that continued adherence to conventional – that is, hierarchical – notions of medical expertise are not working to slow down the epidemic.

In this study, I evaluate the extent to which knowledge produced on environmental factors within type 2 diabetes research has unfolded across scientific disciplines over time. Specifically, I examine the institutional actors who have participated in environmental knowledge production within type 2 diabetes science published from 1990 to 2019. A focus on institutions allows me to engage with hidden forms of power, privilege, and resources that underwrite what seem to be decentralized but are often deliberate political maneuvers. Identifying which institutions and forms of expertise are involved with environmental knowledge production can subsequently reveal which environmental factors are named and prioritized as major drivers of diseases like type 2 diabetes. By asking, who produces knowledge on "the environment" in type 2 diabetes science, I simultaneously engage with the radical potential of environmental knowledge production to underwrite collective movements for justice, and the distinctly hierarchical forms of expertise that are associated with health and medicine in the United States.

My findings show that knowledge production on environmental factors within type 2 diabetes science is unevenly distributed across journals, areas of expertise, and institutions. More specifically, they suggest that institutions with greater access to financial and political resources (e.g., larger endowments, or perceived prestige) can dominate the discussion on environmental factors for more than a decade due to consolidation of knowledge-power. Due to their disproportionate influence, I show that epidemiological, environmental health, and public health interpretations of environmental factors are most relevant within medical discourse now. Importantly, such areas of expertise are partial to definitions of environmental factors commensurable to *population-level* measures of type 2 diabetes. This suggests that there is limited representation of environmental factors related to the *lived experiences* of type 2 diabetes in medical science. Thus the perpetuation of situating certain bodies as the “subjects” of science, rather than as active decision-makers, continues.

BACKGROUND

A major contribution of science and technology studies (STS) scholarship has been the reframing of scientific knowledge production as an outcome of power. The intention of this framing was to refute the myth of science as an apolitical, purely objective process (Croissant and Restivo 1995). Discussions of power, however, sat uneasily in a field that had largely been shaped by poststructuralist and feminist theory. Structural forms of power, which suggest a certain unity regarding the reproduction of social relations that constitute what power *is*, were not the main focus of STS analyses historically. Instead, STS contributions to power and knowledge production centered on the micropolitics that unfurled within the everyday social activities that we called science (Knorr Cetina 1992; Knorr Cetina 2005; Latour and Woolgar 1986). Feminist disruptions of social categories of difference, while originating from critiques of structural inequalities, fixated on the complexities, contradictions, and forms of cooperation that, many argued (Haraway 1999; Harding 1991), were deliberately removed from modern scientific narratives. Actor-network theory, a methodology that could trace the transformation of power along emergent relationships between humans and non-humans (e.g., animals, but also data visualizations, policies, and other material and semiotic representations of the phenomena under study), became an exemplar of an STS approach to power (Baron and Gomez 2016). Here, “structures,” contingent on evolving social orders, hierarchies, and classification schemes, were not just assumed (Callon 1984; Latour 1986), but were accounted for within specific configurations of space, time, and actors.

In response to this unsteady dance around the topic of power, Frickel and Moore (2006) suggested examining how *institutions* shaped scientific knowledge production, specifically within Western contexts. For Frickel and Moore (2006), institutions represented a consolidation of ideas, values, and orders that could take the physical form of academic institutions, such as universities, and state agencies, such as the National Institutes of Health. An examination of institutions could reveal how knowledge production was contingent on the social roles, bureaucratic processes, and negotiations with other institutions for resources in order to capitalize on issues of political salience or longstanding areas of study seen as having inherent value (see Douglas [2014] for discussions of “pure” versus “applied” science). Thus Frickel and Moore’s (2006) “political sociology of science” focused on institutional politics as the accumulation and exchange of prestige, money, gatekeeping ability, and social trust by academic institutions and states agencies, but they also left room to discuss how the procedural components of institutions – e.g., rigmarole, formal versus informal practices – could set standards, conditions, and norms that scientists invariably conformed to while pursuing their everyday work. In other words, scientists, no matter their beliefs about maintaining an “objective” stance, were embedded within institutional politics and were thus political actors.

A focus on institutions within the study of scientific knowledge production also had potential to move the disparate ends of structural and poststructural notions of power closer together. Frickel (2004) demonstrated this while investigating how genetic toxicology emerged as a bonafide discipline. In his study, funding opportunities, network dynamics, and the reframing of scientific problems converged in a way that reached enough political salience to transform scientists' expert identities into formal scientific practice. Kleinman (2003) likewise traced how commercial goals and activities transformed into operational directives that scientists encountered within everyday research contexts. Working in the vein of laboratory studies, Kleinman (2003) revealed that a major task of "doing science" involved optimizing conflicting incentives between "commercial" and "pure science" interests. Approaching from another direction, Frickel, Gibbon, Howard, Kempner, Ottinger, and Hess (2009) drew attention to the ability of decentralized institutional power to suppress knowledge production on urgent issues such as health and environmental injustice; Frickel et al. (2009) called these underinvestigated topics, "undone science." Jeon (2019) elaborated on the normalization of undone science within the laboratory settings of environmental scientists. Perhaps not so coincidentally, scientists featured in Frickel et al.'s (2019) work made claims about "the environment" being too complex for rigorous empirical investigation, which subsequently formed the basis for institutional justifications regarding why some lines research were pursued and not others.

Who produces knowledge on environmental factors

Within work on scientific knowledge production, the conceptual split implied by "scientific knowledge" and "environmental knowledge" provides an intriguing case of power and privilege engendering allegedly new forms of knowledge. Western science, after all, originated from the Othering of "nature" and thus subsumed many things – humans and non-humans like – under its designation (Bird 1987; Banerjee and Bell 2004; Cronon 1996; Merchant 1990; Plumwood 1993). This suggests that Western scientific practice, founded upon the study of nature separate from society, pursues a specific type of knowledge when using the term, "the environment." For example, in areas like environmental health and environmental justice, "the environment" is treated as a site where radical forms of expertise are grounded. This means that knowledge *about* human-environmental interactions often become an important catalyst for grassroots agency and political action (Cable et al. 2008; Morris-Suzuki 2014). More broadly, environmental justice movements hinge on the idea that the environment, due to its ubiquity, engenders knowledge production at an everyday, embodied level, and as such, is valid as expertise unto itself. This argument is especially important when local expertise emerges in response to active neglect or dismissal regarding urgent health issues by established scientific authorities (Brown et al. 2004; McCormick 2003). As such, within these movements, scientific investigations on “the environment” suggest a democratizing effect. The logic being, everyone interacts with the environment and thus contributes unique knowledge downstream of technological disasters and the diffuse spread of pollutants (Brown et al. 2004; Brown 2017).

In other words, who produces knowledge on the environment matters. However, not everyone can access environmental knowledge production in the same way. As discussed, decolonial and feminist scholars have written at length about how Western science was predicated on the Othering of “nature.” This means that the establishment of Western science was contingent on the colonization and classification of Black, Brown, Indigenous, and Asian people as less civilized, less human, and thus ontologically closer to “the environment” (Threadcraft 2016; Washington 2006; Wynter 1994). Such origins continue to impact divisions of labor that contribute to specific reproductions of marginalization within scientific settings like the academy (Moore, Acosta, Perry, and Edwards 2016). In short, because of colonialist logics that likened Black, Brown, Indigenous, and Asian people to “the environment,” these same groups struggle to accumulate legitimacy and authority as scientific knowledge producers. Instead, such groups are far more likely to be the subject-objects of science rather than its instigators.

Taken together, it is clear that there is a contradiction that sits at the heart of knowledge produced on “the environment.” For one, the ubiquity of the environment suggests a potential for democratizing knowledge, where subjective experiences and embodied interactions with the environment are part and parcel of our human engagement with material reality. At the same time, “the environment” has also been used within scientific discourse to establish social orders and classification schemes that underwrite an invisible but rigid hierarchy regarding who is perceived as a scientist or knowledge producer. In this study, I want to address this contradiction by investigating who produces knowledge on “the environment” within the high-stakes context of chronic disease, specifically type 2 diabetes. As discussed, type 2 diabetes is perceived as so commonplace, public health experts have described it as a global epidemic (Hu 2011). Following this logic, it seems worthwhile to ask, does such widespread impact translate into democratic configurations of knowledge production on type 2 diabetes?

HYPOTHESES

As Frickel and Moore (2006) argue, focusing on institutions of knowledge production does not negate critical investigations into processes of knowledge production. Institutional conditions manifest in scientists' everyday work, and individual scientists can press back on institutional standards in important ways. With this in mind, I have focused my analysis on the institutions that contribute to environmental discourse within type 2 diabetes science. Two additional concepts have organized the process by which I answer my research question, "Who produces knowledge on 'the environment' within type 2 diabetes science?" The first concept considers who is dominating the production of environmental discourse, with dominance defined by the frequency of research contributions from a specific area of expertise during the study period – in this case, from 1990 to 2019, or a period of 30 years.

The second concept concerns the diversification of scientific disciplines, which is partially inspired by Kuhnian arguments regarding the evolution of scientific expertise (Kuhn 1962). In this study, diversification of scientific disciplines may unfold within two distinct venues: within areas of expertise associated with producing knowledge on environmental factors, and within academic, government, and other research institutions. My goal is to show which areas of expertise and which institutions have expanded their purview of study to include environmental factors over time, since this would imply an expansion of the "who" associated with knowledge production on environmental factors. However, such an expansion could also suggest a consolidation of dominance among certain areas of expertise, or among certain academic units or institutions over time. In other words, just because there are more areas of expertise involved with producing knowledge on environmental factors related to type 2 diabetes does not mean that the power to produce is equally shared among areas of expertise. Such dynamics are likewise important for precisely defining the "who" behind knowledge production on environmental factors related to type 2 diabetes. In summary, my hypotheses are:

> Hypothesis 1: Epidemiological sciences consistently dominated knowledge production on environmental factors related to type 2 diabetes from 1990 to 2019. Their dominance has implications for how environmental factors within type 2 diabetes disparities research are

characterized, since human-environmental relations are configured in specific ways within these studies, e.g., “environmental factors” are assumed to be external to human bodies.

Hypothesis 2: Areas of expertise associated with producing knowledge on environmental factors related to type 2 diabetes grew more diverse from 1990 to 2019. However, this increase in diversification may have only occurred within certain disciplines, academic units, or institutions, the implication being that only those who had the resources for adding or expanding areas of expertise were actually able to diversify.

METHODS

Within the health sciences, research journals are a primary source of medical knowledge and practice (Jutel 2010; Rasmussen 2020). Thus information on environmental factors within scientific literature can directly impact how medical knowledge is understood and applied to address health issues such as type 2 diabetes. For these reasons, scientific literature is an important “site” of scientific investigation (Rasmussen 2020). Following this logic, I selected scientific literature, produced by scientists who themselves are affiliated with institutions such as universities and state agencies, as the unit of analysis within my investigation of who is producing environmental discourse within type 2 diabetes science.

Sampling

I examined the scientific literature on type 2 diabetes from 1990 to 2019, or over a period of 30 years. I selected this period based on my assumption that examining scientific literature produced over 30 years would reveal important changes in how “the environment” was conceptualized within type 2 diabetes science. Following Timmermans and Tavory (2012)’s argument that qualitative fieldwork often involves gut instinct, I began by selecting six initial areas of expertise listed on Web of Science that pulled from a broad range of scientific disciplines associated with type 2 diabetes. These areas included “endocrinology and metabolism,” “medicine (general and internal),” “nursing,” “toxicology,” “nutrition and dietetics,” and “public, environmental, and occupational health” (Clarivate Analytics 2020). I then identified five peer-reviewed journals in each area that had produced the highest journal impact factor (JIF); at the time of selection, the JIF rankings provided for each journal were calculated in 2018. I also examined the year that each journal was founded, since my intention was to elaborate on conceptualizations of environmental factors in journals that were established before the 30-year study period. Journals that were founded after 1990 were removed from my sample. After this step, twenty journals remained from which I could use to build my sample of research articles.[1]

The process I used to select research articles for my final sample required several revisions. As many scholars have discussed, ongoing revisions in sampling procedures for qualitative work are typical (Timmermans and Tavory 2012). For example, Tarozzi (2015) argued that qualitative research defied any set formulas. Rather, the process of doing research often involved bursts of epiphany in conjunction with completing ordinary tasks in daily life. In this study, such nonlinear developments were most evident in deciding on the criteria I would use to select my sample. I ended up developing a stricter set of criteria – criteria that I believed would be the most effective for answering my research questions – in tandem with examining the research articles I had already collected. The research articles that made up my final sample thus had the following characteristics:

- The focus of the research article had to be on type 2 diabetes. I determined which research articles fit this criteria by searching for articles that contained "type 2" and "environment" at least once, respectively, in the text. Articles that focused on type 1 diabetes were removed from the sample, as were articles where type 2 diabetes was one of several comorbidities, or one of several explanatory variables. Following Jutel's (2010) selection process[2], I also excluded articles

[1] In her study on the discursive construction of medically unexplained symptoms, Jutel (2010) sorted her sample of research articles by "research reports" and "perspective/opinion pieces." I took this as a signal to likewise include editorials, commentaries, and reflections (that is, "non-empirical" literature) in my sample.

[2] Jutel (2010) used two or three terms to search for articles for her sample; she also opted not to use terms that were considered colloquialisms. I followed this process in that I also wanted to include research articles that made explicit reference to type 2 diabetes, rather than articles that alluded to it (e.g., "chronic disease," "metabolic diseases"). Importantly, my selection process was not as comprehensive as those used for meta-reviews. A key difference is that I allowed my selection process to evolve based on my ongoing encounters with the data. Like Jutel (2010), I am confident that my navigation of "intertextual connectivity, critique, interest, expertise, independence, tacit knowledge, chance encounters with new ideas, and dialogic interactions between researcher, 'literature,' and 'data'" (Jutel 2010:232) was reliable enough to build a representative sample.

that focused on medical conditions that were described as preceding type 2 diabetes (e.g., insulin resistance, prediabetes), or were described as a complication of type 2 diabetes (e.g., renal disease).

- The article had to focus on human research participants.
- The article had to feature a first author who was working from an academic, government, or research unit or institution located in the United States, and/or the dataset containing the type 2 diabetes-related outcome variable had to feature human research participants based in the United States.
- The article had to be published between 1990 and 2019.
- The article had to be written in English.

After refining my initial sample, I was left with 160 articles that were published between 1990 and 2019 from 20 peer-reviewed journals spanning 6 areas of expertise pertaining to health, medicine, and type 2 diabetes as defined by Web of Science. Table 1.1 shows the journals associated with each area of study and associated areas of expertise, their corresponding JIF, and the year that each journal was established.

Analytical approach

For this study, I focused on identifying the "who" behind the production of research articles on environmental factors related to type 2 diabetes over time. Specifically, my goal was to identify who, if anyone, dominated knowledge production on environmental factors in terms of areas of expertise, and to trace the distribution of such expertise across scientific institutions. I also drew inspiration from Healy and Moody (2014), who commented that sociologists did not engage frequently enough with data visualizations to present their results. Since I was examining trends over time, I found that data visualizations such as graphs and heat maps illustrated these trends in a compelling manner.

Table 1.1. Peer-reviewed journals used to build sample of research articles published between 1990 and 2019 (N = 160)

Areas of expertise	**Title of journal**	**JIF (2018)**	**Established**
Endocrinology and metabolism	*Diabetes Care*	15.27	1978
	Endocrine Reviews	15.17	1980
	Diabetes	7.20	1952
	Diabetologia	7.11	1965
	Metabolism	6.51	1952
Medicine (general and internal)	*The New England Journal of Medicine*	70.67	1812
	The Lancet	59.10	1823
	The Journal of the American Medical Association	51.27	1883
	The British Medical Journal	27.60	1840
	Annals of Internal Medicine	19.32	1927
Public health, environmental, and occupational health	*Annual Review of Public Health*	10.78	1980
	Environmental Health Perspectives	8.05	1972
	International Journal of Epidemiology	7.34	1972
	Epidemiologic Reviews	6.46	1979
	American Journal of Public Health	5.38	1911
Nursing, toxicology, nutrition and dietetics	*Annual Review of Pharmacology and Toxicology*	12.10	1961
	Critical Reviews in Food Science and Nutrition	6.70	1970
	The American Journal of Clinical Nutrition	6.57	1952
	International Journal of Nursing Studies	3.57	1963
	Journal of Nursing Scholarship	2.54	1967

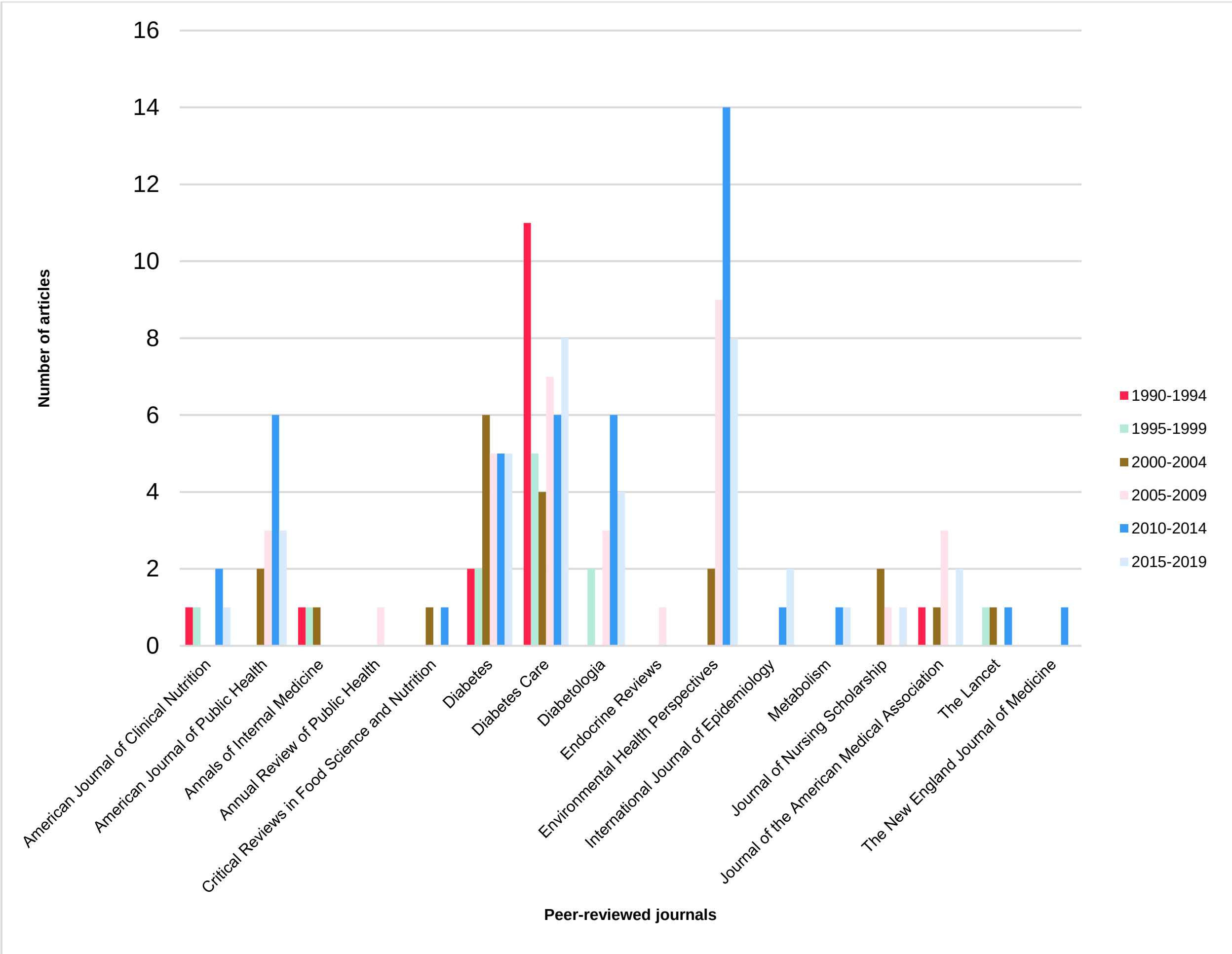
RESULTS

To answer the question, who produces knowledge on the environment within type 2 diabetes science, I identified who produced research articles on environmental factors most frequently within a fixed number of peer-reviewed journals over a period of 30 years. I also considered the question, how does the “who” map onto the ways in which environmental factors were being characterized by areas of expertise according to “where” their expertise was most relevant: for example, in the clinic, or in the laboratory. The results of “who produced knowledge on environmental factors” are organized by peer-reviewed journals and areas of expertise. I also show how areas of expertise are distributed among the most frequent institutional contributors over time.

Dominance in peer-reviewed journals

Figure 1.1 shows the number of research articles featuring environmental factors related to type 2 diabetes published for every five-year period between 1990 and 2019, for each peer-reviewed journal. Overall, for multiple peer-reviewed journals, the number of research articles featuring content on environmental factors increased over time.

Figure 1.1. Peer-reviewed journals contributing to knowledge on environmental factors within type 2 diabetes science (1990-2019, N = 160 research articles)



During the 1990s (represented by the red and green bars), *Diabetes Care* and *Diabetes* were the most prolific venues when it came to article production, with *Diabetes Care* (11 articles produced) moreso than *Diabetes* (2 articles produced). Starting in the mid-2000s (represented by the pink bars), several peer-reviewed journals not only entered the conversation on environmental factors, but overtook *Diabetes Care* in regards to article production. For example, *Environmental Health Perspectives* produced 9 articles, compared to 7 articles from *Diabetes Care*, during the 2005 to 2009 period. During the 2010 to 2014 period (represented by the dark and light blue bars), *American Journal of Public Health*, *Diabetologia*, and *Environmental Health Perspectives* either matched or exceeded the 6 articles produced by *Diabetes Care* during the same period.

Figure 1.2. Number of articles produced on environmental factors from five most prolific peer-reviewed journals (1990-2019)

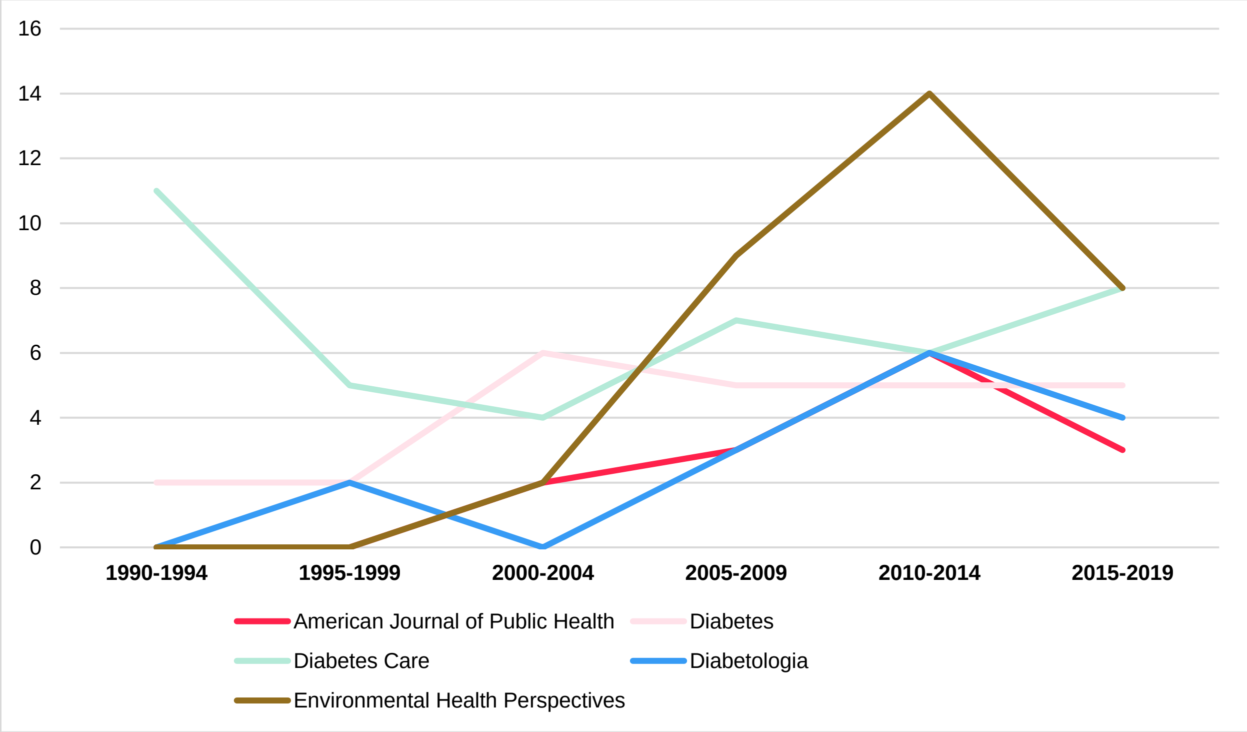


Figure 1.2 shows trends in article production for the five most productive peer-reviewed journals from 1990 to 2019. These journals were *American Journal of Public Health* (14 articles produced in total), *Diabetes* (25 articles produced in total), *Diabetes Care* (41 articles produced in total), *Diabetologia* (15 articles produced in total), and *Environmental Health Perspectives* (33 articles produced in total). In general, increased production of research articles on environmental factors related to type 2 diabetes can be observed across all journals considered. Although it appears that fewer articles were produced during the 2015 to 2019 period when compared to the 2010 to 2014 period, this may be attributed to the sampling procedure. That is, articles published in 2019 may still have been in production during the period I was selecting my sample[3]. When considering each decade between 1990 and 2019, the total number of research articles featuring content on environmental factors related to type 2 diabetes were 28, 53, and 79 articles published during the 1990s, 2000s, and 2010s, respectively.

For several peer-reviewed journals, other trends can be discerned. Figure 1.3 shows the percentage of research articles produced by each peer-reviewed journal (out of the total number of articles published) during each five-year period, with journals sorted from highest to lowest JIF. While journals like *The New England Journal of Medicine* or *The Lancet* have high impact factors, it is clear that they have not been the major venue for ongoing developments in discourse on environmental factors related to type 2 diabetes. Rather, journals that specialize in diabetes medicine, such as *Diabetes Care* and *Diabetes*, have consistently produced articles over a 30-year period to the point where the percentage of articles contributed has never fallen below 10% for each five-year period considered. Indeed, out of all peer-reviewed journals considered, *Diabetes Care* and *Diabetes* are the only two journals that contributed at least one research article for each five-year period considered. This suggests that peer-reviewed journals that focus on diabetes have remained invested in producing discourse on environmental factors.

[3] I downloaded the articles that made up my final sample on December 14, 2019.

Figure 1.3. Percent contributions from peer-reviewed journals sorted by journal impact factor (1990-2019, N = 160 research articles)

Peer-reviewed journals[4]	**Percent contributions by peer-reviewed journal**						**Journal impact factor (JIF)**
The New England Journal of Medicine	0%	0%	0%	0%	2%	0%	70.67
The Lancet	0%	8%	5%	0%	2%	0%	59.10
Journal American Medical Association	6%	0%	5%	9%	0%	6%	51.27
Annals of Internal Medicine	6%	8%	5%	0%	0%	0%	19.32
Diabetes Care	69%	42%	20%	21%	14%	23%	15.27
Endocrine Reviews	0%	0%	0%	3%	0%	0%	15.17
Annual Review of Public Health	0%	0%	0%	3%	0%	0%	10.78
Environmental Health Perspectives	0%	0%	10%	27%	32%	23%	8.05
International Journal of Epidemiology	0%	0%	0%	0%	2%	6%	7.34
Diabetes	13%	17%	30%	15%	11%	14%	7.20
Diabetologia	0%	17%	0%	9%	14%	11%	7.11
Critical Rev. Food Science Nutrition	0%	0%	5%	0%	2%	0%	6.70
American Journal of Clinical Nutrition	6%	8%	0%	0%	5%	3%	6.57
Metabolism	0%	0%	0%	0%	2%	3%	6.51
American Journal of Public Health	0%	0%	10%	9%	14%	9%	5.38
Journal of Nursing Scholarship	0%	0%	10%	3%	0%	3%	2.54
Total research articles published	16	12	20	33	44	35	
Five-year period	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	2015-2019	

Percent contribution of research articles within five-year period[5]

0% 5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55% 60% 65% 70% 75% 80% 85% 90% 95% 100%

Results from Figure 1.3 also suggest a recent shift in the "who" as well as the "what" underlying the production of this discourse. Contributions from journals such as *Environmental Health Perspectives* and

[4] Only 16 out of 20 journals featured research articles that met my selection criteria. The four peer-reviewed journals absent from this table are the *Annual Review of Pharmacology and Toxicology*, the *British Medical Journal*, *Epidemiologic Reviews*, and *International Journal of Nursing Studies*.

[5] Color scale from Chroma.js Color Palette Helper by Gregor Aisch.

the *American Journal of Public Health* resulted in greater shares or percentages of all research articles published during the last two decades. Notably, *Environmental Health Perspectives* and the *American Journal of Public Health* were established in 1972 and 1911, respectively, so their increased shares in the ongoing conversation on environmental factors was not due to them being a "new" peer-reviewed journal. Rather, these findings imply that it was not until recently that each journal's contributors started to explore the link between environmental factors and type 2 diabetes. It thus stands to reason that their recent dominance has influenced how environmental factors related to type 2 diabetes are conceptualized presently, with the theories and methods preferred by environmental health and public health scholars shaping the subsequent discourse.

Dominance from areas of expertise

Areas of expertise associated with each research article were derived from the disciplines, academic units, or institutions that the article's first author[6] listed as part of their professional affiliation. These affiliations were typically located on the first or last page of the article. Many first authors listed multiple professional affiliations, so each discipline, academic unit, or institution that was provided by the author was accounted for. Many first authors also listed their professional affiliations as "nested" units, e.g., Department of Epidemiology, School of Public Health. In this example, both "epidemiology" and "public health" would be coded as areas of expertise associated with the research article. Identifying areas of expertise following this procedure resulted in a greater count of areas of expertise than first authors[7].

Tracking changes in areas of expertise over time required a reduction in the full list of areas of expertise provided by first authors. I thus built *categories* of expertise based on the areas of expertise that were

[6] First authors' professional affiliations were used as an indicator of areas of expertise and environmental epistemology, rather than last authors. While the primary investigator or head of the research laboratory is typically listed as the last author within the physical/natural sciences, I assumed that first authors would adequately represent the major assumptions, theories, and methods for a given area of expertise. Not all contributors were working out of academic institutions, so the division of labor implied by author order – in which it is assumed that the first author invests the most labor – may have been followed at, for example, state agencies.

[7] The name of each academic unit or institution listed by the first author was coded as an independent area of expertise. This means that that a first author – and by extension, the research article they published – was often associated with multiple areas of expertise. I developed this procedure to keep the distinction between, as an example, epidemiology and public health. Arguably, such distinctions were important to retain because the first author listed multiple units as their professional affiliation.

initially present in the 1990 to 1994 period. As new areas of expertise emerged – recall that areas of expertise were drawn directly from the names of disciplines, institutions, or academic units, such as departments – I either sorted them into existing categories of expertise or generated a new category based on my qualitative judgment of its distinctiveness.

Figure 1.4. Categories of expertise associated with research articles sorted by clinical setting and environmental epistemology (1990-2019)

Context	Epistemology	Category expertise	Number of research articles produced[8]					
		endocrinology	3	2	1	2	4	4
		internal medicine	2	1	1	1	9	8
clinical setting	extra-individual to individual	general medicine	0	1	4	8	5	6
		occupational med.	0	0	1	2	0	0
		nursing	0	0	2	1	0	0
		nutrition	3	1	2	2	10	7
clinical research	individual to collective	diabetes	1	0	0	0	0	3
		laboratory medicine	5	2	4	8	5	10
		biological sciences	2	0	1	3	6	4
		genetics	1	1	1	5	1	4
		toxicology	0	0	0	1	5	4
		epidemiology	6	6	4	9	8	5
non-clinical setting	extra-individual to collective	environmental health	0	0	2	6	7	12
		public health	1	0	2	12	16	13
		health care	1	0	1	5	5	3
		social sciences	3	2	2	4	8	3
		engineering	0	0	0	0	0	2
		policy	0	0	1	0	3	0
Five-year period			1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	2015-2019

Number of research articles

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

[8] Categories of expertise do not match research articles in the sample on a one-to-one basis. In other words, it is often the case that multiple categories of expertise are associated with a single research article. As such, there are more than 160 areas of expertise represented in this figure.

I revised the categories as I continued to collect areas of expertise from first authors within each five-year period. By the time I reached 2015 to 2019, I had generated 18 categories of expertise. I then went back through all the areas of expertise listed for each first author and sorted them into one of the 18 categories. Figure 1.4 shows the number of research articles associated with each category of expertise for each five-year period from 1990 to 2019, with areas of expertise listed by its proximity to clinical settings, then further sorted by its focus on "internal to body" (i.e., "extra-individual"), individual, or collective units of analysis.

Organizing categories of expertise by its relevance to clinical or non-clinical settings, as well as its ontological focus on phenomenon internal or external to the human body, contributes to a tentative epistemology about human-environment relations within type 2 diabetes science. That is, I also considered how medical scientists' and practitioners' everyday interactions with type 2 diabetes – e.g., in-person interactions with a person living with type 2 diabetes, or encountering type 2 diabetes as aggregated cases – influenced how they conceptualized and operationalized environmental factors that they deemed relevant to the disease. This builds from work by Darling, Ackerman, Hiatt, Lee, and Shim (2016), who conducted a similar investigation of environmental epistemiologies using interviews with molecular biologists. They found that the biologists they spoke with habitually "molecularized" environmental factors within the context of gene-environmental research, thus reconfiguring "the environment" to fit within the scientific paradigms that they worked with most often. Similarly, Krieger (1985), commenting on the lack of critical muscle in epidemiological theory, noted that epidemiologists used "the environment" as a discursive technique to elaborate on different aspects of a "multifactorial" framework that nevertheless remained vague regarding exact mechanisms of disease causation. These variations in interpretation suggest that socialization, workplace norms, and disciplinary culture also contributed to how environmental factors were made relevant to disease. In this study, I chose to highlight the scientific setting and the conceptual scale at which scientists and practitioners interpreted or investigated environmental factors.

Figure 1.4 shows that overall, there are consistent contributions from first authors affiliated with epidemiology relative to other categories of expertise. Consistent knowledge production from epidemiology over time was the focus of my first hypothesis, and the results presented in Figure 1.4 provide preliminary support for this claim. At the same time, the number of research articles produced by first authors affiliated with epidemiology begin to fall during the 2015 to 2019 period, while the number of research articles linked to other categories of expertise begin to increase. Within clinical settings, first authors affiliated with internal medicine and nutrition began producing more research articles on environmental factors within the last decade. Likewise, within clinical research settings, first authors working with laboratory medicine settings also increased their contributions. It is also important to note that the increase in research articles associated with expertise in “internal medicine” and “laboratory medicine” is accompanied by some uncertainty. While reducing areas of expertise over time, both “internal medicine” and “laboratory medicine” became ad hoc catch-all categories for myriad forms of expertise that concentrated on specialized medicine for adults (“internal medicine”), and medical research intended for application in clinical settings (“laboratory medicine”). For example, one first author specialized in “cardiovascular medicine,” so their expertise was eventually labled, “internal medicine.” Another first author specialized in “systems medicine,” which was subsequently reduced to “laboratory medicine.”

Within non-clinical settings, an increase in the production of research articles can be clearly linked with environmental health and public health. Recall that first authors were often affiliated with multiple areas of expertise. By extension, the research articles they published were also affiliated with multiple categories of expertise. Thus while the number of articles published within each five-year period were not exclusive to each category of expertise, the trends were clear: expertise in environmental health and public health currently dominate the conversation on environmental factors related to type 2 diabetes. Based on their environmental epistemological positioning – both categories tend to examine cases of type 2 diabetes in an aggregate form – we might expect to see a greater prioritization of environmental factors that are conceptualized at group or collective levels in recent literature.

Diversification and consolidation of expertise among institutions

An increase in publications by environmental health and public health scholars in conjunction with a slight decrease in publications from epidemiologists can be taken as compelling evidence for diversification in expertise, which draws from Kuhnian concepts of disciplinary evolution and maturation. Briefly, Kuhn (1962) examined how institutional factors could partially influence the “widening” of a scientific field as opposed to a “narrowing” of expertise that produced increasingly specialized knowledge. As discussed, Frickel (2004) likewise examined institutional factors underwriting the development of interdisciplinary fields such as genetic toxicology. I thus drew from their findings to form my second hypothesis, the major difference being that I also wanted to understand how diversification of expertise at one level of knowledge production could be constrained at another level.

As such, my second hypothesis considered how many research articles were produced by specific institutions over time, and simultaneously noted whether diversification of expertise was occurring within or across institutions. My dataset could accommodate such an analysis, since for each research article, I had already collected first authors’ professional affiliations, which included categories of expertise (as discussed in the previous section) as well as their home institution or organization. There were two main types of institutions that first authors were affiliated with: academic or higher education institutions, and government institutions. Figure 1.5 shows 21 institutions that contributed at least one article during two or more five-year periods between 1990 and 2019, organized by government affiliation and, for academic institutions, size of endowment.

Arguably, few institutions in Figure 1.5 produced articles on environmental factors related to type 2 diabetes at a consistent frequency during the study period. Several institutions, such as the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) and the University of Texas Health Center, showed dominance in the 1990s, but dropped off in contributions in the 2010s. Conversely, institutions like Harvard University and Johns Hopkins University dominated production of research articles during the last two decades, as did other institutions (Stanford University, University of Pennsylvania, and University of Chicago) with large endowments.

Figure 1.5. Institutions that produced research articles for at least two five-year periods sorted by size of endowment (1990-2019)

Government research institution	Number of articles produced						Endowment (2018)[9]
NIDDK	2	2	5	1	1	0	NA
NIH, DHHS	0	0	0	0	4	1	NA
Academic institution[10]							
Harvard University	0	0	2	5	19	4	$38.3 billion
University of Texas Health Science Center	3	2	0	1	0	0	$30.9 billion
Stanford University	0	0	1	0	2	1	$26.5 billion
University of Pennsylvania	0	0	0	0	1	2	$13.8 billion
University of Chicago	0	1	0	0	2	1	$7.9 billion
Washington University	1	0	0	1	0	1	$7.6 billion
Emory University	0	0	0	1	0	1	$7.3 billion
Cornell University	0	1	0	0	1	0	$7.2 billion
University of Southern California	0	1	0	0	1	1	$5.5 billion
Ohio State University	1	1	0	0	0	0	$5.2 billion
Vanderbilt University	1	0	0	2	0	1	$4.6 billion
Johns Hopkins University	0	0	0	2	2	11	$4.3 billion
Brown University	0	0	1	0	1	0	$3.6 billion
University of Washington	1	0	0	0	2	0	$2.8 billion
University of Illinois, Chicago	0	0	0	1	0	1	$2.6 billion
Tufts University	0	0	0	0	1	1	$1.8 billion
Wake Forest University	0	0	1	0	1	0	$1.3 billion
University of South Carolina	0	0	1	0	1	0	$810 million
University at Albany	0	0	0	2	0	1	$71.7 million
Five-year period	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	2015-2019	

Number of research articles

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

[9] The Chronicle of Higher Education. 2019. "College and University Endowments, 2007-18."

[10] Academic institutions within the dotted line are among the institutions with the top twenty largest endowments.

Indeed, when taking into account individual trends in research article contributions from the NIDDK, the National Institutes of Health, Department of Health and Human Services (NIH DHHS), Harvard University, and Johns Hopkins University, it can be suggested that a decline in research articles from NIDDK were accompanied by an increase in research articles from the NIH DHHS, as well as an increase from institutions with large endowments. The former suggests a shift in institutional research priorities between federal agencies, while the latter suggests that academic institutions view research on environmental factors as a lucrative intellectual, financial, and political investment.

Having established trends in research article production at the institutional level, I then considered how areas of expertise attached to each research article were distributed among the institutions listed. Figure 1.6 demonstrates the process I used to trace trends in diversification of expertise within institutions by focusing on first authors' areas of expertise at NIDDK and Harvard University from 1990 to 2019. There are two major trends to note. First is that academic institutions such as Harvard University and Johns Hopkins University, with endowments of $38.3 billion and $4.3 billion in 2018 (The Chronicle of Higher Education 2019), respectively, were accompanied by clear patterns of diversification in expertise. In other words, over the last ten to fifteen years, first authors publishing research articles on environmental factors related to type 2 diabetes, and who were working at Harvard University or Johns Hopkins University, were associated with a wider range of expertise. At Harvard University, first authors publishing in the 1990s may have been affiliated with internal medicine and occupational health, but by the late 2000s, they were also affiliated with epidemiology, nutrition, environmental health, and multiple teaching and research hospitals. At Johns Hopkins University, expertise likewise expanded from environmental health and epidemiology to engineering, big data, and health services research. Across academic institutions, a greater focus on public health and environmental health was evident beginning in the 2010s.

In contrast, first authors working at the University of Texas Health Science Center and NIDDK were not accompanied by a diversification in expertise despite showing dominance in the 1990s. Consequently, both institutions produced less research articles over time. This is despite the University of Texas system

Table 1.2. Example of diversification of areas of expertise and associated number of articles:
National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) compared to Harvard University (1990-2019)

Institution/Five-year period	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	2015-2019
NIDDK	2	2	5	1	1	0
	Diabetes Arthritis Epidemiology Section, Phoenix Epidemiology and Clinical Research Branch; Clinical Diabetes and Nutrition Section	Diabetes Arthritis Epidemiology Section, Phoenix Epidemiology and Clinical Research Branch	Diabetes Arthritis Epidemiology Section; Phoenix Epidemiology and Clinical Research Branch	Phoenix Epidemiology and Clinical Research Branch	Phoenix Epidemiology and Clinical Research Branch	
Harvard University	0	0	2	5	19	4
			Occupational Health Program, Department of Environmental Health, School of Public Health; General Internal Medicine Unit, General Medicine Division, Department of Medicine, Harvard Medical School, Massachusetts General Hospital	Department of Nutrition, School of Public Health; Department of Environmental Health, School of Public Health; Environmental and Occupational Medicine and Epidemiology Program, School of Public Health; Diabetes Unit and Center for Human Genetic Research; Program in Medical and Population Genetics; Department of Medicine, Harvard Medical School, Massachusetts General Hospital	Division of Women's Health, Department of Medicine, Connors Center for Women's Health and Gender Biology, Brigham and Women's Hospital and Harvard Medical School; Division of Cardiovascular Medicine and Channing Division of Network Medicine; Department of Epidemiology; Department of Nutrition, Brigham and Women's Hospital and Harvard Medical School; Harvard School of Public Health	Division of Chronic Disease Research Across the Lifecourse, Department of Population Medicine, Harvard Medical School; Department of Nutrition; Channing Division of Network Medicine, Department of Medicine, School of Public Health, Brigham and Women's Hospital, Harvard Medical School

having a $30.9 billion endowment in 2018 (The Chronicle of Higher Education 2019) and working budgets at the NIDDK and NIH DHHS at $1.6 billion and $26.9 billion in 2018 (U.S. Department of Health and Human Services 2017), respectively. As discussed, production in research articles from the NIH DHHS increased over time while production from NIDDK decreased. The decline in production from both the University of Texas system and NIDDK suggested a shift in institutional research priorities.

Taken together, these findings suggest that the formation of new areas of scientific expertise (Frickel 2004), or the diversification of expertise (Kuhn 1962), were transformations that occurred *within* institutions rather than across institutions. The implication being, any notable increase in diversification in areas of expertise did not necessarily mean that a collective and consensus-driven paradigm shift in type 2 diabetes science was occurring. Rather, institutions with greater access to intellectual, financial, and political resources were either able to match the growth of an emerging area of research – environmental factors – by establishing academic or research units to match, or were initiating discussions on environmental factors as a consequence of establishing these specialized units (determining which came first is beyond the scope of this study). In both cases, the power to determine the direction and development of knowledge within type 2 diabetes science was not democratic; rather, results in Figure 1.5 and Figure 1.6 show that dominance was partially due to power derived by institutional resources.

DISCUSSION

In this study, my goals were to identify who produces knowledge on environmental factors within type 2 diabetes discourse, and to evaluate the extent to which knowledge was produced democratically or dominated by key institutional actors. I also considered how the “who” mapped onto interpretations of environmental factors within the literature being produced. By examining scientific literature sampled from a fixed set of peer-reviewed journals, I showed how first authors affiliated with epidemiology and related areas of expertise, such as environmental health and public health, consistently dominated the production of research articles from 1990 to 2019. Epidemiological interpretations are grounded in an environmental epistemology that assumes environmental factors are external to the body. Within epidemiological analyses, the primary function of environmental factors is to explain the variability in cases of disease within populations who are labeled as distinct due to assumptions of shared race (Montoya 2011). Overall, the dominance of epidemiology within type 2 diabetes science has led to a prioritization of environmental factors that make sense for studying cases of type 2 diabetes in aggregate form, or at the population level. It also suggests that other interpretations of environmental factors that do not appear at the population level may be missing from the literature.

This last point has been critiqued within epidemiological science for some time, certainly since Krieger (1985) discussed Jan Vandenbroucke's critique of the black-boxing around "environmental factors" in epidemiological theory. Krieger's (1985) point, in line with Rose (1985), was that epidemiology's focus on ever-precise issues of measurement precluded an equal if not more important need to invest in theory; otherwise, epidemiologists were running before they would walk. Since epidemiological approaches to operationalizing environmental factors have dominated type 2 diabetes over the last three decades, it is likely that "the environment" as a health-related concept has yet to develop its critical edge within mainstream health and medical science. This is in spite of its radical potential to involve more diverse forms of medical expertise and to lend weight to the everyday details of living with disease. Such contradictions embedded within the production of environmental knowledge need further investigation.

Other forms of dominance in environmental knowledge production were also revealed within this study. For example, dominance occurred within the context of peer-reviewed journals as venues for knowledge production. Moving from the 1990s to the 2010s, specialized journals like *Diabetes Care* and *Diabetes* gradually gave way to *Environmental Health Perspectives* and the *American Journal of Public Health*. Over time, first authors contributing articles more frequently and representing more diverse areas of expertise nevertheless did so from shared institutions. Taken together, these findings indicate both a shift in research priorities across institutions, as well as consolidation of expertise related to environmental factors in type 2 diabetes among a more exclusive group of institutions. As mentioned, this has implications for the conceptualization of environmental factors within health contexts themselves. Epidemiological, environmental health, and public health perspectives consolidated at academic institutions with large endowments and publishing within environmental health and public health journals implies a prioritization of environmental factors involving beyond-the-individual concepts that are most useful when evaluating aggregate cases of type 2 diabetes across space and time.

On the one hand, this loosely supports a more radical framework. The science being produced on environmental factors related to type 2 diabetes is examining factors beyond the individual level. There is hope that discourse on “why type 2 diabetes occurs” has evolved beyond individualized explanations involving lifestyle choices or behaviors. On the other hand, the consolidation of expertise and knowledge production shown by these findings also has implications for the accessibility, accuracy, and applicability of that knowledge. It bears reminding that “environmental factors” is not a hypothetical or abstract concept for people living with type 2 diabetes or frontline healthcare workers; environmental factors, however they are defined, are encountered every day, in myriad and complex ways, that – as these findings suggest – may not be suitably or ethically captured by the scientific infrastructures in place to produce knowledge on the topic. The results from this study show that epidemiologists have had a stronghold in the production of knowledge on environmental factors for close to 30 years, while areas of expertise that have moved in to dominate the discourse over the past 10 to 15 years are derivative of similar analytical techniques in that they privilege viewing type 2 diabetes as a problem of populations. These areas of expertise thus strive to define, quantitatively, the optimal description for these populations. Another problem emerges when such descriptions draw from ideas of social difference (e.g., race, gender, class) that tend to further entrench marginalized populations as scientific subjects.

This tension, between searching for patterns within certain populations who are assumed to be more susceptible to certain diseases or illnesses in order to argue for greater provision of services or policies, while at the same time reducing the lived experiences of people perceived as relevant to the diseases or illnesses being studied, has been a persistent ethical quandary in the realm of health disparities studies. When this dilemma is mapped onto patterns of “who” produces knowledge on environmental factors as revealed in this study, additional ethical concerns emerge. The shift from knowledge production being more evenly distributed among institutions and federal agencies in the 1990s to a major upswing in contributions from two prestigious American universities dampens the implications of diversification of expertise in this area of study. Kuhnian processes of scientific maturation are limited in their ability to explain both the broadening of scientific expertise in these results, as well as the consolidation of this expertise to only a few venues. Rather, these findings shore up the argument from Frickel and Moore (2006) that the political latitude and power accumulation of institutional actors are highly influential on what science gets produced and what science remains “undone” (Frickel et al. 2010).

Applying even loosely the concept of “undone science” to this study, it is clear that other areas of expertise who also have a stake in answering the question, “What is the environment, and how does it affect someone who is living with type 2 diabetes?” are less present. Aside from people living with type 2 diabetes, social science disciplines are almost entirely absent as contributing areas of expertise. Even if the argument can be made that certain journal outlets cater to certain areas of expertise, the question that STS scholars would ask is, why *should* this be a reason to restrict contributions from areas of expertise to address what is considered a broad social problem? What is more, disciplines like anthropology, philosophy, and sociology, while certainly wrestling with their own exclusionary practices, have nevertheless developed rich scholarship that conceptualizes “the environment” as something that affects all dimensions of social life, including the unequal distribution of disease and illness. Their absence suggests that certain paradigms of environmental factors have gained enough force such that when they are taken up and further disseminated by institutions with power, authority, and financial resources, these conceptualizations reach the level of salient, assumed knowledge, while also restricting knowledge production from other disciplinary areas. Findings from this study also suggest that the emergence of such paradigms, rather than being a product of scientific consensus, are not incidental nor inevitable – a key concept for future work that attempts to address the ethical tensions within health disparities studies.

CONCLUSION

There is another point to be made about the results of this study that draws from Gilmore’s (2018) concept of constraining social and material infrastructures. On the one hand, I initially chose to examine the production of knowledge on environmental factors in type 2 diabetes by examining the content of scientific literature, which itself is reflective of the values, experiences, and resources of specific individuals working out of specific academic and government research institutions. On the other hand, my initial choice was actually a product of a constraint that is often encountered in research: the unavailability or inaccessibility of data. Quite frankly, using scientific literature as my dataset was more accessible than conducting interviews or embedding myself in a research or laboratory setting. As such, to Gilmore's (2018) point, the social and material infrastructures behind the production of knowledge on environmental factors related to type 2 diabetes has elevated scientific literature as the most accessible form of data to study this topic. To some extent – and as I have found – the "who" can still be partially determined from this data. Yet scientists' reasoning, troubleshooting, collaborative dynamics, and interactions with social and political contexts – the everyday activities of scientific knowledge production – remain black-boxed. Thus asking the question, what is visible and understood within the topic of environmental factors related to type 2 diabetes, and what is not, also reveals where power is situated within underlying infrastructures.

The next step, then, is to consider the "what" behind the "who," or what environmental epistemologies are present and privileged by the *political* actors revealed in this study. "Environmental factors" in the medical sciences have converged upon what Nichols (2018) might call a site of "polysemic conceptual intension," meaning that scientists are using the same terms – in this case, "environmental factors" – with divergent definitions. While a pluralistic system of knowledge would normally be in line with a feminist philosophical stance, the mutability around the term "environment" in the context of type 2 diabetes has serious consequences for the shape and implementation of prevention and treatment strategies. That is, a clear articulation of environmental epistemologies within type 2 diabetes science, and health disparities research more broadly, is necessary if we are to take environmental factors seriously as potential contributors to the embodied experiences of people living with illness and disease.

ENVIRONMENTAL FACTORS AS BOUNDARY OBJECTS IN TYPE 2 DIABETES SCIENCE

INTRODUCTION

Within the social sciences, the idea of socially constructed natures is familiar, and full of radical potential. This is because one of the assumptions that social constructionism disrupts is that knowledge production is solely the realm of highly trained experts. When knowledge is reframed as a synthesis of lived experience, participation in knowledge production becomes accessible to everyone. In the context of environmental and social justice movements, broad accessibility is key for building momentum across an array of potential contributors. In some cases, carefully-documented grassroots knowledge has engendered the production of counter-narratives that become formidable rebuttals to historical and ongoing patterns of neglect, disinvestment, and health-related injustices within local communities. For example, rather than viewing harm to human bodies as an inevitable consequence of state-sanctioned scientific pursuits, members of environmental justice movements have instead labeled such actions as the deliberate formation of zones of sacrifice by the state in conjunction with corporations (Cable et al. 2008; Kuletz 1998; Morris-Suzuki 2014, Tironi and Rodriguez-Giralt 2017).

As such, different interpretations of "the environment" have underwritten multiple scholarly and social justice endeavors, not only with work on environmental and health justice movements (Brulle and Pellow 2006), but also feminist political ecology (Cote and Nightingale 2012) and the development of decolonial theories related to theft of Indigenous land and other natural resources (Nichols 2020). However, within scholarship on health and medicine, the environment occupies a more precarious position. Environmental factors are not often acknowledged as social constructs, and materiality as a paradigm is not explicitly discussed. Part of this might be because Western medicine is so centered on the human body, its materiality is taken for granted. Certainly the stakes are high within health and medical science; after all, its primary task is the treatment or eradication of disease. However, a problem arises when scientists look upstream or downstream of acute symptoms with the intention to understand why disease occurs, or to prevent development of latent complications: risk factors, especially ones labeled, "environmental factors," often involve a dimension of materiality. For "multifactorial" (Krieger 1985) diseases such as type

2 diabetes, identification of potential risk factors can tap into all the materialities relevant to multiple processes of living, including activities at home, at work, at rest, and everything in between. What then distinguishes the body from the environment when they occupy the same material dimension? What, exactly, justifies the scientific articulation of environmental factors related to health?

In the context of type 2 diabetes, these questions take on additional weight. The symptoms and severity of type 2 diabetes can change over time, hence its designation as a chronic disease. Multiple risk factors have more or less potency at different stages of life; they may be widely dispersed or converge together in unpredictable ways. Research on type 2 diabetes etiology is further complicated by its association with other noncommunicable diseases, like cardiovascular disease or respiratory disease (World Health Organization 2021). Cases have been increasing worldwide for decades, to the point where public health experts have started calling it an "epidemic" (Hu 2011). This suggests that describing type 2 diabetes etiology as multifactorial, or as Krieger (1985) might say, situating it within a "web of causation," is not working: people are still developing type 2 diabetes.

In this study, I use Star and Griesemer's (1989) boundary objects framework to clarify how knowledge produced on environmental factors has contributed to type 2 diabetes science broadly. Specifically, I examine how environmental factors have been "translated" (Star and Griesemer 1989) over multiple disciplinary contexts in a way that smooths over conceptual discrepancies engendered by local interpretations on account of its interpretive flexibility. Part of this requires showing how scholars from different scientific disciplines justify distinct definitions of environmental factors related to type 2 diabetes, but it also requires tracing how some conceptualizations are contingent on ideas published within the literature at an earlier point in time. The two major research questions driving this work are:

1. How did scientists draw discursive boundaries around environmental factors in order to make them distinct risk factors within type 2 diabetes science?

2. What is the explanatory purpose of environmental factors within type 2 diabetes etiology?

My findings show that the interpretive flexibility – or alternatively, the “tackiness” – of environmental factors enabled its prioritization across local groups of scientists that were trying to piece together type 2 diabetes etiology. There is no evidence that scientists convened and standardized definitions of environmental factors; rather, local groups of scientists were able to use environmental factors in their own research and build on each other’s work without explicit consensus. In other words, environmental factors fit the bill as a boundary object. However, this status as a boundary object also enabled the appearance of pastiche science (Jordan-Young and Karkazis 2019), especially regarding where to begin or end the story of type 2 diabetes for specific populations. As such, my findings also show that scientists used the neutral connocations associated with environmental factors to avoid saying who or what was responsible for increased incidence of type 2 diabetes in the United States. Such a silencing was indicative of another form of power.

BACKGROUND

Research on health disparities is essential for identifying the groups or populations most susceptible to illness in relation to where and when they are. What the field has struggled with, however, is how to transform their findings – findings that typically suggest extreme forms of material and social inequality that require immediate amelioration – into political action. Part of the reason may be that epidemiology, a field that has dominated quantitative investigations of health disparities, has been steadfast in its improvement of methods, but less so with articulating foundational theories (Krieger 1985). Krieger (1985), writing in 1985, argued that an over-reliance on the “multifactorial” model to explain why diseases occurred to specific populations has undercut epidemiology’s critical power. That is, designating diseases as an outcome of multiple factors has incentivized epidemiologists to elaborate on the different components of the “web of [disease] causation” (Krieger 1985), but miss the spider altogether.

A multifactorial model for chronic diseases like type 2 diabetes also renders potential risk factors, such as environmental factors, so diffuse that they invariably take on a neutral, apolitical connotation. In her article, Krieger (1985) included Vanderbrouke’s (1988) critique of “environmental factors” as enabling roundabout descriptions of causal mechanisms of disease. Yet despite its perceived lack of critical muscle, research on environmental factors related to health has ballooned since the 1990s. Indeed, "environmental health" has become prioritized to the point where the term has headlined several health initiatives, including the "Environmental Health Matters Initiative," established in 2018 by The National Academies of Sciences, Engineering, and Medicine (The National Academies of Sciences, Engineering, and Medicine 2021), and the "Health and Environment Linkages Initiative," established in 2005 by the World Health Organization (World Health Organization 2021).

Thus, unstandardized definitions of "the environment" do not preclude ongoing scientific work – and under a boundary objects framework (Star and Griesemer 1989), this is a good thing. Indeed, environmental factors could be considered a "boundary object" in that it displays a wide range of interpretive flexibility. Crucially, such interpretive flexibility fits into a decentralized process of knowledge production involving disparate groups whose customized use of the boundary object contributes to a collective, if uncoordinated, scientific project (Star 2010). Given the breadth of empirical and ethical demands of health disparities studies, there may be some value to environmental factors maintaining their interpretive flexibility. At the same time, Jordan-Young and Karkazis (2019) have shown that such flexibility can leave the door open for scientists to engage in "pastiche science," which involves the practice of infusing popular assumptions, myths, and other stories into scientific concepts without empirical backing. There are two major problems with pastiche science: the first problem is that the assumptions that scientists draw from are largely influenced by their own privileged social positionalities. The second problem is that pastiche science is still lent the same legitimacy and authority of empirically rigorous work even when it is primarily composed of scientists' armchair logics.

A continuum of environmental epistemologies

Part of the issue may be that "the environment" itself is a slippery concept. Any given concept usually involves multiple material and semiotic interpretations of the phenomenon under study, but with "the environment," scholars also have to contend with its ubiquity. Greider and Garkovich (1994), writing in 1994, effectively demonstrated how shared material conditions could still be interpreted as myriad “landscapes” based on unique individual- and group-level interactions with the environment. Freudenberg et al. (1995) likewise showed how meanings attached to constructed landscapes could transform over time in tandem with evolving economic and political utilities. In short, work in the social sciences has provided useful guideposts for discussing variation in interpretations of “the environment.” When combined with critical work from feminist science studies, a rough continuum of environmental epistemologies emerges. On one end of the continuum (with “continuum” being a heuristic), there is a depiction of “the environment” as being wholly external to the human body. In other words, the boundary between “the body” and “the environment” is, for all intents and purposes, an actual boundary. The body becomes a unit of analysis as an individual, an actor, a site, a location, or a place – which can then be interpreted, defined, classified, ordered, and imposed upon by forms of power (Gilmore 2018). Here, the body may not be autonomous, but it is distinct; everything outside of the body is considered to be in the realm of “the environment.”

On the other end of the continuum is the idea of assemblages, in which boundaries are nearly impossible to recognize under an epistemology that prioritizes the tracing of action from one “thing” (Ingold 2013) to another (Prasad 2017; Shamir 2013). Viewing the world as a series of ongoing, continuous, simultaneous, and in-formation assemblages may conceivably involve the most minute phenomenon. Scholars who investigate “why things happen” using an assemblages approach do not accept any clear distinctions between the “social” and the “environmental” (Shamir 2013). Action begets action, which at some point may be recognized or interpreted as having an effect. Under an assemblages framework, the concept of “the environment” is deeply troubled, since it is unclear what constitutes a clearly bounded concept when scholars are studying ongoing motions or contingent actions. Between these two extremes, the boundaries between “bodies” and “environments” – or more abstractly, between “society” and “nature” – are depicted in many ways within scientific literature.

Boundary objects and the infrastructures of scientific work

As mentioned, the interpretative flexibility of “the environment” fits well within Star and Griesemer’s (1989) boundary objects framework. However, having interpretive flexibility is just one piece of what constitutes a boundary object; Star (2010) noted that it was also critical to consider how local groups, made distinct by different disciplinary identities or forms of scientific specialization, engaged with the boundary object in settings that made the most sense for ongoing scientific work. Such local interpretations, rather than re-entrench or consolidate interpretations of the boundary object, should only enhance its interpretive flexibility. The expectation being that different local groups would continue to pass the boundary object back and forth – Star (2010) called this "tacking" – so that work could progress in a broader sense without formal consensus, but *with* cooperation.

Boundary objects can help trace the evolution of knowledge over space and time; they can also reveal the underlying infrastructures that enable processes of knowledge production (Star 2010). The boundary object framework is thus useful for considering which groups of scientists are participating in the production of environmental discourse in type 2 diabetes specifically, and in medical science more broadly. As decolonial and feminist science studies scholars have noted, who is granted the opportunity to produce knowledge has a direct impact on the knowledge being produced (Harding 1991; Smith 1999). As such, treating environmental factors as a boundary object not only reveals who is producing environmental knowledge in type 2 diabetes science; doing so also links conceptualizations of environmental factors found in the literature directly to the authors' assumptions, positionalities, and political intentions. This relates to how boundary objects may also help "translate" (Star and Griesemer 1989) scientific work across disparate contexts. The notion of "translation" applied to this study engenders a specific set of questions regarding the purpose or function of "the environment" within medical discourse, and what conditions may prompt any associated functions to change.

METHODS

Peer-reviewed research journals are a primary source of medical knowledge within the health and medical sciences (Jutel 2010; Rasmussen 2020). Thus conceptualizations of environmental factors found within this literature can directly impact the application of medical knowledge to address health issues such as type 2 diabetes. For these reasons, scientific literature is an important "site" of scientific study

(Rasmussen 2020), and was thus my chosen medium for examining knowledge production on environmental factors related to type 2 diabetes.

Sampling

I examined the scientific literature on type 2 diabetes from 1990 to 2019, or over a period of 30 years. I selected this period based on my assumption that examining scientific literature produced over 30 years would reveal important changes in how "the environment" was conceptualized within type 2 diabetes science. Following Timmermans and Tavory (2012)'s argument that qualitative fieldwork often involves gut instinct, I began by selecting six initial areas of expertise listed on Web of Science that pulled from a broad range of scientific disciplines associated with type 2 diabetes. These areas included "endocrinology and metabolism," "medicine (general and internal)," "nursing," "toxicology," "nutrition and dietetics," and "public, environmental, and occupational health" (Clarivate Analytics 2020). I then identified five peer-reviewed journals in each area that had produced the highest journal impact factor (JIF); at the time of selection, the JIF rankings provided for each journal were calculated in 2018. I also examined the year that each journal was founded, since my intention was to elaborate on conceptualizations of environmental factors in journals that were established before the 30-year study period. Journals that were founded after 1990 were removed from my sample. After this step, twenty journals remained from which I could use to build my sample of research articles.

The process I used to select research articles for my final sample required several revisions. As many scholars have discussed, ongoing revisions in sampling procedures for qualitative work are typical (Timmermans and Tavory 2012). For example, Tarozzi (2015) argued that qualitative research defied any set formulas. Rather, the process of doing research often involved bursts of epiphany in conjunction with completing ordinary tasks in daily life. In this study, such nonlinear developments were most evident in deciding on the criteria I would use to select my sample. I ended up developing a stricter set of criteria – criteria that I believed would be the most effective for answering my research questions – in tandem with examining the research articles I had already collected. The research articles that made up my final sample thus had the following characteristics:

- The focus of the research article had to be on type 2 diabetes. I determined which research articles fit this criteria by searching for articles that contained “type 2” and “environment” at least once, respectively, in the text. Articles that focused on type 1 diabetes were removed from the sample, as were articles where type 2 diabetes was one of several comorbidities, or one of several explanatory variables. Following Jutel’s (2010) selection process, I also excluded articles that focused on medical conditions that were described as preceding type 2 diabetes (e.g., insulin resistance, prediabetes), or were described as a complication of type 2 diabetes (e.g., renal disease).
- The article had to focus on human research participants.
- The article had to feature a first author who was working from an academic, government, or research unit or institution located in the United States, and/or the dataset containing the type 2 diabetes-related outcome variable had to feature human research participants based in the United States.
- The article had to be published between 1990 and 2019.
- The article had to be written in English.

After refining my initial sample, I was left with 160 articles that were published between 1990 and 2019 from 20 peer-reviewed journals spanning 6 areas of expertise pertaining to health, medicine, and type 2 diabetes as defined by Web of Science. Table 2.1 shows the journals associated with each area of study and associated areas of expertise, their corresponding JIF, and the year that each journal was established.

Analytical approach

For each article in my sample, I looked at how “the environment” was conceptualized within the actual text. For articles featuring empirical work, I prioritized conceptualizations in the results and discussion sections following my assumption that scholars would contextualize their concepts of environmental factors within the conditions set by their research scope and data. All 160 research articles within my sample were tagged with a unique numerical code, e.g., “1990-001”, indicate the year the article was published, and the order in which I analyzed each article. The unique numerical codes for each article in my sample can be found in the Appendix. Rather than referring to an article from my sample using in-text citations, I use these codes while discussing my findings. Using these codes helps differentiate research articles from my sample with the articles that conceptually inform my broader project of identifying processes of knowledge production on environmental factors related to type 2 diabetes.

Table 2.1. Peer-reviewed journals used to build sample of research articles published between 1990 and 2019 (N = 160)

Areas of expertise	**Title of journal**	**JIF (2018)**	**Established**
Endocrinology and metabolism	*Diabetes Care*	15.27	1978
	Endocrine Reviews	15.17	1980
	Diabetes	7.20	1952
	Diabetologia	7.11	1965
	Metabolism	6.51	1952
Medicine (general and internal)	*The New England Journal of Medicine*	70.67	1812
	The Lancet	59.10	1823
	The Journal of the American Medical Association	51.27	1883
	The British Medical Journal	27.60	1840
	Annals of Internal Medicine	19.32	1927
Public health, environmental, and occupational health	*Annual Review of Public Health*	10.78	1980
	Environmental Health Perspectives	8.05	1972
	International Journal of Epidemiology	7.34	1972
	Epidemiologic Reviews	6.46	1979
	American Journal of Public Health	5.38	1911
Nursing, toxicology, nutrition and dietetics	*Annual Review of Pharmacology and Toxicology*	12.10	1961
	Critical Reviews in Food Science and Nutrition	6.70	1970
	The American Journal of Clinical Nutrition	6.57	1952
	International Journal of Nursing Studies	3.57	1963
	Journal of Nursing Scholarship	2.54	1967

RESULTS

Over the last 30 years, “the environment” has been enrolled in type 2 diabetes in diverse ways. Below, I discuss three concepts that gathered enough momentum in type 2 diabetes literature such that scientists from multiple disciplines were referring to these concepts as de facto definitions for “environmental factors." Following Star and Griesemer's (1989) boundary objects framework, I discuss both the core components of each concept while also illustrating the breadth of its application across different disciplines. In short, I show that cooperation regarding the continued study of "environmental factors" does happen, and as the boundary work framework suggests, occurs without explicitly acknowledged consensus. Whether type 2 diabetes etiology benefits from disparate usages of "environmental factors," however, is another matter.

Environmental factors are "not genetic"

In the 1990s, "the environment" was enrolled into scholarly work that was attempting to piece together the genetic foundations of type 2 diabetes. Scholars would situate "the environment" as secondary or subordinate to genetic drivers of disease, as exemplified by the following passage:

> "If NIDDM is genetically heterogeneous and also influenced by environmental components, population associations and linkage analyses in families may not be as easily interpreted as for diseases involving single major gene defects" (1990-001).

This excerpt, written by a first author with expertise (henceforth, "first author expertise") on metabolism, demonstrates a specific order of contributing factors to type 2 diabetes that remained consistent throughout the study period. Genes were discussed by multiple scholars as being foundational for type 2 diabetes, with "environmental components" extending risk only after a genetic basis for type 2 diabetes was established. 1992-001, written with first author expertise in molecular physiology and biophysics, argued, "The environmental factors contribute to the additivity [of a multifactorial etiology] and to reaching the threshold along with the genetic variables" (1992-001). 1996-002, with first author expertise on medical genetics, likewise argued that "environmental triggers of disease are most likely to have a major impact on genetically predisposed individuals," which meant that "searching for environmental triggers of multifactorial diseases should be most fruitful when it is focused on those at highest genetic risk" (1996-002). While both 1992-001 and 1996-002 referred to a multifactorial etiology, it is clear that "genetic risk" took special priority. Indeed, in the case of 1996-002, the importance of environmental triggers of type 2 diabetes were first conditional on people considered to be “at highest genetic risk.”

Scientists assumed that there was a clear conceptual distinction between “genetic” and “environmental” factors related to type 2 diabetes. Indeed, the way that genetic factors were described by scholars implied a certain stability regarding its contributing role. Even so, some scholars admitted that there were limitations regarding how well genetic factors could explain the ballooning number of cases worldwide (Hu 2011):

> "The increasing incidence rates of diabetes preceding and during this study provide evidence for environmental risk factors for diabetes, because gene frequencies cannot change fast enough to account for these changes in incidence. The disease has also apparently increased in frequency in other populations, including many American Indian tribes that have experienced major socioeconomic changes or migration, often accompanied by increasing obesity and decreasing physical activity" (1993-004).

This excerpt, written with first author expertise in epidemiology and clinical research, justified the investigation of environmental factors “because gene frequencies cannot change fast enough…for these changes in incidence.” Environmental factors, it was implied, occupied a wide range of processes, from “socioeconomic changes,” “migration,” “obesity,” and “decreasing physical activity.” Within this passage, the distinction between genetics and environmental factors was maintained, while its composition strongly suggested that the major reason behind increased incidence could not be genes, since genes could not evolve fast enough; thus it must be environmental factors, which could presumably evolve more quickly. Scholars attempted to apply an order to environmental factors when they positioned “increasing obesity and decreasing physical activity” as a consequence of “socioeconomic changes or migration.” Still, the precise mechanics that linked socioeconomic changes, migration, obesity, and physical activity remained unstated. Importantly, at face value, phrases like “socioeconomic changes” and “migration” are both neutral and unspecific. However, context clues revealed that authors intended for such phrases to evoke a negative connotation. For example, the phrasing by 1993-004 signaled worsening socioeconomic changes experienced by American Indian tribes. To imply rather than to explicitly state the negative connotation associated with such phrases reflects a political decision by the authors to downplay the full impact of "socioeconomic changes" or "migration" on actual lived experiences of human health.

1993-004 also introduces several interpretations of environmental factors that gained widespread cohesion throughout the study period, including environmental factors as processes of migration, modernization, or Westernization; family culture or intrauterine environments; and "lifestyle factors." The coherence of "lifestyle factors," which were closely associated with concepts like obesity, diet, and some degree of physical activity (that is, "more or less" or "a lack of"), depended on its "not genetic" status. Indeed, many scholars assumed that the influence of environmental factors on type 2 diabetes largely took place outside of the body, regardless of the factors themselves involving rather technical calculations of, in the case of "diet," food or nutritional intake, or complex processes that introduced intangible stressors, like "migration."

> "The ethnicity of the group of Nisei men studied here did not seem to greatly affect the nutrient character of their diet. Although their parents were born and raised in Japan, the diets of these men did not resemble the low-protein, low-fat, and high-complex-carbohydrate diets found in Japan. Instead, their diets resembled the diets of other US men, being relatively high in the components of protein and fat. This type of habitual intake, interacting possibly with an underlying genetic susceptibility to diabetes, may contribute to the higher prevalence rate of [diabetes mellitus] seen in this group of American-born Japanese men. It is unlikely that diet is the only environmental determinant of diabetes." (1990-004).

1990-004, written with first author expertise in metabolism, endocrinology, and nutrition, demonstrated a critical conflation of concepts within discussions of environmental factors. Again, environmental factors were "not genetic" factors. What *were* genetic factors, it seemed, were racial or ethnic attributes used to describe group differences. Here, "American-born Japanese men," or "Nisei men," may have an “underlying genetic susceptibility to diabetes,” which made them more likely to develop type 2 diabetes in comparison with “other US men,” even though they shared similar diets. In this case, the conflation of ethnicity and genes was straightforward: Diets were environmental factors, so Nisei men’s diets could not be influenced by their ethnicities. Being “American-born” or primarily socialized in the United States and consuming Americanized diets was shared across Nisei men and “US men,” meaning the only attributes left that made Nisei men distinct was their racial/ethnic designation and their “genetic susceptibility” to type 2 diabetes. This logic was presented in a way that assumed readers would accept the slippage between race/ethnicity and genes (Tallbear 2013).

Defining environmental factors as “not genetics” effectively shut the door on any interpretations that named genes as an environmental factor. Genes, like other components of human bodies, are material and thus change through entanglement with other material phenomenon (Montoya 2011; Tabery 2014). Within type 2 diabetes scholarship, however, scholars enfolded “genetic factors” into an ontology where they assumed an intrinsic, intangible presence, which was further enhanced when it was conceptually linked to racial and ethnic descriptions. Many scholars have offered cogent critiques on the construction of racial and ethnic categories and their naturalization within health disparities research, emphasizing how such categories describe differences between groups or populations (Bliss 2015; Haider 2019; Montoya 2011). Yet as Rose (1985) and Valles (2016) have argued, variation in health outcomes within racialized groups and variation in genetic risk of health outcomes are two different conversations. The point being, “race” is arguably more intangible than “genes,” but the conceptualization of environmental factors as “not genetic” by the scholars in my sample evoked a certain materiality that enhanced its opposing position to a more immaterial interpretation of genetic factors.

This casual but consequential dichotomy of “genes” and “environment” meant that scholars elaborated on genetic and environmental factors in a way that made it increasingly difficult to integrate the two. In other words, the conversations continued to diverge. Because genes were not environmental factors, its conceptualization remained stable. Meanwhile, environmental factors were associated with nearly everything “not genetic” that could possibly influence health outcomes.

Environmental factors as "kitchen sink" factors

It was therefore not a stretch of logic to also conflate environmental factors with "things external to the human body." Out of the many interpretations that were built off this assumption, two ideas gained momentum during the study period. The first involved the idea of environmental factors as obesity, patterns of food consumption, and physical activity (previously labeled "lifestyle factors"), while the second involved the idea of environmental factors as a complex amalgam of access to environmental "goods" and the material infrastructures that enabled or prevented such access.

Obesity, patterns of food consumption, and physical activity were simply defined *as* environmental factors. As noted by 1993-004, "increasing obesity and decreasing physical activity" signaled that environmental factors had had an effect in the context of type 2 diabetes risk. 1992-003, written with first author expertise in psychiatry, wrote, "The 'environmental' variables related to hyperinsulinemia[11] include obesity and low activity levels." Likewise, 1993-001, written with first author expertise in medical research, stated, "The chief potential environmental risk factors for relative hyperinsulinemia are sedentary behavior, abstinence or low alcohol intake, heavy alcohol use, and consumption of energy dense foods." Later, 1993-005, written with first author expertise in epidemiology and public health, described how such environmental factors could be modified, stating:

> "A successful planned series of trials would require the collaborative expertise of behavioral research and modification of exercise, and individuals who are knowledgeable about the Native American environment and how it could be modified. One interesting approach to this would be to modify the environment by providing different foods (i.e., providing specific foods to high-risk individuals) in addition to a well-organized effort to increase energy expenditure." (1993-005).

The slippages that occurred between obesity, patterns of food consumption, and physical activity evoked a naturalized clustering of these and other like terms. Such clusterings suggested that the scholars were

[11] Hyperinsulinemia is a condition in which there are higher levels of insulin in the blood than what is considered normal (Mayo Clinic 2021); while its presence does not automatically warrant a diagnosis of type 2 diabetes, according to the Mayo Clinic (2021), it is closely "associated" with type 2 diabetes.

used to thinking about these terms together. It is therefore incumbent on STS scholars to make such conceptual clusterings “strange.” Perhaps the most confusing aspect of discussing obesity in tandem with patterns of food consumption and physical activity was that obesity, as a label, existed within a typology of bodies, while patterns of food consumption (henceforth, “diet”) and physical activity were complex activities that linked individuals to their surroundings. To interpret obesity as an “environmental factor” would suggest that the body itself was the environment of interest. To suggest that the body was an environment of interest would be to walk back on the “environmental factors are not genetic factors” logic that other definitions of the environment were predicated on. Thus the process used to label risk factors as “environmental” was inconsistent. Different units of analysis – in this case, obesity, a “type” of body, alongside embodied activities like diet and exercise – were nevertheless pulled onto the same analytical plane.

It was clear that scholars intended to suggest that obesity (that is, the development of “obese bodies”) would typically follow specific types of diet and physical activity. It was also likely that they assumed that excess consumption of “energy dense foods” and “decreasing physical activity” preceded obesity. But that is *obesity*; what is the role of the environment in relation to obesity, diet, and physical activity? The passage from 1993-005 suggests that the environment was subject to change, with scholars implying that environmental factors could take the form of “providing different foods” (1993-005). The active verb, “providing,” lends itself to a broader discussion on the interpretation of environmental factors as the quality and affordability of food, opportunities for physical activity, and the material infrastructures that engendered or constrained the presence of each. 2001-001, with first author expertise on psychiatry and human behavior, illustrated the blending of “diet” and other individualizing terms with more-than-individual conditions:

> “…educational programs and individual-level treatments will have limited effectiveness when the environment makes it hard to follow the recommendations—i.e., it is hard to follow a healthful diet if grocery stores do not make healthful foods abundantly and consistently available at reasonable prices. Differences in access to healthful foods and opportunities for physical activity may be one

> of the factors related to the prevalence of obesity in individuals of lower socioeconomic status. Thus, an important new direction for behavioral research is to study ways to change the macroenvironment and thereby change eating behavior and physical activity…Environmental variables may be inherently difficult to study because they are ubiquitous; the most important variables may be widespread, such as television advertisements, car use, presence of fast-food outlets, and availability of palatable energy-dense foods. People may also resist environmental changes in these domains. Small-scale projects are needed to learn how to intervene on environmental variables" (2001-001).

There are a couple of key takeaways related to how environmental factors were discussed within this passage. The first takeaway involved the statement, "the environment makes it hard to follow the recommendations [to improve individual health]," with part of the difficulty involving healthful foods not being "abundantly and consistently available at reasonable prices," which the scholars then labeled as an issue of access. What added to the problem was the ubiquity of the environment; environmental factors were not only access to healthful foods, but also "television advertisements, car use, presence of fast-food outlets, and availability of palatable energy-dense foods." Taken together, these statements suggest that the environment has a major role in preventing healthful behavior.

Defining environmental factors as things that appear in everyday life was shared among multiple scholars during the study period. 2005-004, written with first author expertise in public health, likewise stated, "In contrast to views of self-management that emphasize a supposed ability of the individual to control his or her own behavior, an ecological approach to self-management integrates the skills and choices of individuals with the services and support they receive from (1) the social environment of family, friends, worksites, organizations, and cultures; and (2) the physical and policy environments of neighborhoods, communities, and governments." Here, there were social, physical, and policy environments that underwrote different configurations of social relationships and material conditions that impacted individuals' health. It is likely that there were even more categories or types of environments that were not named. This inspires the question, how many "types" of environments are there, and is it possible to account for them all? Notably, in contrast to 2001-001, 2005-004 implied that the environment – or countless types of environments – could also engender healthful behaviors, not just prevent them.

The environment as a source of help or harm in the management of healthful behaviors relates to the second takeaway, which involved how scholars conceptualized environmental factors as malleable or subject to change. 2005-003, written with first author expertise in nutrition, elaborated:

> "The changes required to reduce the risk of diabetes at the population level are, however, unlikely to be achieved without major environmental changes to facilitate appropriate choices by individuals. Competing interests in school (school lunch programs, funding sources, school boards) and work environments may be major barriers to modification of diet and activity patterns in children and adults. Urban environments may not facilitate activity behaviors owing to the lack of sidewalks, bike paths, athletic fields, etc. Heavy marketing of energy-dense, micronutrient-poor foods and beverages, particularly to children, clearly conflicts with attempts to promote healthy food choices. Whether healthy food choices are available and affordable, particularly to individuals of lower socioeconomic status, may greatly affect the adoption of healthy eating behaviors. A broad-based public health perspective working at various levels—the individual, the work, school, and home environments, in communities, nationally, and internationally—is therefore needed to stem the tide of the diabetes epidemic" (2005-003).

2005-003 and 2005-004 showed that, in addition to social, physical, and policy environments, there was also school, work, urban, home, and perhaps even marketing environments. Although some of these descriptions evoked pastiche science (Jordan-Young and Karkazis 2019), the conceptual malleability of environmental factors also fit into the boundary object framework. To reiterate, Star (2010) emphasized that it was not simply a concept's interpretive flexibility that made it a boundary object; the object had to be adaptable enough be used by local groups. In other words, boundary objects had to be "sticky" enough that local flavors of interpretation could be "tacked" on, absorbed, and informally accepted in subsequent uses of the object. Environmental factors in type 2 diabetes research, as "not genetic, but everything else," thus embodied the role of boundary object well. This was partially enabled by scholars' interpretation that environmental factors could change – could, indeed, be an adjustable lever that engendered or prevented healthful behaviors. This meant that environmental factors could represent multiple pieces of any given behavioral process: environmental factors could be the healthful behaviors themselves, that subsequently fed into more specific concepts such as diet and physical activity, or they could be where and how such activities were engaged with, such as at school, or at work, or during lunch. Because environmental factors had the potential to change, they also had the potential to reconfigure the production and practice of medical knowledge. As 2005-003 implied, because they are everywhere, environmental factors were everyone's problem.

During this study period, scholars discussed individual changes in diets and physical activity in response to changes in material infrastructures that were sometimes couched in a broader concept of "migration," "modernization," or "Westernization." It was assumed that individuals who moved to a new or Western context engaged with material infrastructures that were different from where they came from, which then induced changes in diets and physical exercise. 1991-001, written with first author expertise in clinical epidemiology, provides an example of this logic:

> "Because the migrant populations that have experienced increases in type II diabetes have also typically experienced concomitant modernization, these studies lend weight to the idea that some aspect or aspects of the modernization process are 'diabetogenic'…The most prominently mentioned candidates are the following: increased intake of total calories, fat, and refined sugar, and decreased intake of total and complex carbohydrate, including fiber, and a decreased habitual level of physical activity. Modernization…should not be regarded as a static end point, but rather as an ongoing process" (1991-001)

Both migrant populations and Indigenous populations, assumed to be distinct unto themselves, were pulled into the story of type 2 diabetes because of their entanglement with "modernization" or "Westernization." This took the form of being exposed to and consuming Western foods and engaging less with physical activity than what they “originally” would have. It was clear that changes in diet as a precursor for type 2 diabetes made the most sense for scholars writing during this period. Upon selecting "changes in diet" as a viable explanation for clusters of type 2 diabetes incidence among immigrant or Indigenous populations, scientists would go through great pains to justify their study populations so that the impacts of changing diets could be studied in as isolated a fashion as possible. For example, 1994-001, written with first author expertise in clinical diabetes and nutrition, described two studies that involved displacing Indigenous populations from their "regular" diets. In one scenario, a group of Indigenous people were “taken back" to a "traditional” setting and their weight measured after several weeks. The second study provided "non-traditional" foods to a group of Indigenous people, then measured their weight after several weeks. It was clear that findings from both studies were seen as evidence that modern or Westernized foods caused weight gain among Indigenous people, while returning them to a “traditional” diet achieved the opposite. Different tiers of diet purity were also upheld by 1993-002 and 1998-001, both of whom described the importance of finding populations of African migrants who had not been exposed to Western diets in order to better measure the impact of increased consumption of Western diets on embodied indicators of health, such as waist circumference.

It is important to remember that the broader context of these discussions was to understand what caused type 2 diabetes incidence among specific populations. 1994-001, for example, expressed concerns for the Pima Indians of Arizona, stating, “In parallel with abrupt changes in lifestyle, [obesity and non-insulin dependent diabetes mellitus] prevalences…have increased to epidemic proportions during the past decades” (1994-001). In short, studies that used the framework of migration, modernization, or Westernization would saddle the environment with a negative connotation by default; the environment was problematic because something about it contributed to the appearance of type 2 diabetes. In many of these studies, it was more than implied that for Black, Brown, Indigenous, and Asian populations, "traditional" environments were better for living than “Western” environments. Yet there was little discussion about why migration, modernization, or Westernization occurred in particular directions, from traditional to modern, or from non-Western to Western contexts, and why scientific research focused on these groups of people.

In other words, scientists who centered their work on Black, Brown, Indigenous, and Asian bodies justified doing so out of their concern that such populations were the most severely impacted by type 2 diabetes. However, binding type 2 diabetes etiology to discussions of “migration, modernization, or Westernization” also suggested that scholars chose not to elaborate on why such processes happened in such a way as to make *these* bodies vulnerable to environmental changes that may induce disease. It is therefore reasonable to ask if *these* bodies were selected as “scientifically important” even prior to their association with type 2 diabetes.

Environmental factors are “not genetic,” redux

On account of genetics not being environmental factors, a third interpretation involved heading back into the human body, albeit with the epistemic divide between “genes” and “environment” more present than ever. A groundswell of work examining the influence of “toxic chemicals” on type 2 diabetes risk emerged in the 2000s. One reason for this influx might have been newly available datasets like the National Health and Nutrition Examination Survey (NHANES), which also signaled institutional support and further legitimacy from state agencies like the National Institute of Environmental Health Services (NIEHS).

> "A growing scientific literature implicating a role for environmental chemical exposures has been developed largely through the funding of the NIEHS as part of the institute’s broader interest in understanding endocrine related disorders and the developmental origins of adult disease…The review of the collected literature supported the plausibility of certain environmental chemicals acting as “obesogens” or diabetogenic agents. In some cases, the conclusions were based on surprisingly consistent epidemiological associations. With other chemicals or chemical classes, consistency was found in mechanisms of action. We have little appreciation for the extent to which environmental chemical exposures may be influencing obesity and diabetes rates, but it is becoming increasingly clear that over nutrition and a lack of exercise are not the entire story" (2012-007).

It should be noted that the NIEHS was founded in 1966 (National Institute of Environmental Health Services 2020), and indeed, the phrase, “environmental health” in its name implies that NIEHS researchers had already been considering how the environment influenced health outcomes for many decades. This makes the above excerpt, written by Linda Birnbaum, Director of NIEHS from 2009 to 2020, surprising. Given that it was only recently that “over nutrition and a lack of exercise” were seen as “not the entire story” of type 2 diabetes, the question remains: what does “the environment” stand for in environmental health and in type 2 diabetes science broadly?

In the excerpt above, the environment was used to describe chemicals that, following epidemiological approaches, were associated with bodies considered obese or diagnosed with type 2 diabetes. Dr. Birnbaum suggested that evidence of such associations had grown to the point where the story of obesity and type 2 diabetes warranted change. Using context clues, this suggests that “environmental chemicals” referred to the routes by which chemicals were encountered by people – in this case, through the environment. If this was indeed the implication, then the phrase, “environmental chemicals” would suggest that chemicals traveling through the venue of the environment were not only potential sources of harm, but their “unnaturalness” or “toxicity” was partially due to an assumption that such chemicals should otherwise be located outside of the body. The word “exposures” likewise suggests that epidemiologists were concerned with dosages and routes of exposures of environmental chemicals such that exposures themselves were perceived to be primary “mechanisms of actions.” 2007-002, written with first author expertise in epidemiology and environmental and occupational health, elaborated on this concern:

> "More recently, cross-sectional studies of a nationwide probability sample representative of the general population of the United States have found a strong association between diabetes and a range of persistent environmental contaminants including dioxins, PCBs, and organochlorine pesticides…Because exposure to persistent environmental contaminants differs by place and has changed over time, population and period effects are plausible…The association between diabetes and exposure to persistent organic pollutants was found to be stronger among Mexican Americans…than among non-Hispanic whites or African Americans" (2007-002).

The assumption that environmental chemicals, and more broadly, environmental factors, were external to bodies, was also present here. Encounters with environmental chemicals varied according to where a person was located, or conversely, what was in close proximity to a person's location, itself defined by "place" and "time." Later in the excerpt, 2007-002 described differences in populations using racial and ethnic descriptions. In short, previous interpretations of environmental factors are being reiterated. First, the "not genetic," "external to body," "types" of environmental factors that were subject to change are also embedded in the interpretation of environmental factors as toxic chemicals. However, uncertainty in ontological consistency was enhanced in the context of toxic chemicals because toxic chemicals became a problem to health outcomes through routes of exposure. "Exposure" is a euphemism for consumed, ingested, breathed, absorbed, burned, or other modes of material engagement with the chemicals of interest. This means that toxic chemicals as an environmental factor hinged on their direct interactions with the human body. This helps further refine what was meant by scholars as "not genetic" factors: like genes, some environmental factors could exist within the body, but unlike genes, these environmental factors were unnatural, toxic, harmful, and therefore did not belong.

This rigid ontological boundary between genetic and environmental factors meant that it was increasingly challenging to take stock of the environmental side of the equation in research areas like gene-environmental interactions. As Darling et al. (2016) noted in their interviews with molecular biologists, biologists' tendency to "molecularize and personalize the environment" (Darling et al. 2016:51) truncated a larger story of why the environment was configured in such a way as to enable such gene-environmental interactions in the first place. Again, biologists' approaches to operationalizing environmental factors remained contingent on – and were thus constrained by – genes and the environment being perceived as mutually exclusive concepts.

A second reiteration centered on the slippage between race and population. As noted, there are many problems with describing populations by racial designations, a few being that classifications of race are unstable; they reduce the tremendous variation within racialized groups; and they reify the concept of race itself, which upholds a political project where the recognition of "race" simultaneously establishes subordinating social orders. Again, when discussions on why disease happens – or in the case of 2007-002, why there is an "association between diabetes and exposure to persistent organic pollutants" – relies on race as an explanation, the original topic of inquiry, which focused on an association between *diabetes* and *pollutants*, becomes lost. Race is so naturalized as an explanation for health disparities that it completely subsumes other, more nuanced, explanations. Meanwhile, the question, "why does the association [between diabetes and pollutants] exist?" remains unanswered. Race is thus made present in the story of type 2 diabetes, but its constructed, evolving, and intangible status cannot directly interact with potentially harmful chemicals. This means that the actual bodies that materially engage with potentially harmful chemicals remain invisible in this story. In summary, while striving for precision in the measurement of environmental factors related to type 2 diabetes, bodies themselves – where environmental factors and disease are made relevant – disappear.

DISCUSSION

In type 2 diabetes science, environmental factors act smoothly as a boundary object to support a broad range of scholarship spanning multiple disciplines and scientific specializations. In line with the boundary objects framework, local interpretations of environmental factors did not preclude larger arcs of knowledge production; indeed, there seemed to be few conflicting interpretations of environmental factors related to type 2 diabetes. Instead, previous interpretations of environmental factors laid the groundwork for subsequent use of the term. In the 1990s, environmental factors were firmly established as "not genetic" factors, which helped widen the ontological distance between environmental factors and health-related phenomena – such as genetics – that took place in the human body. Although it was not explicitly stated, the most dominant interpretations were grounded in the assumption that environmental factors were external to the human body. This ontological separation between environmental factors and the body was maintained even after scholars began enrolling toxic chemicals into their definition of environmental factors in the 2000s – chemicals that technically took effect in the body, but maintained its status as an isolated and external risk factor. Notably, empirical work on environmental factors and their relationship to type 2 diabetes etiology proceeded without formal consensus or coordination between scholars. Instead, as Star and Griesemer (1989) discussed, environmental factors as a boundary object helped “translate” local interpretations while also masking uncertainties regarding its conceptualization, thus contributing to an unspoken yet effective prioritization of environmental factors within research on type 2 diabetes etiology.

Even though a loose form of cooperation among multiple disciplines was achieved, there are other questions to consider. One question worth asking is, should there actually be more scrutiny regarding what is meant by environmental factors within type 2 diabetes? That is, should there actually be some form of consensus? Should research potentially be slowed down, even halted, until consensus is democratically reached? The results of this study suggest that such changes to the research process might not be a bad thing. First, as discussed, the interpretive flexibility of a boundary object can also enable pastiche science. Recall that “pastiche science” is a term used by Jordan-Young and Karkazis (2019) to describe the process by which scientists interweave popular assumptions, myths, and other stories into their work to make their empirical findings more convincing. Importantly, the assumptions, myths, and stories that scientists use to “add flesh and bone to the skeletal connections [in their results]” (Jordan-Young and Karkazis 2019:69) are a direct reflection of the scientist’s positionality, which likely occupy white, male, middle class, and other elite statuses. Pastiche science tends to emerge when “the data [doesn’t] coalesce, creating a pastiche that reads like a set of causal connections” (Jordan-Young and Karkazis 2019:78). In their investigation of testosterone or “T,” they describe how T engenders a pastiche science that reinforces stereotypical ideas about race and class in the American context:

> "…race and class were embedded as 'ghost variables' in [literature on testosterone], usually not present on the surface but creating potent meanings through the use of culturally loaded terms, sampling strategies that reinforce class and racial stereotypes, and inferential leaps that go unnoticed because they fit cultural expectations. In this pastiche science, the variables in the causal chain are rarely measured in tandem. Instead, the link between T and violent aggression is made through juxtaposition of multiple stories that include partial associations” (Jordan-Young and Karkazis 2019:82).

Scientists studying type 2 diabetes are grappling with similar uncertainties regarding the environment as a potential causal mechanism. As discussed, environmental factors are often used to summarize specific processes that may contribute to why type 2 diabetes develops – processes that deal with genetic susceptibilities, or food options in school or workplace settings, or access to health services in a specific neighborhood, or acclimating to a new culture. But these processes are complex, multiscalar, and can change dramatically over space and time. Reducing such processes and subsuming them under the label of “environmental factors” might actually not be working in scientists’ favor. As discussed, many scholars offered their own definition of environmental factors; local definitions did not impede scientific work, as is the character of a boundary object. However, such interpretive flexibility of environmental factors suggests that a list of definitions is potentially endless, and the uncertainties that accompany each definition are also embedded in such a list. At some point, scientists may be forced to explain concepts implied by the totality of the list – such as “Westernization,” “migration,” or food insecurity – that they perceive as lying beyond their scholarly purview. They thus engage in pastiche science. The longer the list of definitions grows, the more pastiche the science.

When considered alongside the finding by Krieger, Boyd, De Maio, and Maybank (2021) that scientists still hesitate to name concepts like racism as a primary driver for health inequalities, it is clear that the appearance of pastiche science alongside the production of knowledge on “environmental factors” is not an accident. It may, indeed, be the standard. Scientists, occupying elite positionalities, are only comfortable hinting at the violent and structural harms that engender clustering of diseases like type 2 diabetes. Meanwhile, they package ongoing processes of harm into neutral or individualized terms like “migration” or “access to grocery stores.” Obscuring or muffling these processes is not justice. For all that these studies feature Black, Brown, Indigenous, and Asian bodies, the intergenerational trauma, everyday stress, and forced diasporas as a consequence of ongoing colonialism and racial capitalism are missing from environmental discourse. In other words, Brown, Black, Indigenous, and Asian bodies are *featured* in scientific studies, but are not centered within them. For that to even begin to happen, Black, Brown, Indigenous, and Asian scholars require a larger share of knowledge production.

CONCLUSION

Knowledge production on environmental factors related to type 2 diabetes has proceeded atheoretically as a consequence of its boundary object status, to the point where it invokes the label, "pastiche science." This becomes an issue when the conceptual utility of environmental factors, with all of its pastiche intact, is perpetuated again and again across local scientific groups. Here, interpretations of environmental factors that position them as "not genetic," external factors that are ontologically separate from the body, and that impact racialized groups through processes of "migration, modernization, and Westernization," are legitimized without formally engaging in the scientific process. Krieger's (1985) spider remains missing as the conceptual uncertainties surrounding environmental change are amplified, and as scientists continue to hold separate ethical considerations of who this knowledge represents and ultimately serves. Environmental factors within type 2 diabetes science become a concept to coast on, to superficially link one article to another, and to avoid confronting the conceptual murkiness of the environment in the first place.

But it is not just a matter of getting right the definition of environmental factors. If environmental factors are indeed ubiquitous, if they indeed encompass all processes of living, then the links between environmental factors and health outcomes warrant more expertise than what institutions of knowledge production currently accommodate. Can people afford to wait while the causal mechanisms of disease are "discovered" by experts working out of highly inaccessible institutions? The answer is no, people are not waiting. When disease begins to cluster, grassroots and community-centered science emerge to address health injustices directly. This has happened historically, and it is happening now. These projects understand that people are dying with few diverging paths. Such responsive science deserves more resources to do their work. The study of environmental factors, which has been shown to link disparate efforts at empirical work due to its capacity as a boundary object, can be a venue for the redistribution of power and resources to knowledge producers previously unrecognized as experts.

APPENDIX

Table 2.2. Unique Numerical Codes for Each Article in Sample (N = 160, 1990-2019)

Index	Year	First author	Journal	First author unit	Expertise	Institution
1990-001	1990	Permutt, M. Alan	*Diabetes Care*	Metabolism Division	metabolism	Washington University School of Medicine
1990-002	1990	Kumanyika, Shiriki K.	*Diabetes Care*	Department of Nutrition	nutrition	Pennsylvania State University
1990-003	1990	Irvine, Audrey A.	*Diabetes Care*	Department of Behavioral Medicine and Psychiatry and the Diabetes Center	behavioral medicine, psychiatry	University of Virginia Health Sciences Center
1990-004	1990	Tsunehara, Christine H.	*American Journal of Clinical Nutrition*	Division of Metabolism, Endocrinology, and Nutrition, Department of Medicine	metabolism, endocrinology, nutrition	University of Washington
1990-005	1990	Rich, Stephen S.	*Diabetes*	Department of Laboratory Medicine and Pathology and the Institute of Human Genetics	laboratory medicine, pathology, human genetics	University of Minnesota
1991-001	1991	Stern, Michael P.	*Diabetes Care*	Division of Clinical Epidemiology, Department of Medicine	clinical epidemiology	University of Texas Health Science Center
1992-001	1992	Granner, Daryl K.	*Diabetes Care*	Department of Molecular Physiology and Biophysics	molecular physiology, biophysics	Vanderbilt University School of Medicine
1992-002	1992	Reiber, Gayle E.	*Annals of Internal Medicine*	Health Services Research and Development	health services, research, development	Seattle VA Medical Center
1992-003	1992	Wing, Rena R.	*Journal of the American Medical Association*	Department of Psychiatry	psychiatry	University of Pittsburgh
1992-004	1992	Stern, Michael P.	*Diabetes*	Division of Clinical Epidemiology, Department of Medicine	clinical epidemiology	University of Texas Health Science Center
1993-001	1993	Mayer, Elizabeth J.	*Diabetes Care*	Division of Research	research	Permanente Medical Group
1993-002	1993	Osei, Kwame	*Diabetes Care*	Department of Internal Medicine	internal medicine	The Ohio State University Hospitals
1993-003	1993	Mitchell, Braxton D.	*Diabetes Care*	Division of Clinical Epidemiology, Department of Medicine	clinical epidemiology	University of Texas Health Science Center
1993-004	1993	Knowler, William C.	*Diabetes Care*	Diabetes and Arthritis Epidemiology Section, Phoenix Epidemiology and Clinical Research Branch	epidemiology, clinical research	National Institute of Diabetes and Digestive and Kidney Diseases
1993-005	1993	Kuller, Lewis H.	*Diabetes Care*	Department of Epidemiology, Graduate School of Public Health	epidemiology, public health	University of Pittsburgh
1994-001	1994	Ravussin, Eric	*Diabetes Care*	Clinical Diabetes and Nutrition Section	clinical diabetes, nutrition	National Institute of Diabetes and Digestive and Kidney Diseases

Table 2.2. (cont'd)

1995-001	1995	Stern, Michael P.	*Diabetes*	Division of Clinical Epidemiology, Department of Medicine	clinical epidemiology	The University of Texas Health Science Center
1995-002	1995	Osei, Kwame	*Diabetologia*	Division of Endocrinology and Metabolism, Department of Internal Medicine	endocrinology, metabolism, internal medicine	The Ohio State University Hospitals
1995-003	1995	McCance, D. R.	*Diabetologia*	Diabetes and Arthritis Epidemiology Section, Phoenix Epidemiology and Clinical Research Branch	epidemiology, clinical research	National Institute of Diabetes and Digestive and Kidney Diseases
1996-001	1996	Stern, Michael P.	*Annals of Internal Medicine*	Division of Clinical Epidemiology, Department of Medicine	clinical epidemiology	University of Texas Health Science Center
1996-002	1996	Rothenberg, L. S.	*The Lancet*	Division of Medical Genetics, Department of Medicine	medical genetics	University of California, Los Angeles
1997-001	1997	Aikens, James E.	*Diabetes Care*	Behavioral Medicine Service, Department of Psychiatry	behavioral medicine, psychiatry	University of Chicago
1997-002	1997	Glasglow, Russell E.	*Diabetes Care*	.	.	Oregon Research Institute
1998-001	1998	Okosun, Ike S.	*Diabetes Care*	Department of Preventive Medicine and Epidemiology	preventive medicine, epidemiology	Loyola University Stritch School of Medicine
1998-002	1998	O'Brien, Judith A.	*Diabetes Care*	.	.	Caro Research
1998-003	1998	Nelson, Robert G.	*Diabetes*	Phoenix Epidemiology and Clinical Resesarch Branch	epidemiology, clinical research	National Institute of Diabetes and Digestive and Kidney Diseases
1999-001	1999	Rosenbloom, Arlan L.	*Diabetes Care*	.	.	Children's Medical Services Center
1999-002	1999	Waterland, Robert A.	*American Journal of Clinical Nutrition*	Division of Nutritional Sciences	nutritional sciences	Cornell University
2000-001	2000	Lindsay, Robert S.	*Diabetes Care*	.	.	National Institute of Diabetes and Digestive and Kidney Diseases
2000-002	2000	Whittemore, Robin	*Journal of Nursing Scholarship*	School of Nursing	nursing	Yale University
2000-003	2000	Meigs, James B.	*Diabetes*	General Internal Medicine Unit, General Medicine Division, Department of Medicine	internal medicine	Massachusetts General Hospital and Harvard Medical School
2000-004	2000	Dabelea, Dana	*Diabetes*	Diabetes and Arthritis Epidemiology Section	epidemiology	National Institute of Diabetes and Digestive and Kidney Diseases

Table 2.2. (cont'd)

2000-005	2000	Lindsay, Robert S.	*Diabetes*	.	.	National Institute of Diabetes and Digestive and Kidney Diseases
2001-001	2001	Wing, Rena R.	*Diabetes Care*	Department of Psychiatry and Human Behavior, Miriam Hospital	hospital, psychiatry, human behavior	Brown University, Brown Medical School
2001-002	2001	Jayne, Rae L.	*Journal of Nursing Scholarship*	Nursing Program	nursing	Santa Rosa Junior College
2001-003	2001	Longnecker, Matthew P.	*Environmental Health Perspectives*	Epidemiology Branch	epidemiology	National Institute of Environmental Health Sciences
2001-004	2001	Gautier, Jean-François	*Diabetes*	Phoenix Epidemiology and Clinical Research Branch	epidemiology, clinical research	National Institute of Diabetes and Digestive and Kidney Diseases
2002-001	2002	Bogardus, Clifton	*Diabetes*	Phoenix Epidemiology and Clinical Research Branch	epidemiology, clinical research	National Institute of Diabetes and Digestive and Kidney Diseases
2002-002	2002	Carnethon, Mercedes R.	*Diabetes Care*	Stanford Center for Research in Disease Prevention	disease prevention	Stanford University School of Medicine
2002-003	2002	Karter, Andrew J.	*Journal of the American Medical Association*	Division of Research	research	Kaiser Permanente
2003-001	2003	Schwartz, Gary G.	*Diabetes Care*	Departments of Cancer Biology and Public Health Sciences	cancer biology, public health sciences	Wake Forest University School of Medicine
2003-002	2003	Ordovas, Jose	*The Lancet*	Nutrition and Genomics Laboratory and Obesity and Metabolism Laboratory	nutrition, genomics, obesity, metabolism	Jean Mayer USDA Human Nutrition Research, Center for Aging at Tufts University
2004-001	2004	Jack, Jr., Leonard	*Annals of Internal Medicine*	.	chronic disease prevention, health promotion	National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention
2004-002	2004	Zierold, Kristina M.	*American Journal of Public Health*	Department of Environmental Health Services, Arnold School of Public Health	environmental health, public health	University of South Carolina
2004-003	2004	Horowitz, Carol R.	*American Journal of Public Health*	Department of Health Policy	health policy	Mount Sinai School of Medicine
2004-004	2004	Willcox, Joye K.	*Critical Reviews in Food Science and Nutrition*	Department of Food Science	food science	North Carolina State University
2004-005	2004	Tsaih, Shirng-Wern	*Environmental Health Per.*	Occupational Health Program, Department of Environmental Health	occupational health, environmental health	Harvard School of Public Health

Table 2.2. (cont'd)

2004-006	2004	Rotimi, Charles N.	*Diabetes*	Department of Microbiology, College of Medicine	microbiology	National Humane Genome Center at Howard University
2005-001	2005	Kao, W.H. Linda	*Diabetes Care*	Department of Epidemiology, Bloomberg School of Public Health	epidemiology	John Hopkins University
2005-002	2005	Dutton, Gareth R.	*Diabetes Care*	Department of Psychology	psychology	Louisiana State University
2005-003	2005	Schulze, Mattias B.	*Annual Review of Public Health*	Department of Nutrition	nutrition	Harvard School of Public Health
2005-004	2005	Fisher, Edwin B.	*American Journal of Public Health*	National Program Office of The Robert Wood Johnson Foundation Diabetes Initiative	.	Washington University
2005-005	2005	Schulz, Amy J.	*American Journal of Public Health*	School of Public Health	public health	University of Michigan
2005-006	2005	Abate, Nicola	*Diabetes*	Division of Endocrinology and Metabolism and the Center for Human Nutrition, Department of Medicine	endocrinology, metabolism, human nutrition	University of Texas Southwestern Medical Center at Dallas
2006-001	2006	Schulz, Leslie O.	*Diabetes Care*	Department of Health Sciences	health sciences	University of Wisconsin-Milwaukee
2006-002	2006	Mulvaney, Shelagh A.	*Diabetes Care*	Center for Evaluation and Program Improvement; Department of Pediatrics	evaluation, pediatrics	Vanderbilt University
2006-003	2006	Johnson, Rolanda L.	*Journal of Nursing Scholarship*	School of Nursing	nursing	Vanderbilt University
2006-004	2006	Fujiyoshi, Phillip Thomas	*Environmental Health Perspectives*	Department of Environmental Toxicology	environmental toxicology	University of California-Davis
2006-005	2006	Dubowsky, Sara D.	*Environmental Health Perspectives*	Department of Environmental Health	environmental health	Harvard School of Public Health
2006-006	2006	Schreinemachers, Dina M.	*Environmental Health Perspectives*	National Health and Environmental Effects Research Laboratory, Office of Research and Development	health, environmental effects	U.S. Environmental Protection Agency
2006-007	2006	Franks, Paul W.	*Diabetes*	Phoenix Epidemiology and Clinical Research Branch	epidemiology, clinical research	National Institute of Diabetes and Digestive and Kidney Diseases
2007-001	2007	Lee, Duk-Hee	*Diabetes Care*	Department of Preventive Medicine and Health Promotion Research Center, School of Medicine	preventive medicine, health promotion	Kyungpook National Laboratory

Table 2.2. (cont'd)

2007-002	2007	Cox, Shanna	*Environmental Health Perspectives*	Department of Epidemiology; Department of Environmental and Occupational Health, Rollins School of Public Health	epidemiology, environmental and occupational health	Emory University
2007-003	2007	Codru, Neculai	*Environmental Health Perspectives*	Department of Epidemiology and Statistics, School of Public Health	epidemiology, statistics	University at Albany, Rensselaer
2007-004	2007	Edwards, Thea M.	*Environmental Health Perspectives*	Department of Zoology	zoology	University of Florida
2007-005	2007	Kouznetsova, Maria	*Environmental Health Perspectives*	Department of Epidemiology and Biostatistics, School of Public Health	epidemiology, biostatistics	University at Albany
2007-006	2007	Hamilton, Marc T.	*Diabetes*	Department of Biomedical Sciences; Dalton Cardiovascular Research Center	biomedical sciences, cardiovascular research	University of Missouri-Columbia
2007-007	2007	Lehman, Donna M.	*Diabetes*	Division of Clinical Epidemiology, Department of Medicine	clinical epidemiology	University of Texas Health Science Center
2007-008	2007	Franks, P. W.	*Diabetologia*	Genetic Epidemiology and Clinical Research Group, Department of Public Health and Clinical Medicine, Section for Medicine	genetic epidemiology, clinical research	Umea University Hospital
2008-001	2008	Pettitt, David J.	*Diabetes Care*	.	.	Sansum Diabetes Research Institute
2008-002	2008	Plescia, Marcus	*American Journal of Public Health*	Chronic Disease and Injury Section	chronic disease, injury	North Carolina Division of Public Health
2008-003	2008	vom Saal, Frederick S.	*Journal of the American Medical Association*	Division of Biological Sciences	biological sciences	University of Missouri
2008-004	2008	Navas-Acien, Ana	*Journal of the American Medical Association*	Department of Environmental Health Sciences; Department of Epidemiology; Welch Center for Prevention, Epidemiology, and Clinical Research	environmental health sciences, epidemiology	John Hopkins Bloomberg School of Public Health
2008-005	2008	Kile, Molly L.	*Journal of the American Medical Association*	Department of Environmental Health, Environmental and Occupational Medicine and Epidemiology Program	environmental health	Harvard University School of Public Health
2008-006	2008	Golden, Robert	*Environmental Health Perspectives*	.	.	ToxLogic, LLC

Table 2.2. (cont'd)

2008-007	2008	Gaulton, Kyle J.	*Diabetes*	Department of Genetics	genetics	University of North Carolina at Chapel Hill
2008-008	2008	Florez, J. C.	*Diabetologia*	Diabetes Unit and Center for Human Genetic Research; Program in Medical and Population Genetics; Department of Medicine	human genetic research, medical and population genetics, medicine	Massachusetts General Hospital; Broad Institute of Harvard and MIT; Harvard Medical School
2008-009	2008	Lee, D. H.	*Diabetologia*	Department of Preventive Medicine and Health Promotion, Research Center, School of Medicine	preventive medicine, health promotion	Kyungpook National University
2009-001	2009	Grant, Richard W.	*Diabetes Care*	Division of General Medicine, Department of Medicine; Department of Medicine	general medicine, medicine	Massachusetts General Hospital; Harvard Medical School
2009-002	2009	Johnson, Richard J.	*Endocrine Reviews*	Division of Nephrology	nephrology	University of Florida
2009-003	2009	Turyk, Mary	*Environmental Health Perspectives*	Division of Epidemiology and Biostatistics, School of Public Health	epidemiology, biostatistics	University of Illinois-Chicago
2010-001	2010	King, Diane K.	*Diabetes Care*	Institute for Health Research	health research	Kaiser Permanente Colorado
2010-002	2010	Pucher, John	*American Journal of Public Health*	Bloustein School of Planning and Public Policy	planning, public policy	Rutgers University
2010-003	2010	Krishnan, Supriya	*American Journal of Clinical Nutrition*	Slone Epidemiology Center	epidemiology	Boston University
2011-001	2011	Hu, Frank B.	*Diabetes Care*	Departments of Nutrition and Epidemiology; Channing Laboratory, Department of Medicine	nutrition, epidemiology, laboratory, medicine	Harvard School of Public Health; Brigham and Women's Hospital and Harvard Medical School
2011-002	2011	Zhang, Luxia	*Diabetes Care*	Channing Laboratory, Department of Medicine; Renal Division, Department of Medicine; Renal Division, Department of Medicine	laboratory, medicine, renal	Brigham and Women's Hospital and Harvard Medical School; Brigham and Women's Hospital and Harvard Medical School; Peking University First Hospital
2011-003	2011	Ludwig, Jens	*The New England Journal of Medicine*	.	.	University of Chicago; National Bureau of Economic Research
2011-004	2011	Brender, Jean D.	*American Journal of Public Health*	Texas A&M Health Science Center	health science	School of Rural Public Health
2011-005	2011	Freedman, Vicki A.	*American Journal of Public Health*	Department of Health Systems and Policy of the School of Public Health	health systems, policy, public health	University of Medicine and Dentistry of New Jersey

Table 2.2. (cont'd)

2011-006	2011	Gittelsohn, Joel	*American Journal of Clinical Nutrition*	Center for Human Nutrition, Department of International Health	nutrition, international health	John Hopkins Bloomberg School of Public Health
2011-007	2011	Puett, Robin C.	*Environmental Health Perspectives*	South Carolina Cancer Prevention and Control Program and Department of Environmental Health Sciences, Arnold School of Public Health	cancer prevention, cancer control, environmental health sciences, public health	University of South Carolina
2011-008	2011	Neel, Brian A.	*Diabetes*	Committee on Molecular Pathogenesis and Molecular Medicine, Pritzker School of Medicine	molecular pathogenesis, molecular medicine, medicine	University of Chicago
2011-009	2011	Dabelea, Dana	*Diabetes*	Department of Epidemiology, Colorado School of Public Health	epidemiology, public health	University of Colorado Denver
2011-010	2011	Dabelea, Dana	*Diabetologia*	Department of Epidemiology, Colorado School of Public Health	epidemiology, public health	University of Colorado Denver
2012-001	2012	Awad, Atif B.	*Critical Reviews in Food Science and Nutrition*	Department of Exercise and Nutrition Sciences, School of Public Health and Health Professions	exercise, nutrition sciences, public health	University at Buffalo
2012-002	2012	Patel, Chirag J.	*International Journal of Epidemiology*	Department of Pediatrics, Division of Systems Medicine; Lucile Packard Children's Hospital	pediatrics, systems medicine	Stanford University School of Medicine
2012-003	2012	Maull, Elizabeth A.	*Environmental Health Perspectives*	Biomolecular Screening Branch, Division of the National Toxicology Programs, National Institute of Environmental Sciences	biomolecular screening, toxicology, environmental sciences	National Institutes of Health, Department of Health and Human Services
2012-004	2012	Boekelheide, Kim	*Environmental Health Perspectives*	Department of Pathology and Laboratory Medicine, Division of Biology and Medicine	pathology, laboratory medicine, biology, medicine	Brown University
2012-005	2012	James-Todd, Tamarra	*Environmental Health Perspectives*	Division of Women's Health, Department of Medicine, Connors Center for Women's Health and Gender Biology	women's health, gender biology	Brigham and Women's Hospital and Harvard Medical School
2012-006	2012	Thayer, Kristina A.	*Environmental Health Perspectives*	Division of the National Toxicology Program, National Institute of Environmental Health Sciences	toxicology, environmental health sciences	National Institutes of Health, Department of Health and Human Services
2012-007	2012	Birnbaum, Linda S.	*Environmental Health Perspectives*	Division of the National Toxicology Program, National Institute of Environmental Health Sciences	toxicology, environmental health sciences	National Institutes of Health, Department of Health and Human Services

Table 2.2. (cont'd)

2012-008	2012	Fang, Shona C.	*Environmental Health Perspectives*	Department of Environmental Health, Harvard School of Public Health	environmental health, public health	Harvard School of Public Health
2012-009	2012	Silverstone, Allen E.	*Environmental Health Perspectives*	State University of New York Upstate Medical University	medicine	State University of New York Upstate Medical University
2012-010	2012	Snedeker, Suzanne M.	*Environmental Health Perspectives*	Department of Microbiology and the Institute for Comparative and Environmental Toxicology	microbiology, comparative toxicology, environmental toxicology	Cornell University
2012-011	2012	Holtcamp, Wendee	*Environmental Health Perspectives*	.	.	.
2012-012	2012	Kang, H.P.	*Diabetologia*	Division of Systems Medicine, Department of Pediatrics; Lucile Packard Children's Hospital	systems medicine, pediatrics	Stanford University School of Medicine
2012-013	2012	Smits, M.M.	*Diabetologia*	Division of Metabolism, Endocrinology, and Nutrition, Department of Medicine; VA Puget Sound Health Care Systems	metabolism, endocrinology, nutrition	University of Washington
2012-014	2012	Qi, L.	*Diabetologia*	Department of Public Health Sciences	public health	University of California
2013-001	2013	Mozaffarian, Dariush	*Diabetes Care*	Division of Cardiovascular Medicine and Channing Division of Network Medicine; Department of Epidemiology; Department of Nutrition	cardiovascular medicine, network medicine, epidemiology, nutrition	Brigham and Women's Hospital and Harvard Medical School; Harvard School of Public Health
2013-002	2013	Zheng, Ju-Sheng	*Diabetes Care*	Department of Food Science and Nutrition; Jean Mayer U.S. Department of Agriculture Human Nutrition Research Center on Aging	food science, nutrition, aging	Zhejiang University; Tufts University
2013-003	2013	Hill, James O.	*Diabetes Care*	University of Colorado School of Medicine	medicine	University of Colorado
2013-004	2013	Afable-Munsuz, Aimee	*American Journal of Public Health*	Division of General Internal Medicine, Department of Medicine	internal medicine	University of California
2013-005	2013	Maizlish, Neil	*American Journal of Public Health*	California Department of Public Health	public health	.

Table 2.2. (cont'd)

2013-006	2013	Taylor, Kyla W.	*Environmental Health Perspectives*	Office of Health Assessment and Translation, Division of the National Toxicology Program, National Institute of Environmental Health Sciences	health assessment, toxicology, environmental health sciences	National Institutes of Health, Department of Health and Human Services
2013-007	2013	Wu, Hongyu	*Environmental Health Perspectives*	Department of Nutrition, Harvard School of Public Health	nutrition, public health	Harvard School of Public Health
2013-008	2013	Nicole, Wendee	*Environmental Health Perspectives*	.	.	.
2014-001	2014	Kahn, Steven E.	*The Lancet*	Division of Metabolism, Endocrinology and Nutrition, Department of Medicine	metabolism, endocrinology, nutrition	VA Puget Sound Health Care System, University of Washington
2014-002	2014	Gaskin, Darrell J.	*American Journal of Public Health*	Hopkins Center for Health Disparities Solutions; Department of Health Policy and Management	health disparities, health policy, health management	Johns Hopkins Bloomberg School of Public Health
2014-004	2014	Sun, Qi	*Environmental Health Perspectives*	Channing Division of Network Medicine, Department of Medicine; Department of Epidemiology	network medicine, epidemiology, public health	Brigham and Women's Hospital and Harvard Medical School; Harvard School of Public Health
2014-005	2014	Das, Swapan Kumar	*Diabetes*	Department of Internal Medicine	internal medicine	Wake Forest School of Medicine
2014-006	2014	Colwell, Christopher S.	*Diabetes*	Laboratory for Circadian and Sleep Medicine, Departments of Psychiatry and Biobehavioral Sciences	circadian and sleep medicine, psychiatry, biobehavioral sciences	University of California Los Angeles, David Geffen School of Medicine
2014-007	2014	Vassy, Jason L.	*Diabetes*	Harvard Medical School; Section of General Internal Medicine; Division of General Internal Medicine and Primary Care	internal medicine, primary care	VA Boston Healthcare System; Brigham and Women's Hospital
2014-008	2014	del Rosario, Melissa C.	*Metabolism*	Phoenix Epidemiology and Clinical Research Branch	epidemiology, clinical research	National Institute of Diabetes and Digestive and Kidney Diseases
2014-009	2014	Klimentidis, Yann C.	*Diabetologia*	Mel and Enid Zuckerman College of Public Health, Division of Epidemiology and Biostatistics	public health, epidemiology, biostatistics	University of Arizona
2014-010	2014	Bramswig, Nuria C.	*Diabetologia*	Department of Genetics, Perelman School of Medicine	genetics	University of Pennsylvania
2015-001	2015	Dashti, Hassan S.	*Diabetes Care*	Nutrition and Genomics Laboratory	nutrition, genomics, human nutrition	Jean Mayer U.S. Department of Agriculture Human Nutrition Research Center on Aging at Tufts University

Table 2.2. (cont'd)

2015-002	2015	Gujral, Unjali P.	*Diabetes Care*	Nutrition and Health Sciences Program, Graduate Division of Biomedical and Biological Sciences	nutrition, human sciences, biomedical sciences, biological sciences	Laney Graduate School, Emory University
2015-003	2015	Kuo, Chin-Chi	*Diabetes Care*	Department of Epidemiology; Department of Environmental Health Sciences; Welch Center for Prevention, Epidemiology and Clinical Research; Kidney Institute and Division of Nephrology, Department of Internal Medicine	epidemiology, environmental health sciences, prevention, clinical research, nephrology, internal medicine, public health	Johns Hopkins Bloomberg School of Public Health; Johns Hopkins Medical Institutions; China Medical University Hospital and College of Medicine, China Medical University
2015-004	2015	Rehkopf, David H.	*American Journal of Public Health*	Division of General Medical Disciplines	general medicine, medicine	Stanford University School of Medicine
2015-005	2015	Kuo, Chin-Chi	*International Journal of Epidemiology*	Department of Epidemiology; Department of Environmental Health Sciences; Welch Center for Prevention, Epidemiology and Clinical Research; Kidney Institute and Division of Nephrology, Department of Internal Medicine	epidemiology, environmental health sciences, prevention, clinical research, nephrology, internal medicine, public health	Johns Hopkins Bloomberg School of Public Health; Johns Hopkins Medical Institutions; China Medical University Hospital and College of Medicine, China Medical University
2015-006	2015	Semenkovich, Clay F.	*Diabetes*	.	.	Washington University School of Medicine
2015-007	2015	Ferguson, Jane F.	*Metabolism*	Cardiovascular Institute; Division of Cardiovascular Medicine	cardiovascular medicine	Perelman School of Medicine at the University of Pennsylvania; Vanderbilt University Medical Center
2015-008	2015	Reddy, Marpadga A.	*Diabetologia*	Department of Diabetes and Metabolic Diseases Research	metabolic diseases research	Beckman Research Institute of City of Hope
2016-001	2016	Chen, Zhanghua	*Diabetes Care*	Division of Environmental Health, Department of Preventive Medicine	environmental health, preventive medicine	Keck School of Medicine of the University of Southern California, Los Angeles
2016-002	2016	Schwartz, Stanley S.	*Diabetes Care*	.	.	Main Line Health; University of Pennsylvania
2016-003	2016	Han, Benjamin H.	*Journal of Nursing Scholarship*	Division of Geriatric Medicine and Palliative Care	geriatric medicine, palliative care	NYU School of Medicine
2016-004	2016	Ley, Sylvia H.	*American Journal of Public Health*	Department of Nutrition	nutrition, public health	Harvard T.H. Chan School of Public Health

Table 2.2. (cont'd)

2016-005	2016	Rundle, Andrew G.	*Journal of the American Medical Association*	Mailman School of Public Health	public health	Columbia University
2016-006	2016	Aminov, Zafar	*Environmental Health Perspectives*	Department of Environmental Health Sciences, School of Public Health; Institute for Health and the Environment	environmental health sciences, public health	University at Albany, State University of New York
2016-007	2016	Auerbach, Scott	*Environmental Health Perspectives*	Division of the National Toxicology Program, National Institute of Environmental Health Sciences	toxicology, environmental health sciences	National Institutes of Health, Department of Health and Human Services
2016-008	2016	Ruiz, Patricia	*Environmental Health Perspectives*	Computational Toxicology and Methods Development Laboratory, Division of Toxicology and Human Health Sciences	computational toxicology, methods development, toxicology, human health services, toxic substances, disease registry	Agency for Toxic Substances and Disease Registry
2016-009	2016	McArdle, Patrick F.	*Diabetes*	Division of Endocrinology, Diabetes and Nutrition, Departmetn of Medicine; Program in Epidemiology and Human Genetics	endocrinology, diabetes, nutrition, epidemiology, human genetics	University of Maryland School of Medicine
2017-001	2017	Grau-Pérez, Maria	*Diabetes Care*	Department of Environmental Health Sciences; Department of Environmental Health Sciences	environmental health sciences, public health	Johns Hopkins Bloomberg School of Public Health; Columbia University Mailman School of Public Health
2017-002	2017	Jernigan, Valarie Blue Bird	*American Journal of Public Health*	College of Public Health, Department of Health Promotion Sciences	public health, health promotion sciences	University of Oklahoma, Tulsa
2017-003	2017	Bancks, Michael P.	*Journal of the American Medical Association*	Department of Preventive Medicine	preventive medicine	Northwestern University Feinberg School of Medicine
2017-004	2017	Liu, Gang	*International Journal of Epidemiology*	Department of Nutrition	nutrition, public health	Harvard T.H. Chan School of Public Health
2017-005	2017	Grau-Pérez, Maria	*Environmental Health Perspectives*	Department of Environmental Health and Engineering; Department of Environmental Health Sciences	environmental health, environmental engineering, public health, environmental health sciences	Johns Hopkins Bloomberg School of Public Health; Columbia University Mailman School of Public Health

Table 2.2. (cont'd)

2017-006	2017	Cardenas, Andres	*Environmental Health Perspectives*	Division of Chronic Disease Research Across the Lifecourse, Department of Population Medicine	chronic disease research, population medicine	Harvard Medical School and Harvard Pilgrim HealthCare Institute
2017-007	2017	Kuo, Chin-Chi	*Environmental Health Perspectives*	Department of Epidemiology; Department of Environmental Health Sciences; Welch Center for Prevention, Epidemiology and Clinical Research; Kidney Institute and Big Data Center	epidemiology, public health, environmental health sciences, prevention research, clinical research, kidneys, big data	Johns Hopkins Bloomberg School of Public Health; Johns Hopkins Bloomberg School of Public Health; Johns Hopkins Medical Institutions; China Medical University Hospital and College of Medicine, China Medical University
2017-008	2017	Alderete, Tanya L.	*Diabetes*	Department of Preventive Medicine, Division of Environmental Health	preventive medicine, environmental health	University of Southern California
2017-009	2017	Skyler, Jay S.	*Diabetes*	Diabetes Research Institute	diabetes research	University of Miami Miller School of Medicine
2018-001	2018	Hirsch, Annemarie G.	*Diabetes Care*	Department of Epidemiology and Health Services Research; Department of Environmental Health and Engineering	epidemiology, environmental health, engineering	Geisinger Health System; Johns Hopkins Bloomberg School of Public Health
2018-002	2018	Seltenrich, Nate	*Environmental Health Perspectives*	.	.	.
2018-003	2018	Sun, Qi	*Environmental Health Perspectives*	Department of Nutrition; Channing Division of Network Medicine, Department of Medicine	nutrition, network medicine, public health	Harvard T.H. Chan School of Public Health, Brigham and Women's Hospital and Harvard Medical School
2018-004	2018	Dai, Yang D.	*Diabetes*	.	biomedical research	Biomedical Research Institute of Southern California; The Scripps Research Institute
2019-001	2019	Divney, Anna A.	*Diabetes Care*	Department of Community Health and Social Sciences	community health, social sciences	CUNY Graduate School of Public Health and Health Policy
2019-002	2019	Güngör, Darcy	*American Journal of Clinical Nutrition*	.	.	Panum Group
2019-003	2019	Golden, Sherita H.	*Diabetologia*	Department of Medicine	.	Johns Hopkins University School of Medicine
2019-004	2019	Sargis, Robert M.	*Diabetologia*	Department of Endocrinology, Diabetes, and Metabolism, Department of Medicine; ChicAgo Center for Health and EnvironmenT (CACHET)	endocrinology, diabetes, metabolism, health, environment	University of Illinois at Chicago
2019-005	2019	Kyono, Yasuhiro	*Diabetologia*	Department of Computational Medicine and Bioinformatics; Department of Human Genetics; Institute for Genomics and Systems Biology	computational medicine, bioinformatics, human genetics, genomics, systems biology	University of Michigan; University of Chicago

ENVIRONMENTAL FACTORS AS RELATIONS OF POWER IN TYPE 2 DIABETES SCIENCE

INTRODUCTION

Human diseases and the distribution of health outcomes are common justifications for the pursuit of science. Such justifications cut across multiple scientific disciplines, although institutionally-supported interdisciplinary work on health and medicine has appeared only recently, and quite tentatively (Jacobs and Frickel 2009). Some collaborations focus on sharing methods; for example, statistical methods developed by physicists have been used to conduct genetic research (Sella and Hirsh 2005). Common ground can also be found in the shared study of material phenomenon by multiple disciplines, although this is often overlooked. Nevertheless, in recent decades, a new interpretation of materiality in medicine has emerged in the form of "environmental factors." While there has been some work in political ecology to identify the meanings associated with this term (Brisbois, Delgado, Barraza, Betancourt, Cole, Gislason, Mertens, Parkes, and Saint-Charles 2017; Neely 2020; Nichols and Del Casino, Jr. 2020), , its function within medical discourse remains unclear.

Given its growing presence in disease etiologies, the meanings and discursive strategies associated with "environmental factors" ought to be clarified. This is particularly important for chronic, "multifactorial" (Krieger 1985) diseases like type 2 diabetes. Type 2 diabetes is considered multifactorial on account of the multiple and complex factors that contribute to its development. Such factors have varying potency at different stages of life, and may be widely dispersed or converge together in unpredictable ways. Research on type 2 diabetes etiology is further complicated by its association with other noncommunicable diseases, like cardiovascular disease and respiratory disease (World Health Organization 2021). Cases have also been increasing worldwide for decades, to the point where public health experts have started calling it an "epidemic" (Hu 2011). Importantly, its distribution is largely uneven. In the United States, disparities in type 2 diabetes are commonly described using differences in age or classifications of race and ethnicity (Cowie, Casagrande, and Geiss 2018).

Environmental factors have been evoked as potential contributors to chronic diseases like type 2 diabetes, but in practice, its appearance in disease etiologies reflect ad hoc, atheoretical interpretations. Theories about what the environment *is* – that is, associated ontologies and epistemologies – are rarely found in medical literature. This suggests that there is an opportunity to clarify what medical scientists, practitioners, and scholars (nominally, "experts") mean when they discuss environmental factors. In this study, I interview such experts on their interpretations of environmental factors within the context of type 2 diabetes. My initial research question was, "How do medical experts' everyday interactions with people living with type 2 diabetes inform their interpretations of environmental factors?"

Rather than provide straightforward definitions, I found that medical experts used environmental factors to refer to the material and semiotic conditions that made preventing and managing disease extremely difficult for the people they worked with. Specifically, medical experts' interpretations of environmental factors revealed relations of power that people living with type 2 diabetes were beholden to. Experts also perceived that they were beholden to similar processes and structures of power. Experts organized their responses around discursive boundaries distinguishing conceptualizations of "the environment" that ultimately revealed how little power medical experts had over environmental factors related to type 2 diabetes, and to health more broadly. Some experts explicitly linked environmental factors to power, where who had the power to invoke environmental change, had the power over the distribution of health. Who these relations of power were centered upon, however, remained unnamed. These associations between power and the environment evoked a political ecology framework, where power both engenders and is derived from environmental change.

BACKGROUND

Power and the environment is challenging to discuss in tandem. One reason might be that among several branches of science, the environment is treated as a stage or backdrop upon which human activities play out (Robbins 2004). In contrast, scholarship in environmental sociology, underpinned by postmodernist theory, reconceptualized "the environment" as a social actor starting in the 1970s (Catton and Dunlap

1978). Since then, terms like “the environment,” “nature,” and “nonhumans” have been enrolled in a broad range of work investigating social change (Bird 1987; Cronon 1996). While interpreting nonhumans’ intentions are discouraged since they lie beyond our empirical reach (Lloro-Bidart 2017; York and Longo 2017), nonhumans are still recognized for their agency and largely unpredictable effects (Escobar 1999; Lloro-Bidart 2017). This makes many scholars uncomfortable, since Western knowledge systems tend to invert the power relationship: humans have control over nature, not the other way around (Simpson 2017; Smith 1999). Thus a discussion on power and the environment also requires thinking about the ontological boundaries between humans and nonhumans, including shared forms of materiality and who we include under the label, “social.”

One area of research that carefully considers power and the environment together is political ecology. Scholars working under a political ecological framework pay special attention to how environmental phenomenon informs the conditions for social change, or extends existing systems of inequality. As a theory, political ecology also accommodates the uncertainties that come with considering human and nonhuman relationships. Since its intellectual roots lie in political economy, political ecologists are prone to center their analyses on fixed power structures, but there has been more flexibility as the field has matured. Presently, political ecological analyses also consider the ways in which power emerges from evolving social relationships. Swyngedouw’s (1999) work, for example, demonstrates how essential resources like water form the heart of governance logics and classifications of citizenry. His study shows how different groups of people have different relationships with water: some control its potability and distribution, and some access water through the decisions of others. Such relationships thus engender social notions of class and other categories of difference. Elaborating on his “hydrosocial” model, Swyngedouw (1999) encourages scholars to ask “serious questions about who controls, who acts, and who has the power to produce what kind of socionature” (Swyngedouw 1999:461).

Feminist political ecologists use similar approaches to show how humans’ varied relationships with landscapes are not incidental, but are constitutive of local interpretations of gender. That is, gender is enacted through divisions of labor in households, communities, and broader society, with labor itself taking the form of specific relationships with the environment. According to FPE scholars, such relationships can feed into the maintenance of social and cultural norms, family structures, and economic and educational opportunities. Key to FPE is that human-environmental interactions reify gender by reproducing or extending gendered *relations* into new contexts in concurrence with environmental change (Richmond, Elliot, Matthews, and Elliot 2005; Truelove 2011).

Actor-network theory (ANT) has likewise engaged with power and the environment by putting humans and nonhumans on an even keel, thus practicing the conceptual “symmetry” as elaborated on by Callon (1984) and Shamir (2013). This means that in analyzing social outcomes, scholars working under an ANT framework will not assume that humans are the primary drivers for such outcomes. Rather, nonhumans are assumed to have agency – be agents, or actants – that can assert power into a situation in unpredictable and mostly unknowable ways. Thus ANT discards rigid delineations between society and nature, and even between social and political contexts. Shamir (2013) argues, “This method of inquiry does not ignore ‘context.’ Rather, it traces the actions and movements that link the sites of big and small so as to make them commensurable: if context matters, let it make itself present in and through these movements” (Shamir 2013:7). Under ANT, power is emergent, and without a static or “true” form. While ANT does not reject structural forms of power, accompanying analyses fixate on *how* structural power manifests in discernible ways. The argument being, the only way to show that structural power happens is by following how that power appears in social life, and how it shapes itself in unique ways under new circumstances. Thus an ANT approach to power concentrates on studying power relations – that is, the transfer and transformation of power that is contingent on ever-forming relationships.

Power, the environment, and medical science

When considering power and the environment in the context of medical science, different language is used. Here, environmental factors and their impact on health outcomes have relevance and high stakes, but they are not addressed head on. Power, on the other hand, is often discussed within the context of knowledge production, with scholars attending to the unequal positioning of practitioners and people living with illness or disease as a broader issue of “expert” versus “lay” narratives. Predictably, scholars have found that explanations for why disease happens tend to differ between these groups. Shim (2005), for example, examined how epidemiologists and "lay people" made sense of the role of racism in cardiovascular disease etiology. In contrast to epidemiologists' "apolitical construction of race" (Shim 2005:431), Shim (2005) found that "lay people" perceived racism as the primary reason for disparities in cardiovascular disease. In their examinations of "medically unexplained symptoms," Rasmussen (2020) and Jutel (2010) have likewise shown how such labels become a leverage point for medical experts to reinsert their authority within physician-patient interactions and other scientific spaces. In short, despite the authority that medical experts and scientists wield, the concepts that they use to explain why disease happens may differ greatly from the explanations employed by the people they are treating. Such imbalances in knowledge production not only reentrenches unequal power distributions within expert-lay configurations; they also may lead to actual treatments being wholly ineffective.

A burgeoning area of research is the political ecology of health, which delves deeper into unresolved issues around distribution of illness, material bodies, and the recognition of embodied health as indicators of environmental injustices (Brisbois et al. 2017; Neely 2020; Nichols and Del Casino, Jr. 2020). Such work still lies on the periphery of core medical science, even when chronic diseases like type 2 diabetes have been linked to a multitude of environmental factors, i.e., a variety of factors that people may encounter in daily living. How those factors are identified, classified, and prioritized is unclear, making a sequence of treatment for type 2 diabetes difficult. Relatedly, scholarship on how knowledge is produced on diabetes – that is, how medical scientists and health care providers deploy their expertise to diagnose or help individuals manage the disease – is scant. One exception is O'Donnell's (2015) socio-historical analysis of type 2 diabetes, which shows how changes in class dynamics in the United States shifted the etiological framing of type 2 diabetes: disease that was previously an outcome of social organization was soon attributable to individual behaviors. Otherwise, environmental knowledge production within contexts like type 2 diabetes remain difficult to articulate given the conceptual overlaps and ambiguity around terms like "the environment" and "multifactorial." For example, Darling et al.'s (2016) interviews with molecular biologists studying gene-environment interactions revealed a tendency for scientists to morph, transform, and epistemologically force ambiguous concepts like "environmental factors" into their primary paradigm. In their study, molecular biologists “molecularized” environmental factors to fit within the scope of their everyday work.

In this study, I compare the interpretation of “environmental factors” by medical experts across different scientific paradigms. My goal is to identify areas of conceptual overlap, since such areas may be more viable for developing treatment strategies for type 2 diabetes that are supported by multiple levels of health care. I am also interested in any emergent tensions that may accompany questions about experts’ professional contexts, particularly regarding relations of power within medical science and practice. In short, I am interested in understanding how medical experts, working with people living with type 2 diabetes, explain who or what is responsible for the variation in the distribution of type 2 diabetes.

METHODS

To answer my research questions, I conducted in-person, in-depth interviews with 24 medical experts who worked with people living with type 2 diabetes in some capacity. My goal was to cast as wide a net as possible when it came to “experts,” since doing so would facilitate a variety of perspectives on environmental factors related to type 2 diabetes. I deliberately focused on “expert” perspectives as part of a long-term project to establish a baseline understanding of the most mainstream ideas regarding “environmental factors” within the most legitimized knowledge on type 2 diabetes. That said, some of my participants may have also been people living with type 2 diabetes; I did not ask my participants to disclose this to me during our conversation. Findings from this study reflect the perspectives of people who either volunteered to be interviewed on account of their meeting the aforementioned criteria, or were asked to participate following a convenience-to-purposive-to-snowball sampling procedure.

Selecting the sample

Recruitment for interviews took place from October 2019 to March 2020, or over a six-month period. I initially sought participants whose primary professional occupation fell into one of two categories: medical practitioners, or health and medical science researchers. I initially followed a convenience sampling technique by distributing a recruitment flyer among my personal contacts, professional listservs, and message boards located at two academic institutions in Michigan. Four weeks after I began my search, I had recruited 6 participants. At this point, I decided to follow a purposive sampling procedure, meaning that I began corresponding with medical experts whom I judged would be a good fit for my study. The next 18 participants were recruited from two academic institutions in Michigan using purposive and snowball sampling.

Conducting interviews

All interviews were conducted in person. A majority of interviews took place in participants' offices or a public common space, such as a conference room, common sitting area, or shared laboratory space. The location for each interview was decided ahead of time by each participant. Participants were provided with a consent form which they were asked to read before the interview. All participants agreed to being recorded. I used an iPhone and a portable audio recorder to record interviews. I used verbal cues to communicate when I started and stopped recording. The data collection procedures for this study were approved by the Institution Review Board at Michigan State University (STUDY00003326).

Participants were asked questions related to how type 2 diabetes was diagnosed, how environmental factors "entered the picture" in the context of type 2 diabetes, and how their occupation approached studying or addressing environmental factors that impacted people living with type 2 diabetes. Interviews lasted between 15 to 70 minutes and were transcribed and analyzed by the author using multiple rounds of abductive coding (Tavory and Timmermans 2014). In general, the interview participants featured in this study were more than 18 years of age, had at least 3 years of experience in their professional field, and worked with people living with type 2 diabetes in some capacity. Participants ran the gamut regarding their connection to medical science; some participants were medical students, and others were health scholars or practitioners with decades of experience.

RESULTS

Below, I argue that medical experts discussing environmental factors in the context of their everyday work were describing relations of power that introduced opportunities or constraints to act on behalf of the people they were working with – people living with type 2 diabetes. They elaborated on these relations in a couple of ways: by describing processes in which environmental factors became relevant in the lives of the people they were working with, and by describing who had control over environmental factors such that health outcomes – and health disparities – could change significantly in tandem with environmental change.

Control over environmental factors in everyday life

Participants described environmental factors that appeared in everyday life as constraints to actions. One participant, who was training to be a medical practitioner, described such constraints as things that people could not control:

> "...[I] usually would think of, kind of like a nature versus nurture. Where, if it's not something, you know, inherent, intrinsic to your body, the way you were born, then it's something in your environment that you are exposed to, and you kind of can't control. And that's all, to some degree, environmental. That's how I split it up."

Conceptualizing environmental factors as aspects of living with type 2 diabetes that could not be controlled were often described using a hypothetical "you." In the statement above, "nature versus nature" was placed in parallel with factors that were "inherent, intrinsic to your body" versus environment factors that could not be controlled. However, descriptions like "inherent" and "intrinsic" also suggested a lack of control; both terms implied that the body was imbued with an unchangeable essence, possibly impervious to medical care. This suggests that, unlike with the body, the lack of control associated with environmental factors is perceived more flexibly, although it is unclear in what way.

The hypothetical “you” often occurred in conjunction with participants describing a rigid set of conditions that illustrated how environmental factors could challenge the prevention or management of type 2 diabetes. Many environmental factors described by the participants definitively suggested that individuals would have little to no control over environmental factors. For example, a family practitioner described environmental factors as the following:

> “...environmental factors would be where you live. Where you grew up, right. Where you live. What's your level of education. What's your access to food. What's your access to clean food. What's your ability to understand and implement the knowledge about what clean food is. Do you know how to cook food. Right, it's all, it all comes down from, a lot of it starts from upbringing. It's complex, because that also stems to…it's your level of confidence, that if you need to take charge of your health, are you able to. To do so, are you empowered to, disempowered, and so on.”

There are a couple of key takeaways. First is that the full breadth of environmental factors that are unable to be controlled spans multiple dimensions of society – dimensions that are integrated, but also highly complex as standalone concepts. “Where you live” suggests physical location, but also proximate neighborhood characteristics, local culture, and governance. “Where you grew up” also suggests that “where you live” is particularly important in early life. “Education” is often implied as education attained during early life, or prior to adulthood. “Access to food,” and related concepts of “clean food” and knowledge about to cook clean food, suggest a system of production and distribution that is conceptually separate from how education and neighborhood impact a person’s life. This participant linked these elements to a person feeling empowered or disempowered to prevent or manage type 2 diabetes. This relates to the second takeaway, which is how the incongruence regarding a lack of control over the body versus the environment continues to build. Many environmental factors – where one grows up, one’s educational attainment, one’s access to clean food – are perceived as being out of a person’s control. Yet it is suggested that a person living with type 2 diabetes needs to engage with these factors regardless, to assert themselves in a way such that they are “empowered” to manage their disease. “Empowered” suggests that there was a previous condition or state where someone felt like they did not have power.

Such conditions occur when something else is more powerful – in this case, environmental factors. It is therefore important to recognize that the environmental factors being described are social institutions (education), systems (food), culture and norms (neighborhoods, upbringing, knowledge), and processes of sorting people into different groups, or establishing exclusivity or order (issues of access). In other words, the conditions described here are collective processes that are out of an individual's control by definition of them being social institutions, systems, culture, norms, and ordering schemes. A participant working in public health education elaborated on this interpretation of environmental factors by describing such factors in their ideal form in order to support a healthy life – a life, it is suggested, without type 2 diabetes:

> "…if [a] child wakes up at wherever they live and the house is, more of a healthy lifestyle, like there's minimal stress, minimal trauma, and yeah, if we were to speak of a perfect world, okay. So if their living condition is conducive to a healthy living, mentally, physically, financially, socially, all of it. Interior and exterior. So if there's lighting. If there's green space. If there's, like outside their house, like their neighborhood. You know, if there's green space to go hang out, if there's sidewalks that are actually usable. If the streetlights are there. And not, if there's not a lot of blight and graffiti and smashed windows and all that kind of stuff. And then if they actually have access to healthcare, as they need it. That's convenient to them. If there's recreational opportunities somewhere, whether it's at school, or at a facility near their place or whatever. If the learning institution is also aligned with creating healthy lifestyles, again, mentally, physically, intellectually, whatever."

This statement seems to fill the negative space that was carved out by the first two statements in that it reveals how practitioners perceived which environmental factors are needed to maintain a healthy life, conceivably from cradle to grave. The environmental factors mentioned, however, are quite familiar: there was a house and a sense of home; there was a neighborhood, and the physical aspects – lighting, green space, sidewalks, lack of blight – that made up that neighborhood. Schooling was mentioned, as was access, this time regarding health care and recreation. Here, "access" and "opportunities" were used as synonyms. The participant also described multiple dimensions of health itself; there were mental, physical, financial, social, and intellectual dimensions that could be influenced by "living conditions." Stress and trauma were also mentioned – in this depiction, they should be minimal, but overall, their relationship to environmental factors is unclear. This participant used the hypothetical life of a child – which takes the place of a hypothetical "you" – to show how embedded the child was within such conditions. Describing environmental factors in this way further emphasized the lack of control that a child – or "you" – had over the essential aspects of a potentially healthy life.

Who does not have control – and alternatively, who does – is a question related to who has power. A participant working in nutrition provided a partial answer to an emergent question of who had power amidst these conditions when they described how relations of power constituted health itself:

> "Everybody is affected by type 2. Because everybody is eventually intertwined in this. So say I've just been diagnosed with type 2. I'm affected by it. Then anybody around me is affected by it. My immediate family is, because now they have to deal with me. And they had to deal with me before, but now, if I have to change medications or something, how are the medications going to affect me. They've got to deal with those things. My shopping or my food intake might change. They've got to deal with that…And then, how they react to it. Now how they're reacting to it, how their moods change, how their reacting might affect their friends, or their coworkers or something. The pharmacy. Pharmacy is affected by it because now they have to take on more and more [people who have] diabetes, and more medications. The doctor, my provider, is affected by it, because now he's gotta manage me. Anybody else that I see, has to manage me. They're affected by it. Then you have society in general because, wow, there's now the financial burden that other people have to take because I'm now, in a sense, a statistic of that financial burden being, say, spread out amongst everybody else. So type 2, like any major chronic disease, affects everybody. We're all involved with it."

The challenges that an individual person may encounter after receiving a diagnosis of type 2 diabetes placed alongside the idea of an “empowered’ individual who is motivated to manage their type 2 diabetes continues to build on the incongruence previously discussed. The relationships between people described in this statement are defined by relations of power, and specifically, differences in power between the person who was diagnosed with type 2 diabetes, and the people who need to “manage” the disease that the person embodies. This statement demonstrates the ambivalence surrounding the individualization of type 2 diabetes: on the one hand, the participant is describing who is affected by a type 2 diabetes diagnosis, taking care not to pinpoint the individual as responsible for the diagnosis. On the other hand, the situation is framed as other actors’ responsibilities being triggered as a consequence of the diagnosis. Family members have to “deal with” or react to new foods, medications, and other health routines, and their own health might be impacted. Pharmacists and health care providers have to manage this person as an addition to their work load. This person is also impacting others through a “financial burden” that exists due to how our society is set up to share responsibility regarding the management of disease.

Thus there is a contradiction in the power relations being described: One person diagnosed with type 2 diabetes could potentially impact dozens or hundreds or thousands of other people’s lives. To have an effect is one definition of power, so the person with a diagnosis of type 2 diabetes has, from one perspective, power over others. But the relations described continue to be venues for exchanges of power, such that from another perspective, it could be argued that family, pharmacists, and health care providers have power over the individual. Without their actions, this person could not manage the disease on their own. It is notable that such a contradiction appears in a discussion about environmental factors. It is also worth asking, what would relations of power look like if the description was inverted like the previous statements, where instead of describing what happens to society with a single person’s diagnosis of type 2 diabetes, a participant describes how a single person might be supported by society such that they do not receive a diagnosis?

Lack of control and matters of access

Among several participants, descriptions of environmental factors prompted discussions about the relationships that people with a diagnosis of type 2 diabetes had with other social actors, and with the physical elements of major social institutions like neighborhoods, school, work, and recreation. A related discussion involved describing environmental factors as matters of access. When considering matters of access, the power dynamic seems clearer: broadly, individual people do not control what they have access to. Indeed, the term "access" is oriented towards an assumption that the discourse involves lack of access, despite the neutrality of the term. Who determines what people have access to is not elaborated on, and the issue of some people resolving barriers to necessities is also not discussed. Rather, as a participant who works in nursing and public health articulated, matters of access can open a door for discussions of structural inequalities that are upheld collectively:

> "[Environmental factors are] safe housing for somebody with diabetes. If they don't have adequate refrigeration, [it] can be, limit the amount of, the kind of foods that they can eat…Environmental, when we're talking about food, are grocery stores available, are they close, are they easy to get to, do you have a car to get to the grocery. If not, what kind of public transportation's available. Because some people, if there's not adequate resources for them, they end up shopping at the pantry where they, most of them carry WIC products. If you're on WIC, there's a selection of WIC products. But most of the food is not fresh fruits and vegetables."

This participant discussed matters of access regarding food, where the multiple dimensions associated with "access" suggest, above all, that access to food is a process that an individual has more or less control over. Here, the participant's description of matters of access translated into a matter of location of home, or the place where one lives. Housing must be safe, must have good refrigeration, most be close to grocery stores or have options for transportation to get to grocery stores, before the types of food that can support healthy maintenance of type 2 diabetes can be accessed. The Special Supplemental Nutrition Program for Women, Infants, and Children, or WIC, which distributes federal grant money to state governments for "supplemental foods, health care referrals, and nutrition education for low-income pregnant, breastfeeding, and non-breastfeeding postpartum women, and to infants and children up to age five who are found to be a nutritional risk" (Food and Nutrition Service, U.S. Department of Agriculture 2021), was also mentioned. WIC benefits include food assistance, nutrition education, and referrals to other social services. This participant later said:

> "WIC is awful. Like, I worked in WIC, and you have to bring your child with you. And they have to go in for the appointment. They put in sometimes as long as two hours or longer. The kids get grumpy, tired, hungry, all this stuff. Going to WIC is a real, real, chore, I tell you. And I admire the people who have to take the bus and get there, and drag their kids in and all that stuff, like how much work it is to play the system."

Several relations of power appear in these statements. As discussed, power has a role to play in how accessible healthy food is; many conditions have to be met before people living with type 2 diabetes can access healthy food, and those conditions, such as quality of housing and location of home, are not the sole responsibility of individuals. Other actors – as in, other individuals, as well as society in general – can intervene to influence how well such conditions are fulfilled. One intervention, WIC, was described by the participant as "awful" because – it can be surmised – of the long list of conditions that have to be met before WIC is accessible. The list of conditions that must be met before healthy food is accessible for people enrolled in WIC are thus even longer, requiring many hours of energy and resources that draw from multiple dimensions of life. The same participant then described how challenges with accessing resources can also be geographically clustered:

> "So isolation, they maybe don't have as many people in the neighborhood that they can count on, if they had an emergency. Oh, who is it that asked this question. It might even be Bernie Sanders, I don't know. But it's like, if you needed, if had an emergency, who could you go to, to borrow twenty dollars? A lot of people don't have anybody that they could borrow twenty dollars off of because everybody that lives nears them is in the same, situation. Being rural makes that even worse because you don't really have an abundance of neighbors or a community where you see

> each other all the time at the same store or over at the library or things like that, because if you're far removed and have unstable – almost everybody who lives way out in the country has some kind of transportation, but it might be unreliable and break down and they have problems with that too."

The participant described how people in rural areas might have "some kind of transportation," but having access to transportation is more than just a box to be checked when it comes to accessing resources needed to maintain health. If transportation is not reliable, it may introduce new challenges that exacerbate the forms of vulnerability that the participant had described earlier. Isolation and financial precarity makes healthy living difficult for an individual person, but as previously discussed, healthy living requires multiple contributors and conditions that collectively make it easier for people to maintain treatment of disease. In short, this example shows how matters of access as relations of power have a spatial and thus material dimension. The barrier to access emergency funds, for example, may be especially high because of social configurations – isolation – that nevertheless have a material basis. Many participants shared similar interpretations of matters of access as environmental factors, including the following participant working in public health education:

> "You may physically have issues about accessing? But even if you are able to access, do you feel like your voice is heard. Do you feel like your needs are being met. Because you may have, from all the other factors, financial issues, or lack of transportation, or I'm only just trying to put food on the table, or my spouse beats me, or, you know. And so, a lot of that might even just create a lack of access because, yeah, I might physically be there, but now my doctor has diagnosed me with diabetes – well, I don't have any money. To now go get the testing strips and poke my finger. And even if I do find that I have high blood sugar, I don't have the knowledge, and I may not have the time to go work with the diabetes educator because I've got four kids and I have to take a city bus. And bring my kids with me. Because they don't have support. Yeah, so, it's a lot of things."

In this statement, it is yet again evident that environmental factors are designated as such because they represent factors related to health maintenance that lie out of individuals' control, as signaled by the hypothetical "you." More pointedly, this participant described challenges as not only matters of "access," but also as having a sense of agency – "do you feel like your voice is heard – while navigating through multiple routines of health maintenance. Resources could be physically available, but may not be financially feasible or accommodate the mental, physical, and emotional stress loads associated with work, family, and other responsibilities. For all that access is commonly used in conjunction with environmental factors, several participants insisted on drawing out the nuance embedded in the term. In summary, matters of access are reflective of who has power in society, specifically regarding whose voice is heard and whose voice is not heard. Power, however, is not often discussed in corresponding scientific literature. Below are several exceptions.

Environmental factors as reproductions of social inequalities

> Interviewer: Do you think that type 2 diabetes occurs randomly throughout our society?
>
> Participant: No. No because of all of the social determinants that influence access to resources. Distribution of resources. Distribution of power, more importantly, I think, influences that to which it's random. Nothing health-related is random. And I think of all of the public health campaigns, especially those that talk about your zipcode and mortality, I think, they just emphasize that.

For this participant working as an epidemiologist, type 2 diabetes etiology is a direct outcome of who has power in society. Power is linked to both "access to resources" and "distribution of resources." Describing power as both matters of access and matters of distribution suggest that there are two forms of power being discussed. Access to resources, as mentioned, involves not only the physical presence of resources necessary for health maintenance, but also the physical, mental, and emotional capacities that individual have to fulfill health maintenance needs. To have power to fulfill those needs is to have a way to renew the capacities required. Power required for the distribution of resources, however, implies an almost disembodied process of making available resources to certain communities and not others. And yet, people are making those decisions; in other words, some people, who have such power to make decisions about the distribution of resources, are making decisions such that some communities will see a higher prevalence of type 2 diabetes. When answering the question, does type 2 diabetes occur randomly, this participant adamantly stated that cases are contingent on the decisions of people in power. Another participant working in public health articulated the function of environmental factors within these narratives:

> “It just isn't usually a random disease. It's usually a lot of environmental impacts – well, I mean, could be lots of things perhaps playing into it. It's not necessarily something that's, like, in the water, or anything like that. It's not like an environmental contaminant in that regards. It's more related to, if we're looking at nutrition specifically, food systems, in an area – because physical activity, is kind of a hard one because people usually have more control over that. They may not be able to go to specific gyms and stuff like that, but even walking and stuff can decrease blood glucose and increase insulin sensitivity so it's more of a motivational piece. And as you know, in general, we're not very good at meeting physical activity recommendations. We're not very good at meeting more sound eating habits. It's kind of hard – it can often be kind of hard. Just looking at from a behavioral aspect."

For this participant, who works in public health, environmental impacts related to health were not the physical presence of contaminants. Rather, environmental impacts referred to “food systems, in an area,” which appends the previous description of access to necessities for health maintenance. The word “systems” likewise suggest collective activities that reproduce patterns – distributions – of food, and subsequently, health, that may lead to type 2 diabetes. The question then becomes, who has control over systems? Individuals do not have control over environmental factors, which here, are described as systems. But matters of access and distribution are also related to power, which inevitably converges onto some form of social actor. Someone, or several people, have more control over systems than others, since it already has been established that it is not people living with type 2 diabetes. Their non-presence in these narratives evokes Krieger’s (1985) question, “where is the spider?” in web of causation models of disease. Later, this participant elaborated on the different pieces of the food system that could make healthy eating so challenging:

> "...to me, the big environmental factors driving that are the fact that the food system pushes mostly food products and not real food in quantities that are too large. And that we live in places where, it's hard to get to those healthy food sources. Like there is healthy food out there, but most places are inundated with unhealthy foods that, if you took a representative [selection] of the foods in a grocery store and you just ate a sample of those for your whole life, you'll wind up with, I mean, odds are, you would wind up with some kind of chronic disease. Diet-related chronic disease. Because it's mostly not good food."

Again, food systems were equated with environmental factors, which conveyed a sense of autonomy; the food system "pushes out food products and not real food in quantities that are too large." This pseudo-autonomy also suggests a lack of control over the collective pieces of a food system, as well as the replication of the motion, "pushes." It is suggested that for any one "whole life," the dominant presence of these not-real, not-good foods will lead to diet-related chronic disease. Here, environmental factors do not preclude understanding that some foods are not good or are not healthy. But are these environmental factors avoidable? It seems that they are not. A participant working in community nutrition presented one explanation why:

> "I mean, they go hand in hand. I think it's a linear relationship, in that the environmental factors are potentially driving the actual lifestyle behaviors, which is then driving their management of type 2 diabetes, or their potential diagnosis. Of diabetes as well, so I think the environmental factors are the driving factor, in my opinion. And I mean, as far as like, increasing the likelihood, I think that's the same in response to, where do we see the highest rates of type 2 diabetes? In places that don't have access to fruits and vegetables, that don't have access to physical activity, that don't have access to healthcare. So it's directly related, in my opinion."

Here, the key takeaway is that it is the environmental factors that assert the control over lifestyle factors. The narrative of individuals needing to steer the wheel when dealing with the maintenance of their healthy lives is revealed as illogical because this participant claims outright that people have had very little control over such conditions to begin with. Indeed, this participant describes an order: environmental factors will govern individual “lifestyle behaviors,” which can partially determine type 2 diabetes diagnosis. In other words, individualizing treatment for type 2 diabetes makes a difference on a one-to-one basis at best, and only for those most privileged. This description thus inspires the question, for everyone else, why are political actions not considered as part of type 2 diabetes treatment? This was more or less suggested by a participant working in epidemiology, who described in detail how power flows, imbues, and is constitutive of every environmental factor involved with health:

> "I would say there are at least three dimensions to the environment, right? You have the built environment, you have the social environment, and then I think you have the geography. The actual landscape of a space. And when I think of built environment, I tend now to think of buildings, or structures that have been erected. A physical location that have been designed, and put in place, in some location. When I think of social environment, I'm very much thinking about, you get indicators of safety, power, access to resources, or any of that are in a geographic space. But those social indicators do not have to be built environment factors…oftentimes I hear built environment to include things like parks and gardens and such. But I think it's a bit more nuanced than that. To build a building is one thing, but to have green space is yet another. And some of these things are naturally, you can control, or others, you can't control. I think to have a park, a park is more of a natural, in theory, a natural space. But then when you put a playground on that park, it changes the amount of attention it receives. When you add fences to this park, it is now being defined as a space, whether it's inclusive or not, we'll figure it out. And as soon as you see beer cans, or trash not taken out, or broken street lights, or no nets on the hoop, or no backboard and just the hoop. Now we have a space that's showing us elements of built, physical, and, social environment. And those things collectively in my opinion, determine, how people will use a resource. So getting back to...there's a lot of lifestyle behavioral work that I think is important for

> diabetes. But there is also these things, these systems that are structuring resource. When you have all of those environmental pieces coming together, you have evidence of what the power dynamic has been in that space. Who gets to control it, and you get a sense of investment, in that space. When you see the investment, then you kind of have a feel for who's really going to use it.

This participant described how relations of power shaped the environmental factors that subsequently influenced the “lifestyle behaviors” previously discussed. Importantly, environmental factors change over time; they can evolve, even as the relations of power shaping them stay the same. Parks accumulating beer cans, trash, and broken streetlights show, as this participant states, the “systems that are structuring resource” – resources that are discussed in scientific discourse as being key for treating a disease like type 2 diabetes. The components of a space can signal who has power, based on the changing use and meanings of that space. Such changes also loop back to matters of access and lack of control. In other words, the pace of change of environmental factors, that partially governs accessibility and usability, is also an indicator of power. Positive change can speed up, slow down, or permanently stall based on the powerful’s priorities. A family practitioner likewise elaborates:

> “…you know, you just, you do the best you can, but we really are very limited with the current insurance situation. That, in the current economic situation, that there's a majority of people who can’t – I mean, I read some article that, what percentage of the people in the country can afford a four-hundred dollar emergency bill? And it's like, I don't know what the percentage is, but it's a very large percentage, couldn't come up with four-hundred dollars. Well, how are they going to afford their medication? It's, it's political. I mean, I don't think of it as environmental. Political and social, and economic. That’s the environment that I see that really interferes with this.”

DISCUSSION

In this study, I investigated how medical practitioners and scholars defined environmental factors related to type 2 diabetes within their everyday work. Upon asking about environmental factors, a broad range of practitioners and scholars described environmental factors that impacted everyday life for people living with type 2 diabetes. Many of their descriptions took the form of piecing together hypothetical barriers to resources that people living with type 2 diabetes required for disease treatment and maintenance of a healthy life. Several participants described these barriers as being very difficult to surmount individually; people managing disease have to rely on others' time, knowledge, material resources, and patience to traverse the first step of obtaining the resources they need. Others perceived individuals as having little to no control over environmental factors, suggesting that people living with type 2 diabetes were more or less locked into a set of conditions that would make it extremely difficult to manage their diabetes in a healthy manner. Still others reframed the uneven distribution – or major clustering – of type 2 diabetes cases as a matter of who has power, since who has power governs the conditions from which type 2 diabetes can emerge.

It is this last framing that feels especially important: in discussing environmental factors related to type 2 diabetes, participants revealed relations of power at multiple scales, among multiple social actors, and across multiple material conditions, that were packaged into the term. That is, describing environmental factors encouraged participants to discuss the processes that people living with type 2 diabetes had to fulfill in order to maintain disease. But because of the way that unequal power relations expanded across space and time, many of the processes described seemed to take a cyclical shape. Reproduction of unequal power relations occurred at home, regarding the safety and quality of housing, regarding family life. Moving further away from the home, it also involved the presence, safety, and quality of neighborhood characteristics, including healthy food options, green spaces, infrastructure like parks, streetlights, and sidewalks, and transportation options. Opportunities for work, money, medicines, health care services were especially contingent on transportation, which could vary based on the social configurations of a space, including how many people were actually nearby and the prevailing culture regarding asking for help. Participants hinted at these power relations when they used phrases like, "lack of control," or "access," or "distribution," or "systems." It was evident that participants were well-versed in the complexity and interconnectedness of relations of power and how such relations impacted the health distribution of health outcomes. Even so, most participants avoided naming who or where this power converged.

Still, the message remains clear: whoever has power to evoke environmental change, has power over health. This is slightly different from the social determinants of health framework, which also concentrated on access to resources, but focused on explaining uneven distributions of disease by looking at variation between individual cases (Link and Phelan 1995; Krieger 1985; Rose 1985). Focusing explicitly on who has power to instigate change is a template borrowed from political ecology. In Swynedouw's (1999) and Truelove's (2011) work, power unfurled from state bureaucracies to reinforce and extend categories of resource use that subsequently informed different classes of citizenry. Nichols (2020), who works out of a decolonial framework in the vein of Maldanado-Torres (2016), showed how theft of land by state institutions were implicated in cyclical forms of change that continue to violently disrupt lives in the present. As mentioned, there is new engagement with the puzzle involving not just social determinants of health and where they originate from, but the forms of power that give the "social" a material presence and people in power the latitude to make change that can either harm or protect major populations. In this sense, "social determinants" are not an adequate phrase; neither are "environmental factors." Both sound too neutral, and do not exhibit the relations of power that medical experts themselves articulate.

CONCLUSION

In these interviews, participants recognized and described relations of power that underwrote unjust distributions of type 2 diabetes, even though interview prompts were centered on "environmental factors." It was almost as if, in discussing environmental factors, medical practitioners and scholars reflected not only on how the people they worked with – people living with type 2 diabetes – were embroiled in reproductions of inequalities already in motion; they also reflected on their own roles in these systems, distributions, and configurations of power. Some participants placed themselves in a position similar to that of people living with type 2 diabetes: they felt they had little control over the conditions that governed their work and subsequently limited the expertise and assistance they could provide to people with disease. This unexpected consequence of a discussion on environmental factors evokes insights from actor-network theory, since ANT has room to accommodate how relations of power are reproduced, even within discourse. Notably, participants described the consequences of relations of power, but did not name the nodes or convergence points. There was a sense that to do so would require stepping out of their roles as practitioners and scholars. This is something that ANT and other approaches to scientific knowledge production can examine in future research: Who has the power to *name* who has power within legitimized forms of science and expertise, both in literature and in practice?

CONCLUSION

In this dissertation, I engaged with two puzzles that involved bodies and the distribution of power underwriting the production of knowledge on the environment within type 2 diabetes science. The first puzzle involved questioning the ontological boundaries between bodies and environments. Findings from this study revealed that bodies were present within type 2 diabetes science, but were described in a way that continued to subordinate them as subjects-objects of science as opposed to essential contributors. The second puzzle involved relations of power that engendered knowledge production processes in such a way as to reinforce “expert” versus “subject-object” bodies. Types of bodies were held distinct across multiple mediums – within scientic literature, and in interviews – that were nevertheless vulnerable to similar relations of power that held their “types” in place. While expressing awareness that many environmental factors contributed to challenges with type 2 diabetes management, medical experts also designated such factors as political projects. Political projects, it was implied, were outside their purview of expertise. Who, then, makes decisions that maintain type 2 diabetes disparities in the United States?

I drew from three STS concepts to illustrate how configurations of power could emerge in different ways. Under Frickel and Moore’s (2006) “political sociology of science,” I showed how diverse forms of expertise participating in environmental knowledge production did not preclude the consolidation of opportunities to produce knowledge by a handful of institutional actors. Indeed, findings suggested that institutions with the most prestige, privilege, and financial resources had the most control over the diversification of research on environmental factors related to type 2 diabetes. In other words, knowledge production on environmental factors within type 2 diabetes science was unevenly distributed across journals, areas of expertise, and institutions. More specifically, my findings suggested that institutions with greater access to financial and political resources (e.g., larger endowments, or perceived prestige) dominated the discussion on environmental factors for more than a decade due to consolidation of knowledge-power. Due to their disproportionate influence, I showed how epidemiological, environmental health, and public health interpretations of environmental factors were most relevant within medical discourse now. Importantly, such areas of expertise are partial to definitions of environmental factors commensurable to *population-level* measures of type 2 diabetes. This suggested that there was limited representation of environmental factors related to the *lived experiences* of type 2 diabetes in medical science. Thus the perpetuation of situating certain bodies as the "subjects" of science, rather than as active decision-makers, continued.

Next, using Star and Griesemer's (1989) boundary objects framework, I showed how knowledge production collectively progressed among disparate groups of scientists who only marginally shared similar conceptualizations of "the environment" in the context of type 2 diabetes. Their collective efforts further compounded the problematic legitimacy associated with pastiche forms of science, which combined scientists' privilege positionalities with tenuous empirical results. Thus the interpretive flexibility – or alternatively, the "tackiness" – of environmental factors enabled its prioritization across local groups of scientists that were trying to piece together type 2 diabetes etiology. There was no evidence that scientists convened and standardized definitions of environmental factors; rather, local groups of scientists were able to use environmental factors in their own research and build on each other's work without explicit consensus. In other words, environmental factors fit the bill as a boundary object. However, this status as a boundary object also enabled the appearance of pastiche science (Jordan-Young and Karkazis 2019), especially regarding where to begin or end the story of type 2 diabetes for specific populations. As such, my findings also showed that scientists use the neutral connocations associated with environmental factors to avoid saying who or what is responsible for increased incidence of type 2 diabetes in the United States, thus weakening the full critical impact of their analyses.

Lastly, I examined how medical experts used "environmental factors" as a shorthand to refer to relations of power that reproduced material barriers to type 2 diabetes management, while simultaneously reproducing constraints in the provision of services such that experts felt limited in their abilities to effectively intervene. The reproduction of unequal power relations that subsequently extended constraints to action was reminiscient of political ecology and actor-network theory, since both frameworks focused on the transformation of power through material and semiotic conditions. Rather than provide straightforward definitions, I found that medical experts used environmental factors to refer to the material and semiotic conditions that, from their perspective, made preventing and managing disease extremely difficult for the people they worked with. Specifically, medical experts' interpretations of environmental factors revealed relations of power that people living with type 2 diabetes were beholden to. Experts also perceived that they were beholden to similar processes and structures of power. As such, experts organized their responses around conceptualizations of "the environment" that were intended to illustrate how little power medical experts had over environmental factors related to type 2 diabetes, and to health more broadly. Conversely, a few experts explicitly linked environmental factors to power, in which they discussed "who" had the power to invoke environmental change, had the power over the distribution of health. Who these relations of power were centered upon, however, remained unnamed. Such associations between power and the environment evoked a political ecology framework, where power both engenders and is derived from environmental change.

Thus STS frameworks, as tools that critique processes of knowledge production, can make clear the mechanisms that uphold unequal power relations. Within these studies, reproductions of categories of difference upon which social orders, hierarchies, and stratified systems are based were likewise present in the discourse exchanged by medical experts. Experts had undue power as authorities of knowledge, and thus were part of the process of reproduction. Yet they were also able to question the validity of unequal relations and identify points of failure in the process that engendered limitations in their ability to serve people living with type 2 diabetes. This was all revealed by questioning the conceptual and political purpose of "the environment" within type 2 diabetes discourse, and within health disparities studies.

Extending the utility of STS frameworks further, it can be argued that three distinct forms of power were revealed from each study that demonstrated why studying the processes of knowledge production – or what Swyngedouw (1999) would call the processes that constitute the production of socionature – matter. In the first study, power was consolidated and exercised at the level of institutions. Institutions with more power had more latitude to steer and capitalize on salient issues within science. In the second study, scientists defined environmental factors that effectively reduced populations to their racial identities, thus reinforcing their position of being subjects rather than instigators of science. This was enabled through the medium of scientific literature, where the power, authority, and credibility of scientists are most potent. In the third study, I revealed how medical experts perceived people living with type 2 diabetes as being subjected to structural conditions and processes that limited their agency, and how they also perceived that they were subject to the same. Again, this was all revealed by asking about *environmental factors* related to type 2 diabetes.

In short, the purpose of the environment does not stray too far from Ursula Le Guin's notion of the carrier bag (Le Guin 1986). In this study, it was shown that environmental factors were drawn into multiple productions of multiple forms of science. Such is the metaphor of the carrier bag in that it can accommodate multiple stories. Sociologists of science and scientific knowledge are very focused on these stories – that is, on the contents of the bag. I argue that we should also examine who carries the bag. Future studies of scientific knowledge production need to focus on *who* produces knowledge, and *what* knowledge is produced as a consequence of the who. Such studies could be an inroad into identifying what relations of power are maintained so that knowledge production continues to proceed unequally, and with only weak contributions to social justice. As mentioned, this study proceeded the way it did – by focusing on the perspectives of medical experts – because it was the path of least resistance. The embodied knowledge of experts were privileged here, because I, as a scholar, also felt the constraint of maintaining certain bodies as subject-objects. Our field needs to take responsibility for these conditions. Genuine redistribution of knowledge-power can and should begin from members of the mainstream scientific community, with investigations of power – including who benefits and who does not regarding environmental change – formalized and normalized within academic settings. Only then can we begin to produce science for the people, and not just for those in power.

POLICY RECOMMENDATIONS

Despite sources of power remaining unnamed within environmental discourse, it is clear that power is derivative of the scientific infrastructures that enable not just the positioning of people living with type 2 diabetes as non-experts, but also acts as an ineffective deterrent to increasing incidence of type 2 diabetes worldwide. All the more reason to consider expanding who is considered an "expert" when it comes to environmental factors related to health. As previously argued, the lived experiences of scientists cannot be extracted from the actual production of science, while concepts like pastiche science also suggest that scientists' subjectivities will inevitably influence the findings that are disseminated. If lived experiences are important for understanding the mechanisms by which environmental factors influence health at an everyday level – arguably, the level where it matters most – then nowhere is expertise more informed than with people living with type 2 diabetes. Right now, conventional infrastructures of science "capture" the lived experiences of people living with type 2 diabetes through the intellectual interventions of academic experts. As argued, this contributes to a perpetuation of the "subject" positioning, despite efforts to avoid this by scientists trained in even the most radical forms of participatory science. I want to a propose a simpler line of action, which is to directly compensate the experts who can provide insights into the everyday mechanisms of environmental risk factors for their scientific work.

Such a proposal falls into a grassroots approach to knowledge production that is typically led by community leaders, activities, and concerned allies. But the supporting infrastructures that could bolster their work are not there. This seems counter to the goal of knowledge production, which is intended to expand understanding. Who understands how environmental factors impact health better than people *living* the environmental conditions that can exacerbate or improve upon disease and illness? As Gilmore (2018) argues, the body has and continues to be a site of scientific and political interest. Given this, whose expertise is most relevant there?

Taking seriously the task of reducing disease requires a redistribution of power. This includes the power to produce knowledge that is deemed credible and actionable and authentically just. One way that scientific infrastructures could transform to meet the needs of grassroots approaches to science is funnel funding directly to the very communities that scientists seek to center in their work. There are numerous gates to leap over when it comes to accessing funding from government agencies like the NIH, not the least of which is institutional affiliation. To remove some of those gates so that grassroots, community-led forms of science can access the same financial resources would at least partially ameliorate the criticisms aimed at Western scientific practices, including the reproduction of exclusion and privilege that is consolidated, as the first study suggests, at some of the most well-known universities in the world.

The point being, scientific knowledge production nearly always engenders a division of labor. Scientific knowledge is limited by the experiences and imaginations of who is seen as a credible scientist. This means that right now, science, particularly Western science, is extremely limited. If the goal of science is to understand and interprete and document what happens in the world, then science requires a group effort. The problem is that deliberate gatekeeping leads to poor results when it comes to, in this case, humanely and democratically addressing unjust distributions of disease. To reiterate, the most straightforward option – and thus likely the most controversial – is to provide funding and the *time* to use such resources to support community-led science. Notably, such an action would require major transformations regarding existing social, financial, and political infrastructures to support a more decentered and democratic process of knowledge production. Indeed, becoming an academic or researcher might require engaging in public service, similar to the AmeriCorps program, instead of conducting research exclusively within an university setting.

FUTURE WORK

Beyond processes of knowledge production, knowledge products themselves are also up for scrutiny. Some of this work has centered specifically on the availability of data, particularly data that is intended to model complex environmental and social processes. Linking environmental data to social data is notoriously tricky. At minimum, units of analysis and scales must be commensurate, but more than that, the conceptualization – or rather, operationalization – of environmental phenomenon needs to do justice to the complex phenomenon under study. Right now, tracing the addition of a playground or the accumulation of trash within a green space feels like it would require enormous effort on the part of the scientists. Hence the suggestion for community-led efforts – but the supporting infrastructures themselves must also change to accommodate the collection of such data. Right now, scientists may feel that they have neither the time nor the incentive to thread the needle between disparate sets of data, covering multiple geographic areas, at multiple scales, with multiple ways of measuring similar phenomenon. Yet such information is required to understand how environmental change provokes changes to the clustering of diseases like type 2 diabetes.

My next step is to therefore take inventory of available data that operationalizes environmental processes in the United States. I would also assess the quality of the data; for example, does the resolution accurately capture the phenomenon being studied, and how can it be effectively used in analyses. Some scientists have claimed that such a project is too complex (Frickel et al. 2010). However, as is the central argument of this study, it is not that producing such data is impossible; it is that our current scientific infrastructures do not work from a broad enough definition of "expertise" to normalize the production of such data. Once again, a genuine attempt to democratize scientific endeavors by those currently privileged within scientific institutions would meaningfully contribute to the amelioration of injustices that for many, are everyday matters of life and death. As scholars of STS and scientific knowledge production, we can and should consistently press for the normalization of democratically-generated dataience, and affirming forms of expertise.

BIBLIOGRAPHY

BIBLIOGRAPHY

Bakker, Karen and Gavin Bridge. 2006. “Material worlds? Resource geographies and the matter of nature.” *Progress in Human Geography* 30(1):5-27.

Banerjee, Damayanti and Michael Mayerfeld Bell. 2004. “Ecogender: Locating Gender in Environmental Social Science.” *Society and Natural Resources* 20(1):3-19.

Baron, Luis Fernando and Ricardo Gomez. 2016. “The Associations between Technologies and Societies: The Utility of Actor-Network Theory.” *Science, Technology and Society* 21(2):129-148.

Bird, Elizabeth Ann R. 1987. “The Social Construction of Nature: Theoretical Approaches to the History of Environmental Problems.” *Environmental Review* 11(4):255-264.

Bliss, Catherine. 2015. “Genetic Approaches to Health Disparities.” *Genetics, Health, and Society* 16:71-93.

Brisbois, Ben W., Andrés Burgos Delgado, Douglas Barraza, Óscar Betancourt, Donald Cole, Maya Gislason, Frédéric Mertens, Margot Parkes, and Johanne Saint-Charles. 2017. “Ecosystem approaches to health and knowledge-to-action: towards a political ecology of applied health-environment knowledge.” *Journal of Political Ecology* 24(1):693-715.

Brown, Phil. 1995. “Naming and Framing: The Social Construction of Diagnosis and Illness.” *Journal of Health and Social Behavior* 35(Extra Issue):34-52.

Brown, Phil. 2017. “Integrating Medical and Environmental Sociology with Environmental Health: Crossing Boundaries and Building Connections through Advocacy.” *Journal of Health and Social Behavior* 54(2):145-164.

Brown, Phil, Rachel Morello-Frosch, and Stephen Zavestoski. 2011. *Contested Illnesses: Citizens, Science, and Health Social Movements*. Berkeley, CA: University of California Press.

Brown, Phil, Stephen Zavestoski, Sabrina McCormick, Brian Mayer, Rachel Morello-Frosch, and Rebecca Gasior-Altman. 2004. “Embodied Health Movements: New Approaches to Social Movements in Health.” *Sociology of Health & Illness* 26(1):50-80.

Brulle, Robert J., and David N. Pellow. 2006. "Environmental Justice: Human Health and Environmental Inequalities." *Annual Review of Public Health* 27:103-124.

Bruun, Henrik and Richard Langlais. 2003. “On the embodied nature of action.” *Acta Sociologica* 46(1):31-49.

Cable, Sherry, Thomas E. Shriver and Tamara L. Mix. 2008. “Risk Society and Contested Illness: The Case of Nuclear Weapons Workers.” *American Sociological Review* 73(3):380-401.

Callon, Michel. 1984. “Some elements of a sociology of translation: domestication of the scallops and the fishermen of St. Brieuc Bay.” *Sociological Review Monograph Series: Power Action and Belief, A New Sociology of Knowledge* 32(S1):196-233.

Catton, William R., Jr. and Riley E. Dunlap. 1978. “Environmental Sociology: A New Paradigm.” *Environmental Sociology* 13(1):41-49.

Centers for Disease Control and Prevention. 2020. “National Diabetes Statistics Report.” Retrieved August 2, 2021. (https://www.cdc.gov/diabetes/data/statistics-report/index.html).

Clarivate Analytics. 2020. “Web of Science Core Collection Help.” Retrieved July 15, 2021. (https://images.webofknowledge.com/images/help/WOS/hp_subject_category_terms_tasca.html).

Cole, Stephen 2004. “Merton’s Contribution to the Sociology of Science.” *Social Studies of Science* 34:829-844.

Collins, Harry M. and Robert Evans. 2002. “The Third Wave of Scientific Studies: Studies of Expertise and Experience.” *Social Studies of Science* 32:235-296.

Cowie, Catherine C., Sarah Stark Casagrande, and Linda S. Geiss. 2018. “Chapter 3:Prevalence and Incidence of Type 2 Diabetes and Prediabetes.” Pp. (3-1)-(3-25) in *Diabetes in America, Third Edition*, edited by Catherine C. Cowie, Sarah Stark Casagrande, Andy Menke, Michelle A. Cissell, Mark S. Eberhardt, James B. Meigs, Edward W. Gregg, William C. Knowler, Elizabeth Barrett-Connor, Dorothy J. Becker, Frederick L. Brancati, Edward J. Boyko, William H. Herman, Barbara V. Howard, K. M. Venkat Narayan, Marian Rewers, and Judith E. Fradkin. Bethesda, MD: National Institute of Diabetes and Digestive and Kidney Diseases.

Cote, Muriel and Andrea J. Nightingale. 2012. “Resilience thinking meets social theory: Situating social change in socio-ecological systems (SES) research.” *Progress in Human Geography* 36(4):475-489.

Croissant, Jennifer and Sal Restivo. 1995. “Science, Social Problems, and Progressive Thought: Essays on the Tyranny of Science.” Pp. 39-87 in *Ecologies of Knowledge: Work and Politics in Science and Technology*, edited by Susan Leigh Star. Albany, NY: State University of New York Press.

Cronon, William. 1996. *Uncommon Ground: Rethinking the Human Place in Nature*. New York, NY: W.W. Norton & Company, Inc.

Darling, Katherine Weatherford, Sara L. Ackerman, Robert H. Hiatt, Sandra Soo-Jin Lee, and Janet K. Shim. 2016. “Enacting the molecular imperative: How gene-environment interaction research links bodies and environments in the Post-Genomic Age.” *Social Science and Medicine* 155:51-60.

Douglas, Heather. 2014. “Pure science and the problem of progress.” *Studies in History and Philosophy of Science* 46:55-63.

Elliott, James R. and Scott Frickel. 2015. “Urbanization as Socioenvironmental Succession: The Case of Hazardous Industrial Site Accumulation.” *American Journal of Sociology* 120(6):1736-1777.

Escobar, Arturo. 1999. “After nature: Steps to an anti-essentialist political ecology.” *Current Anthropology* 40(1):1-30.

Food and Nutrition Service, U.S. Department of Agriculture. 2021. “Special Supplemental Nutrition Program for Women, Infants, and Children (WIC).” Retrieved July 11, 2021. (https://www.fns.usda.gov/wic).

Freudenberg, William R., Scott Frickel and Robert Gramling. 1995. “Beyond the Nature/Society Divide: Learning to Think About a Mountain.” *Sociological Forum* 10(3):361-392.

Frickel, Scott. 2004. *Chemical Consequences: Environmental Mutagens, Scientist Activism, and the Rise of Genetic Toxicology*. New Brunswick, NJ: Rutgers University Press.

Frickel, Scott and Kelly Moore. 2006. *The New Political Sociology of Science: Institutions, Networks, and Power*. Madison, WI: University of Wisconsin Press.

Frickel, Scott, Sahra Gibbon, Jeff Howard, Joanna Kempner, Gwen Ottinger, and David J. Hess. 2010. “Undone Science: Charting Social Movement and Civil Society Challenges to Research Agenda Setting.” *Science, Technology, and Human Values* 35(4):444-473.

Gilmore, Ruth Wilson. 2018. “Abolition geography and the Problem of Innocence.” *Tabula Rasa* 28:57-77.

Grant, Don, Mary Nell Trautner, Liam Downey, and Lisa Thiebaud. 2011. “Bringing the Polluters back In: Environmental Inequality and the Organization of Chemical Production.” *American Sociological Review* 75(4):479-504.

Greider, Thomas and Lorraine Garkovich. 1994. “Landscapes: The Social Construction of Nature and the Environment.” *Rural Sociology* 59(1):1-24.

Haider, Asad. 2018. *Mistaken Identity: Race and Class in the Age of Trump*. Brooklyn, NY: Verso Books.

Haraway, Donna. 1999. “Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective.” Pp. 172-188 in *The Science Studies Reader*, edited by Mario Biagioli. New York, NY: Routledge.

--. 2017. “Symbiogenesis, Sympoiesis, and Art Science Activism for Staying with the Trouble.” Pp. M25-M50 in *Arts of Living on a Damaged Planet*, edited by Anna Tsing, Heather Swanson, Elaine Gan, and Nils Bubandt. Minneapolis, MN: The University of Minnesota Press.

Harding, Sandra. 1991. *Whose Science? Whose Knowledge?* Ithaca, NY: Cornell University Press.

Healy, Kieran and James Moody. 2014. “Data Visualization in Sociology.” *Annual Review of Sociology* 40:105-128.

Hu, Frank B. 2011. “Globalization of diabetes: the role of diet, lifestyle, and genes.” *Diabetes Care* 34(6):1249-1257.

Hughes, Thomas P. 2004. *American Genesis: A Century of Invention and Technological Enthusiasm, 1870-1970*. Chicago, IL: The University of Chicago Press.

Ingold, Tim. 2012. “Toward an ecology of materials.” *Annual Review of Anthropology* 41:427-442.

Jacobs, Jerry A. and Scott Frickel. 2009. "Interdisciplinarity: A Critical Assessment." *Annual Review of Sociology* 35:43-65.

Jasonoff, Sheila and Sang-Hyun Kim. 2015. *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*. Chicago, IL: The University of Chicago Press.

Jeon, June. 2019. "Invisibilizing politics: Accepting and legitimating ignorance in environmental sciences." *Social Studies of Science* 49(6):839-862.

Jordan-Young, Rebecca M. and Katrina Karkazis. 2019. *Testosterone: An Unauthorized Biography*. Cambridge, MA: Harvard University Press.

Jutel, Annemarie. 2010. "Medically unexplained symptoms and the disease label." *Social Theory and Health* 2010(8):229-245.

Kleinman, Daniel Lee. 2003. *Impure Cultures: University Biology and World Commerce*. Madison, WI: The University of Wisconsin Press.

Knorr Cetina, Karin D. 1992. "The Couch, the Cathedral, and the Laboratory." Pp. 113-138 in *Science as Practice and Culture*, edited by Andrew Pickering. Chicago, IL: The University of Chicago Press.

--. 2005. "The Fabrication of Facts: Towards a Microsociology of Scientific Knowledge." Pp. 223-244 in *The Sociology of Knowledge*, edited by Nico Stehr and Volker Meja. New Brunswick, NJ: Transaction Books.

Krieger, Nancy. 1985. "Epidemiology and the Web of Causation: Has Anyone Seen the Spider?" *Social Science and Medicine* 39(7):887-903.

Krieger, Nancy, Rhea W. Boyd, Fernando De Maio, Aletha Maybank. 2021. "Medicine's Privileged Gatekeepers: Producing Harmful Ignorance About Racism and Health." *Health Affairs Blog*. doi: 10.1377/hblog20210415.305480.

Kuhn, Thomas. 1962. *The Structure of Scientific Revolutions*. Chicago, IL: The University of Chicago Press.

Kuletz, Valerie. 1998. *The Tainted Desert: Environmental and Social Ruin in the American West*. New York, NY: Routledge.

Latour, Bruno. 1986. "The powers of association." *The Sociological Review* 32(S1):264-280.

Latour, Bruno and Steve Woolgar. 1986. *Laboratory Life: The Construction of Scientific Facts*. Princeton, NJ: Princeton University Press.

Le Guin, Ursula. 1986. "The Carrier Bag Theory of Fiction." Retrieved July 19, 2021. (https://theanarchistlibrary.org/library/ursula-k-le-guin-the-carrier-bag-theory-of-fiction).

Link, Bruce and Jo Phelan. 1995. "Social Conditions as Fundamental Causes of Disease." *Journal of Health and Social Behavior* 51(S):241-255.

Lloro-Bidart, Teresa. 2017. "A feminist posthumanist political ecology of education for theorizing human-animal relations/relationships." *Environmental Education Research* 23(1):111-130.

Maldonado-Torres, Nelson. 2016. "Outline of Ten Theses on Coloniality and Decoloniality." Retrieved July 11, 2021. (http://frantzfanonfoundation-fondationfrantzfanon.com/article2360.html).

McCormick, Sabrina. 2003. "The Personal is Scientific, the Scientific is Political: The Public Paradigm of the Environmental Breast Cancer Movement." *Sociological Forum* 18(4):545-576.

Merchant, Carolyn. 1990. *The Death of Nature: Women, Ecology, and the Scientific Revolution*. New York, NY: HarperOne.

Merton, Robert K. 1968. "The Matthew Effect in Science." *Science* 159:56-63.

--. 1973. "The Normative Structure of Science." Pp. 267-278 in *The Sociology of Science*, by Robert K. Merton. Chicago, IL: The University of Chicago Press.

Molnar, Virag. 2016. "The Power of Things: Material Culture as Political Resource." *Qualitative Sociology* 39(2):205-210.

Monteleone, Rebecca. 2018. "Beyond Participation: Empowering people with disabilities in research and design." *Technology and Innovation* 20:133-139.

Montoya, Michael J. 2011. *Making the Mexican Diabetic: Race, Science, and the Genetics of Inequality*. Oakland, CA: University of California Press.

Moore, Helen A., Katherine Acosta, Gary Perry, and Crystal Edwards. 2016. "Splitting the Academy: The Emotions of Intersectionality at Work." *The Sociological Quarterly* 51(2):179-204.

Morris-Suzuki, Tessa. 2014. "Touching the Grass: Science, Uncertainty, and Everyday Life from Chernobyl to Fukushima." *Science, Technology and Society* 19(3):331.362.

National Institute of Environmental Health Services. 2020. "NIEHS 50th Anniversary." Retrieved July 6, 2021. (https://www.niehs.nih.gov/about/anniversary/index.cfm).

Neely, Abigail. 2020. "Entangled agencies: Rethinking causality and health in political-ecology." *Environmental and Planning E: Nature and Space*. doi: 10.1177/2514848620943889.

Nichols, Carly E. and Vincent J. Del Casino, Jr. 2020. "Towards an integrated political ecology of health and bodies." *Progress in Human Geography* 45(4):776-795.

Nichols, Robert. 2020. *Theft is Property! Dispossession and Critical Theory*. Durham, NC: Duke University Press.

O'Donnell, Shane. 2015. "Changing social and scientific discourses on type 2 diabetes between 1800 and 1950: a socio-historical analysis." *Sociology of Health and Illness* 37(7):1102-1121.

Oyěwùmí, Oyèrónké. 1997. “Visualizing the Body: Western Theories and African Subjects.” Pp. 1-30 in *The Invention of Women, Making an African Sense of Western Gender Discourses*. Minneapolis, MN: The University of Minnesota Press.

Prasad, Amit. 2017. “Introduction: Global Assemblages of Technoscience.” *Science, Technology and Society* 22(1):1-5.

Plumwood, Val. 1993. *Feminism and the Mastery of Nature*. London, UK: Routledge.

Rasmussen, Erik Børve. 2020. “Making and managing medical anomalies: Exploring the classification of ‘medical unexplained symptoms.” *Social Studies of Science* 50(6):901-931.

Rice, James. 2013. “Further Beyond the Durkheimian Problematic: Environmental Sociology and the Co-construction of the Social and the Nature.” *Sociological Forum* 28(2):236-260.

Rice, Jennfer L., Brian J. Burke, and Nik Heynen. 2015. “Knowing Climate Change, Embodying Climate Praxis: Experiential Knowledge in Southern Appalachia.” *Annals of the Association of American Geographers* 105(2):253-262.

Richmond, C., S. J. Elliott, R. Matthews, and B. Elliot. 2005. "The political ecology of health: perceptions of environment, economy, health and well-being among 'Namgis First Nation." *Health & Place* 11(4):349-365.

Robbins, Paul. 2004. *Political Ecology: A Critical Introduction*. Malden, MA: Blackwell Publishing.

Rose, Geoffrey. 1985. “Sick individuals and sick populations.” *International Journal of Epidemiology* 30(3):427-432.

Sella, Guy and Aaron E. Hirsch. 2005. “The application of statistical physics to evolutionary biology.” *Proceedings of the National Academy of Sciences of the United States of America* 102(27):9541-9546.

Shamir, Ronen. 2013. *Current Flow: The Electrification of Palestine*. Stanford, CA: Stanford University Press.

Shapin, Steven. 1995. “Here and Everywhere: Sociology of Scientific Knowledge.” *Annual Review of Sociology* 21:289-321.

Shim, Janet K. 2005. “Constructing ‘Race’ Across the Science-Lay Divide: Racial Formation in the Epidemiology and Experience of Cardiovascular Disease. *Social Studies of Science* 35(3):405-436.

Simpson, Leanne Betasamosake. 2017. *As We Have Always Done: Indigenous Freedom through Radical Resistance*. Minneapolis, MN: University of Minnesota Press.

Smith, Linda Tuhiwai. 1999. *Decolonizing Methodologies: Research and Indigenous Peoples*. London, UK: Zed Books Ltd.

Sorensen, Estrid. 2007. “The Time of Materiality.” *Forum: Qualitative Social Research* 8(1):1-19.

Star, Susan Leigh. 1991. "Power, Technology and the Phenomenology of Conventions: On Being Allergic to Onions." Pp. 26-56 in *A Sociology of Monsters: Essays on Power, Technology and Domination*, edited by John Law. London, UK: Routledge.

--. 2010. "This is Not a Boundary Object: Reflections on the Origin of a Concept." *Science, Technology, and Human Values* 35(5):601-617.

Star, Susan Leigh and James R. Griesemer. 1989. "Institutional Ecology, 'Translations,' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39." *Social Studies of Science* 19(3):387-420.

Swyngedouw, Erik. 1999. "Modernity and Hybridity: Nature, Regeneracionismo, and the Production of the Spanish Waterscape, 1890-1930." *Annals of the Association of American Geographers* 89(3):443-465.

Tabery, James. 2014. *Beyond Versus: The Struggle to Understand the Interaction of Nature and Nuture*. Cambridge, MA: The MIT Press.

Tallbear, Kim. 2013. *Native American DNA: Tribal Belonging and the False Promise of Genetic Science*. Minneapolis, MN: University of Minnesota Press.

Tarozzi, Massimiliano. 2015. "Practices to Exercise Conceptualization in GTM." Pp. 147-152 in *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*, edited by Juliet Corbin and Anselm Strauss. Thousand Oaks, CA: SAGE Publications, Inc.

Tavory, Iddo and Stefan Timmermans. 2014. *Abductive Analysis: Theorizing Qualitative Research*. Chicago, IL: The University of Chicago Press.

Taylor, Dorceta E. 2000. "The Rise of the Environmental Justice Paradigm: Injustice Framing and the Social Construction of Environmental Discourses." *American Behavioral Scientist* 43(4):504-587.

The Chronicle of Higher Education. 2019. "College and University Endowments, 2007-18." Retrieved May 5, 2021 (https://www.chronicle.com/article/college-and-university-endowments-2007-18/?bc_nonce=cyqoaukegx7k4ko6kv2y18&cid=reg_wall_signup).

The National Academies of Sciences, Engineering, and Medicine. 2021. "Environmental Health Matters Initiative." Retrieved July 6, 2021. (https://www.nationalacademies.org/our-work/environmental-health-matters-initiative).

Threadcraft, Shatema. 2016. *Intimate Justice: The Black Female Body and the Body Politic.* New York, NY: Oxford University Press.

Timmermans, Stefan and Iddo Tavory. 2012. "Theory Construction in Qualitative Research: From Grounded Theory to Abductive Analysis." *Sociological Theory* 30(3):167-186.

Tironi, Manuel and Israel Rodriguez-Giralt. 2017. "Healing, knowing, enduring: Care and politics in damaged worlds." *The Sociological Review Monographs* 65(2):89-109.

Truelove, Yaffa. 2011. "(Re-)Conceptualizing water inequality in Delhi, India through a feminist political ecology framework." *Geoforum* 42(2011):143-152.

U.S. Department of Health and Human Services. 2017. "HHS FY 2018 Budget in Brief – NIH." Retrieved July 4, 2021. (https://www.hhs.gov/about/budget/fy2018/budget-in-brief/nih/index.html).

Valles, Sean. 2016. "Race in Medicine." Pp. 419-431 in *The Routledge Companion to Philosophy of Medicine*, edited by Miriam Soloman, Jeremy R. Simon, and Harold Kincaid.

van Koppen, Kris. 2017. "Incorporating nature in environmental sociology: a critique of Bhaskar and Latour, and a proposal." *Environmental Sociology* 3(3):173-185.

Vandenbroucke, Jan P. 1988. "Is 'the causes of cancer' a miasma theory for the end of the twentieth century?" *International Journal of Epidemiology* 17(4):708-709.

Washington, Harriet. 2006. *Medical Apartheid: The Dark History of Medical Experimental on Black Americans from Colonial Times to the Present*. New York, NY: Harlem Moon.

World Health Organization. 2021. "Diabetes." Retrieved July 5, 2021. (https://www.who.int/news-room/fact-sheets/detail/diabetes).

Wynter, Sylvia. 1994. "No Humans Involved: An Open Letter to My Colleagues." *Forum N. H. I. Knowledge for the 21st Century* 1(1):42-71.

York, Richard and Stefano B. Longo. 2017. "Animals in the world: A materialist approach to sociological animal studies." *Journal of Sociology* 53(1):32-46.