

“Sweet Blood: Toward an Environmental History of Diabetes, Chronic Disease, and Race in North America”

Program on Health, Disease, and Environment in World History
Center for Historical Research, The Ohio State University
March 1, 2013

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In February 1963 a team of researchers from the National Institute of Arthritis and Metabolic Diseases, or NIAMD, a branch of the National Institutes of Health (NIH), arrived in Phoenix, Arizona. They were on a mission to study rheumatoid arthritis, or RA, a systemic inflammatory disorder now identified as an autoimmune disease that commonly strikes people in the prime of adulthood. The NIH team was part of a comparative epidemiological study of RA in two Native American communities: the Blackfeet Confederacy of Montana and the Pima or Akimel O’odham, living about thirty-five miles southwest of Phoenix on the Gila River Indian Reservation, which hugged the life-giving river for which it was named.¹

Environment mattered because the NIH researchers speculated that RA incidence—expressed as the risk of developing the disease within a specified period of time—was lower in hot and arid climates (like Arizona) than cold and semi-arid climates (like Montana).² Diagnosis of RA then was similar to methods today: patient and family history, plus radiographs and blood tests for rheumatoid factor (RF). The NIH scientists also tested sera for glucose levels of 969 Pima aged 30 years and older. Seemingly by accident, they discovered that “postprandial blood sugars” were “significantly elevated in 30 percent of subjects,” or approximately one in three Pima.³ Later sampling revealed what physicians and nurses working at the Indian Health Service of the U.S. Public Health Service (IHS) clinic in Sacaton on the Gila River Reservation had long known: diabetes was commonplace among the Pima. In 1965 the NIH reported prevalence—the number of cases of a disease within a given population at a specific time—of diabetes among the Pima as “15

Previous versions of this paper were presented at the University of Massachusetts at Boston (joint seminar with the School of Nursing, Native American and Indigenous Studies Program, and the Department of History) and the History of Science and Medicine Colloquium at Yale University. Thanks to attendees at these events for their questions and comments, and thanks in particular to Connie Y. Chiang, Michael Lansing, Christopher W. Meserve, M.D., Kathryn Morse, Joshua Reed, Paul Sabin, Donald Stanley, M.D., Joseph E. Taylor III, and Conevery Bolton Valenčius, for their suggestions and comments on this essay. For consistency, I use Chicago Manual of Style format for my citations, including biomedical literature.

¹ The description of the initial arrival of the NIH research team comes from Stephanie Stegman, “Taking Control: Fifty Years of Diabetes in the American Southwest, 1940-1990” (Ph.D. diss., Arizona State University, 2010), 62-65. An important note: in this paper, I use the terms “Native,” “Native American,” “Indian,” and “American Indian” interchangeably when referring to indigenous peoples in aggregate to reflect the historical contingency behind these terms, preferring to use “Indian” and its variants when quoting directly from documents or discussing comments by non-Indians. Whenever possible, I try to use specific tribal names, like Akimel O’odham or Pima, again depending on context.

² Incidence is precisely expressed as a proportion or rate, often as: # of new cases in a fixed time period /number of people at risk per year.

³ Max Miller, Thomas A. Burch, Peter H. Bennett, and Arthur G. Steinberg, “Prevalence of Diabetes Mellitus in American Indians: Results of Glucose Tolerance Tests in the Pima Indians of Arizona” (Abstract), *Diabetes* 14, no. 7. (July 1965): 439-440. Total sample size taken from Peter H. Bennett and Thomas A Burch, “The Distribution of Rheumatoid Factor and Rheumatoid Arthritis in the Families of Blackfeet and Pima Indians,” *Arthritis and Rheumatism* 11, no. 4 (August 1968): 546.

times the rate of the United States as a whole.”⁴ Other numbers were equally alarming. Among the adult Indian patients admitted to the Phoenix IHS Hospital, 26 percent were “diabetic” and among Pima alone, the rate was 45 percent—higher than any other group.⁵

G. Donald Whedon, the NIAMD director, immediately grasped the importance of the Arizona findings. As he explained in 1965 memo to NIH Director James A. Shannon, the discovery of “extremely high prevalence and incidence rates” among the Pima provided “an unparalleled opportunity” to study the natural history of diabetes as well as “the influence of heredity and environment” on the disease and its complications. Similar studies on the U.S. population, he continued, would be impossible due to the overwhelming scale and “extreme mobility” of the sample size. What Whedon failed to mention was how the Pima’s relative confinement to the Gila River Reservation was what made them, in part, an epidemiologist’s dream—a distinct cohort living under distinct conditions. Whedon urged the NIH to begin a long-term study in Arizona with the Pima as the subjects to investigate how environment together with genetics help to rewrite existing knowledge on diabetes at the time.⁶

Whedon asked other experts in endocrinology and genetics to weigh in on the proposed initiative, including Arthur G. Steinberg, a human geneticist at Western Reserve University (later Case Western Reserve) in Cleveland. Comparing the Arizona site to another study at the Joslin Diabetes Clinic in Boston, he listed the advantages: “socio-economic uniformity,” the ability to select subjects at random knowing “that more than 30 percent of those selected will become diabetic,” an isolated population, and that physicians could “know patients as individuals.”⁷ Buoyed by the enthusiastic endorsement of experts like Steinberg, the NIH established the Epidemiology and Field Studies Branch (EFSB), in 1965, later renamed the Phoenix Epidemiology and Clinical Research Branch (PECRB), to begin long-term prospective observational studies at the Gila River Indian Reservation.⁸

The epidemiological uniqueness of the Pima mattered, but so did the environmental and historical context. Their human history, however, was even more rich and complex. The Pima, who lived along or near the banks of the Gila River, one of central Arizona’s largest waterways, were part of a larger continuum of called the O’Odham (“the people”) that had lived in the region for centuries, perhaps longer. Each group of O’Odham identified themselves by where they lived: the Tohono O’Odham, for example, were the “Desert People” while the Akimel O’Odham were the “River People.” The Pima had survived and thrived through the brutal era of Spanish colonial rule, the Mexican revolution, and the 1846-48 Mexican-American War. Following the arrival of American rule and the creation of their reservation in 1859, the Pima had morphed into a confined and defined population. Within the course of four generations, they had gone from a vibrant

⁴ G. Donald Whedon, Director, NIAMD, to Director, NIH, Weekly Report: “Unique Prevalence of Diabetes Mellitus Found Among Pima Indians,” July 7, 1965, National Archives at College Park, Maryland (hereafter abbreviated NA-CP), Record Group 443: Records of the National Institutes of Health (hereafter abbreviated RG 443), Central Files of the Office of the Director, National Institutes of Health, 1960-1982 (hereafter abbreviated CF-NIH Director), Box 102, Folder RES 9-13:NIAMD/NIAMDD, 1948-1972; see also Stegman, 64.

⁵ Maurice L. Sievers, “Disease Patterns Among Southwestern Indians,” *Public Health Reports* 81, no. 12 (December 1966): 1078.

⁶ Whedon to Director, NIH, “Epidemiology and Field Studies in Phoenix Area,” July 21, 1965, NA-CP, RG 443, CF-NIH Director, Box 102, Folder RES 9-13:NIAMD/NIAMDD, 1948-1972. The NIAMD was renamed the National Institute of Arthritis, Diabetes, and Digestive and Kidney Diseases (NIADDDK) in 1981 and again as the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) in 1986 with the formation of National Institute of Arthritis and Musculoskeletal and Skin Diseases.

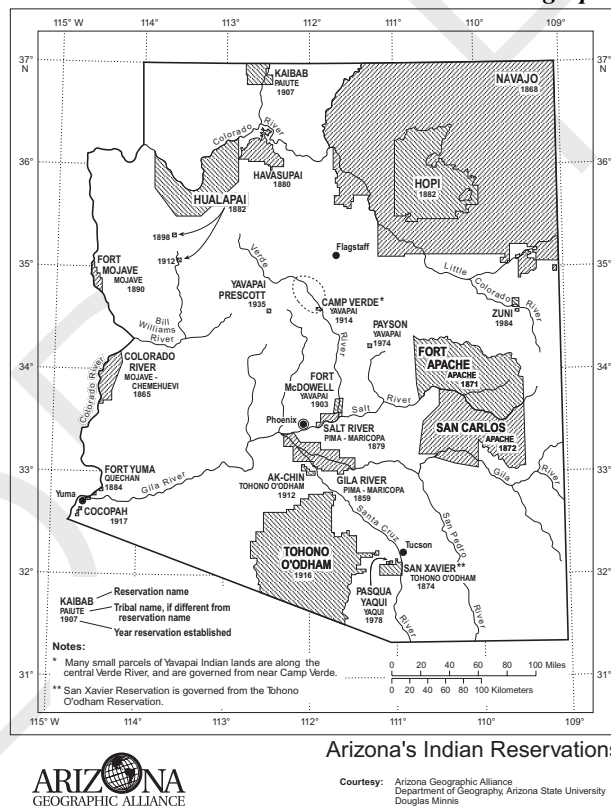
⁷ Recommendations from Dr. Arthur G. Steinberg, May 14, 1965, NA-CP, RG 443, CF-NIH Director, Box 102, Folder RES 9-13:NIAMD/NIAMDD, 1948-1972. It is slightly ironic that Steinberg was interested in individuals since epidemiologists and geneticists, as a rule, focus on populations. In epidemiological terms, risk is often expressed as: # of events of disease / # of subjects at risk.

⁸ The name changed in 1984. For the purposes of consistency, I use the latter name, the Phoenix Epidemiology and Clinical Research Branch (PECRB), most frequently in the main text.

agricultural economy that provided American emigrants and homesteaders grain and produce to an impoverished community dependent upon federal assistance for their livelihood. The Pima's perceived cultural uniformity and lack of mobility was the product of human history, too. It was the result of federal Indian policy combined with larger transformations to the Gila River along which the Akimel O'odham had lived for centuries.⁹

But it was their perceived natural history as a population—homogeneous and physically isolated while proximate to the modern city of Phoenix—that made the Pima ideal subjects for the NIH researchers. Other coincidences, however, were significant if not fully understood by the NIH team at the time. By the early 1960s, advances in genetics and the rise of epidemiology on a national level as a powerful biomedical discipline shaped how the initial NIH team and its successors would define, study, and interpret the etiology of diabetes. In what seemed like a providential encounter between science and Native peoples, environment and culture intertwined to produce one of the most enduring studies of chronic disease in modern biomedicine. As medical anthropologist T. Kue Young puts it, “much of what endocrinologists know about human diabetes today is derived from studies among the Pima in Arizona.”¹⁰

[Fig. 1: Arizona's Indian Reservations. Source: Arizona Geographical Alliance]



⁹ There is a rich and extensive historical and anthropological literature on the O'odham that is too large to cite here. The general contours of the details in this paragraph come from Robert Rossell, “History of the Pima,” Gary Witherspoon, “Pima and Papago Ecological Adaptations,” and Leyland C. Wyman, “Pima and Papago Social Organization,” from *Handbook of North American Indians: Volume 10: Southwest* Alfonso, Ortiz, ed. (Washington, DC: Smithsonian Institution, 1983): 149-92.

¹⁰ T. Kue Young, *The Health of Native Americans: Toward a Biocultural Approach* (New York: Oxford University Press, 1994), 220.

But the influence of the Pima studies go far beyond the biomedical literature. Thanks to the NIH-funded studies, the Pima have become synonymous with America's present-day diabetes epidemic, particularly how obesity may be driving the outbreak. The arguably most famous portrayal remains Malcolm Gladwell's 1998 article, "The Pima Paradox," for *The New Yorker*, in which he used the NIH studies to explain how genetics interacted with environmental changes to produce obesity, which he labeled as the primary contributor to diabetes among the Pima.¹¹ Others have followed Gladwell's lead. Pick up any book on diet and nutrition today, thumb through the pages, and you likely will see the Pima as the example of a modern lifestyle run amok. Contemporary debates over high-protein and low-carbohydrate diets, the insidious effects of sweeteners like high fructose corn syrup, or the benefits of so-called "Paleolithic diets" often cite the Pima studies to support their particular platform.¹² Many of these popular works simplify the complex work done by the NIH scientists even as they help to justify further the importance of the ongoing research in Arizona.

For their part, the enrolled members of the Gila River Indian Community, the present day name for the Pima reservation, have an understandably ambivalent relationship with the disease that has superficially come to define them. A 1999 three-part series on the front page the *Arizona Republic*, titled "A People in Peril: Pimas on the Front Lines of an Epidemic," captured their frustration.¹³ While the series underscored the long history behind the diabetes epidemic among the Pima and the PECRB's research mission, it also further angered some tribal members who believed the series was unnecessarily sensationalistic and fanned long-smoldering resentments over racism and paternalism. Franklin Pete Jackson, then president of the board of directors of the Gila River Health Care Corporation, believed his comments in the series were taken out of context. In an op-ed for the *Arizona Republic*, Jackson stated that journalists and other researchers had "failed to tell the story of a community living with the disease and its complications." Instead, he believed future stories should emphasize the community's strength and survival in the face of more than two centuries of social and environmental change.¹⁴

The story of Native resilience is an important and inspiring part of my larger project, but for this essay, my focus is on the environmental history of how researchers and clinicians created and disseminated biomedical knowledge about diabetes among the Pima. This paper is a preliminary synthesis of ongoing research for my larger project: an environmental and social history of diabetes from the mid-nineteenth century to the present. Over the course of the last two years, thanks, in part, to studies and research in public health and biomedical science, as well as the history of medicine, science, and technology, three salient questions have emerged: how shifts in diet and nutrition may have altered chronic diseases such as diabetes; how has diabetes become enmeshed within particular landscapes, communities, and bodies unequally over the past century; and how have scientific and clinical understandings of diabetes changed over time? In this paper, I address last question, and, as a result, the voices here are primarily those of scientists and physicians, not the Native peoples who live with diabetes and its complications.

¹¹ Malcolm Gladwell, "The Pima Paradox," *The New Yorker* (February 8, 1998): 45-57.

¹² For a very small sample of recent salient works, see J. Eric Oliver, *Fat Politics: The Real Story Behind America's Obesity Epidemic* (New York: Oxford University Press, 2005), 104-119; Gary Taubes, *Good Calories, Bad Calories: Fats, Carbs, and the Controversial Science of Diet and Health* (New York: Anchor Books/Random House, 2007), 89-99, 235-51; and Spencer Wells, *Pandora's Seed: Why the Hunter-Gatherer Holds the Key to Our Survival* (New York: Random House, 2010), 61-90.

¹³ Graciela Sevilla, "A People in Peril: Pimas on the Front Lines of an Epidemic," *Arizona Republic* (Phoenix, AZ), October 31-November 2, 1999.

¹⁴ Franklin Pete Jackson, "Op-Ed: Pima's Spirit Missing from Series," *Arizona Republic* (Phoenix, AZ), December 16, 1999.

To review, diabetes mellitus, to use its full name, is often defined as an excessively high level of glucose (colloquially called sugar) in the blood.¹⁵ Older Americans who live with diabetes and were educated in how to manage it before modern therapies and monitoring technology sometimes say they have the “sweet blood.” At its core, diabetes is a biochemical disorder linked to a particular organ—the pancreas and its cell receptors for insulin—and its role in regulating the body’s metabolism by transporting glucose into cells. The pancreas has an endocrine function, which comprises only about one percent of its mass and comes from clusters of cells spread throughout the organ like tiny islands in a vast sea. These beta cells, poetically named the islets of Langerhans after the pathologist who first observed them, produce the hormone insulin, which regulates how the body’s cells metabolize or store glucose.

The proper balance of insulin is critical. Simply put, diabetes is either the inability to produce insulin (usually Type 1) or a mixture of an inability to produce insulin and an incapacity for cells to take insulin across the cell membrane (Type 2). But diabetes is no so much a single discrete disease as a condition with multiple possible causes. There are two main types. In the first variation, the insulin producing beta cells are destroyed by an autoimmune response, resulting in the complete lack of insulin production. This form, which often affects the young, used to be called juvenile or insulin-dependent diabetes; today it is called Type 1. The second variation, which is far more common and usually affects people in middle age or older, used to be called adult- or maturity-onset, or non-insulin-dependent diabetes. Today, it is called Type 2. In this version, the beta cells are in overdrive, producing more insulin than normal because tissues where the body stores glucose—primarily the liver and fat—cannot accept insulin across their cell walls. In some cases, the beta cells also fail as they attempt to produce increasing amounts of insulin.

In either form, persistently high levels of glucose can wreak havoc on the human body. To simplify a complex series of physiological processes associated with Type 2 diabetes, what is commonly called insulin resistance changes the body’s fat or lipid metabolism by breaking down more fats to release energy, which in turn releases more lipoproteins that move fats through and between cells, including cholesterol and triglycerides. As these fats move throughout the circulatory system, they can cause atherosclerosis or the hardening of arteries, heart attack and stroke, reduced vision or blindness, renal failure, nerve damage, and gangrene in the limbs, especially the feet. Some studies also suggest that high levels of insulin often precede the development of many arterial diseases long before diabetes manifests itself.¹⁶

Both forms of diabetes, especially what we now label as Type 1, were relatively rare until the mid-twentieth century. The advent of injectable insulin in 1922, wonderfully retold in Michael Bliss’s acclaimed history, saved countless patients living with the Type 1 variant. Yet over the last decades of the twentieth century, the number of cases Type 1 has climbed while insulin therapy has proven to be far from the hoped for panacea.¹⁷ Many researchers point to environmental causes, but

¹⁵ More specifically, screening techniques for glycated hemoglobin, usually referred to HbA1c, identify plasma glucose concentration over prolonged periods of time. Hemoglobin A1c was first separated from other hemoglobin types in 1958. See T.H. Huisman, E.A. Martis, and A. Dozy, “Chromatography of hemoglobin types on carboxymethylcellulose,” *Journal of Laboratory and Clinical Medicine* 52, no. 2 (August 1958): 312–27.

¹⁶ Surprisingly, there are few overall histories of diabetes research and treatment—just as there are few histories of chronic disease within the history of medicine. For succinct overviews of diabetes, see Robert Tattersall, *Diabetes: The Biography* (New York: Oxford University Press, 2009), 1-3; and Peter H. Bennett and William C. Knowler, “Definition, Diagnosis, and Classification of Diabetes Mellitus and Glucose Homeostasis,” in *Joslin’s Diabetes Mellitus*, 14th ed., ed. C. Ronald Kahn, et al. (Philadelphia: Lippincott, Williams and Wilkins, 2005): 331-40. In addition to Tattersall, see Mauck, “Managing Care” and James Wright Presley, “A History of Diabetes Mellitus in the United States, 1880-1990” (Ph.D. diss., University of Texas at Austin, 1991).

¹⁷ Michael Bliss, *The Discovery of Insulin* 25th ann. ed. (University of Chicago Press, 1982, 2007); see also Thea Cooper and Arthur Ainsberg, *Breakthrough: Elizabeth Hughes, the Discovery of Insulin, and the Making of a Medical Miracle* (New York: St. Martin’s Press, 2010). Bliss’s book remains the definitive work on the topic. For the best account of the early shortcomings of insulin therapy,

improved testing may also explain the rising incidence. Type 2 has also skyrocketed, partly due to changes in diet and physical activity linked to rising levels of obesity and partly due to increased life expectancy although incidence is increasing among adolescents and children as well.¹⁸ Environmental changes may also influence the declining average age at which Type 2 now appears.¹⁹ Some researchers, as I discuss later, suggest that exposure to certain exogenous chemicals, broadly labeled as “endocrine disruptors,” may be behind the rise in Type 2 diabetes.²⁰ Regardless of the potential causes behind the outbreak of either type, according to the Centers for Disease Control, as of 2010 approximately 25.8 million people, or 8.3 percent of all Americans, are living with diabetes and the vast majority with Type 2.²¹ It does not strain hyperbole to say that by the start of the twenty-first century, diabetes has become an all-American affliction.

But what is an environmental history of diabetes? A definition of environmental history may clarify my approach. Environmental history today analyzes the reciprocal and interrelated formation of the material world alongside human ideas of that world and the structures we create to exploit it. Sometimes, that exploitation often entails exploiting people dependent upon particular forms of nature as well. Environmental history also challenges the nature of agency—the ability of human beings to act individually or collectively in the world—as well as how the natural world can restrict or redirect human agency. In this analysis, environment encompasses not only the physical landscapes in which human (and non-human) beings live but also other activities and behaviors: diet and nutrition (we are what we eat, which is what we harvest or cultivate in nature), exercise (which expends energy we derive from what we consume), the exposure to pollutants and toxicants, plus social and socioeconomic conditions.²² This definition is also congruent with past and present definitions of environment within medicine itself—from the older neo-Hippocratic tradition of “airs, waters, and places” to contemporary concerns over the possible environmental causes of diseases like cancer. To paraphrase Gregg Mitman, to see diabetes historically in this way is to see

see Chris Feudtner, *Bittersweet: Diabetes, Insulin, and the Transformation of Illness* (Chapel Hill: University of North Carolina Press, 2003). Feudtner, a physician at the Children’s Hospital of Philadelphia, suggests that the advent of injectable insulin yielded a new version or “transmuted” form diabetes as a result of extending the lifespan of juvenile-onset diabetics, which resulted in further complications later in life.

¹⁸ For example, see O. Pinhas-Hamiel, L.M. Dolan, S.R. Daniels, D. Standiford, P.R. Khoury, and P. Zeitler, “Increased Incidence of Non-insulin-dependent Diabetes Mellitus among Adolescents,” *Journal of Pediatrics* 128, no. 5, part 1 (May 1996): 608-15.

¹⁹ For general audience book on the possible causes behind the mounting prevalence of both types, see Dan Hurley, *Diabetes Rising: How a Race Disease Became a Modern Pandemic, and What to Do about It* (New York: Kaplan Publishing, 2010). For another recent short overview, focusing on research and treatment, see Kenneth S. Polonsky, “The Past 200 Years in Diabetes,” *New England Journal of Medicine* 367, no. 14 (October 4, 2012): 1332-40.

²⁰ For a recent survey of research on the links between exogenous chemicals and diabetes, focused on obesity as well, see Kristina A. Thayer, Jerrold L. Heindel, John R. Bucher, and Michael A. Gallo, “Role of Environmental Chemicals in Diabetes and Obesity: A National Toxicology Program Workshop Review,” *Environmental Health Perspectives* 120, no. 6 (June 2012): 779-89.

²¹ For population level statistics of diabetes in the United States, see <http://www.cdc.gov/diabetes/consumer/research.htm> [accessed September 15, 2012] and “Increasing Prevalence of Diagnosed Diabetes—United States and Puerto Rico, 1995-2010,” *Morbidity and Mortality Weekly Report* 61, no. 45 (November 16, 2012): 918-21 and <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6145a4.htm> [accessed January 28, 2013].

²² For older but still cogent definitions of how environmental historians approach environmental change, see Arthur F. McEvoy, “Toward an Interactive Theory of Nature and Culture: Ecology, Production, and Cognition in the California Fishing Industry,” in *The Ends of the Earth: Perspectives on Modern Environmental History* (New York: Cambridge University Press, 1988), 211-29; Richard White, “American Environmental History: The Development of a New Historical Field,” *Pacific Historical Review* 54, no. 3 (August 1985): 297-335 and “Afterword—Environmental History: Watching a Historical Field Mature,” *Pacific Historical Review* 70, no. 3 (February 2001): 103-11; and Ted Steinberg, “Down to Earth: Nature, Agency, and Power in History,” *American Historical Review* 107, no. 3 (June 2002): 798-820. For agency specifically, see Linda Nash, “The Agency of Nature or the Nature of Agency?,” *Environmental History* 10, no. 1 (January 2005): 67-69; and Walter Johnson, “On Agency,” *Journal of Social History* 37, no. 1 (Fall 2003): 113-24.

it “as not a thing but a relation... a way of being in the world that changes in both place and time”—that is, to see it as environmental history.²³

My argument is that modern explanations of diabetes epidemiology deeply entwine with shifting biomedical knowledge of Native Americans as distinctive populations residing in distinctive environments. This knowledge emerged from a long and entangled relationship between race, environment, and health in American history. It grew out of and was refined within particular scientific networks that were embedded both within particular landscapes and tethered to larger webs of knowledge. The consequences of how this knowledge was created and dispersed have helped to define, in part, evolving scientific and lay understandings of diabetes and chronic disease. Without denying the enormous importance of the NIH investigations for detecting, evaluating, and promoting diabetes research and treatment, this research has also produced unintended consequences for biomedical researchers and people living with the disease alike.²⁴

At the dawn of the twentieth century, many clinicians and researchers believed that what was then called adult-onset diabetes was environmental in origin. The subsequent studies of Native peoples and of the Pima in particular buttressed a rising emphasis on genetic explanations in the post-World War II era. The perceived genotypic homogeneity of the Pima paradoxically helped to cement universal understandings of the disease’s etiology and natural history. Recent research, however, suggests that diabetes is a polygenic disease. Environmental change may thus play a decisive if contingent role again in explanations for the increased prevalence of Type 2 diabetes across all populations today.

Reevaluating this history may have important implications for how we understand diabetes as a disease. According to historian Charles Rosenberg, we live an era of “managed fear” where civilization itself often blamed for our myriad ills. As Rosenberg concludes, this narrative of managed fear has had powerful implications for health policy, medical care, and basic research. The narrative of diabetes that we follow today follows this trajectory. Diabetes is a disease of modernity, of bodies ill-adapted for world of abundant calories and limited physical activity, of populations more vulnerable than others because of their racial or socioeconomic status, of a derangement between human nature and the natural world, of civilization itself as risk. This narrative emerged, in no small part, from research on the Akimel O’odham or Pima.²⁵

In recent years, historians of medicine have explored how shifting ideas of race and other social differences, like gender and class, shape narratives surrounding the research and treatment of particular diseases. For example, as Keith Wailoo argues, the historical roots of current theories on cancer epidemiology and treatment are deeply entwined with ideas of race and gender. In trying to explain such “epidemiological mysteries” as different mortality rates for black and white women

²³ Gregg Mitman, *Breathing Space: How Allergies Shape our Lives and Landscapes* (New Haven: Yale University Press, 2007), 252. For a summary of the neo-Hippocratic tradition, see Charles E. Rosenberg, “Epilogue: *Airs, Waters, Places*. A Status Report,” *Bulletin of the History of Medicine* 86, no. 4 (Winter 2012): 661-70. For a recent report that defines environment as broadly as I do here, see *Breast Cancer and the Environment: Prioritizing Prevention*, Report of the Interagency Breast Cancer and Environmental Research Coordinating Committee (Research Triangle Park, NC: National Institute of Environmental Health Sciences, National Institutes of Health, U.S. Department of Health and Human Services, 2013) and <http://www.niehs.nih.gov/about/boards/ibcercc/> [accessed February 12, 2013]. As the IBCERCC report states, “the environment includes lifestyle and behavioral factors, chemical and physical agents, and social and cultural influences.”

²⁴ The literature on critical science studies is immense and complex, but for a thoughtful summary of its effects on research and teaching across the academy, see Anne Fausto-Sterling, “Science Matters, Culture Matters,” *Perspectives in Biology and Medicine* 46, no. 1 (Winter 2003): 109-24. For the importance of place or geography in science, see Robert E. Kohler, *Lords of the Fly: Drosophila Genetics and the Experimental Life* (Chicago: University of Chicago Press, 1994) and David N. Livingston, *Putting Science in its Place: Geographies of Scientific Knowledge* (Chicago: University of Chicago Press, 2003).

²⁵ My ideas here grow from two essays by Charles E. Rosenberg: “Managed Fear: Contemplating Sickness in an Era of Bureaucracy and Chronic Disease,” 23rd John P. McGovern Award Lecture, Boston, Massachusetts, May 8, 2008, copy in author’s possession; and “Pathologies of Progress: The Idea of Civilization as Risk,” *Bulletin of the History of Medicine* 72, no. 4 (Winter 1998): 714-30.

from breast cancer, scientists and clinicians have relied upon “theories of difference and social change, and an active racial imagination” to explain the variations.²⁶ In recent years, however, there has been an emerging synthesis of the history of medicine with environmental history, resulting in several path-breaking studies.²⁷

Yet blind spots remain. And perhaps none is as problematic as the connection of race and environment to health. The treatment of Native Americans by environmental historians and historians of medicine stands out in particular. Despite decades of scholarship debunking the so-called “the ecological Indian,” in matters of health and disease, Natives as subjects are often depicted as either biologically fragile to infectious disease, or highly resistant to modernity’s ravages.²⁸ Ideas of racial vulnerability or resistance to disease also have a long history within

²⁶ Keith Wailoo, *How Cancer Crossed the Color Line* (New York: Oxford University Press, 2011), 8. For a representative sample of this scholarship, see Shelia Rothman, *Living in the Shadow of Death: Tuberculosis and the Social Experience of Illness in American Society* (New York: Basic Books, 1994); Nancy Tomes, *The Gospel of Germs: Men, Women, and the Microbe in American Life* (Cambridge, MA: Harvard University Press, 1998); Wailoo, *Drawing Blood: Technology and Disease Identity in Twentieth-Century America* (Baltimore: The Johns Hopkins University Press, 1999); Margaret Humphries, *Yellow Fever and the South* (Baltimore: The Johns Hopkins University Press, 1999); Wailoo, *Dying in the City of Blues: Sickle Cell Anemia and the Politics of Race and Health* (Chapel Hill: University of North Carolina Press, 2000); Susan Reverby, ed., *Tuskegee’s Truths: Rethinking the Tuskegee Syphilis Study* (Chapel Hill: University of North Carolina Press, 2000); Laura Briggs, *Reproducing Empire: Race, Sex, Science, and U.S. Imperialism in Puerto Rico* (Berkeley: University of California Press, 2002); Warwick Anderson, *Colonial Pathologies: American Tropical Medicine, Race, and Hygiene in the Philippines* (Durham: Duke University Press, 2006); Todd L. Savitt, *Race and Medicine in Nineteenth- and Early-Twentieth Century America* (Kent, OH: Kent State University Press, 2006); Reverby, *Examining Tuskegee: The Infamous Syphilis Study and Its Legacy* (Chapel Hill: University of North Carolina Press, 2009); Samuel Kelton Roberts, Jr., *Infectious Fear: Politics, Disease, and the Health Effects of Segregation* (Chapel Hill: University of North Carolina Press, 2009); and Jim Downs, *Sick from Freedom: African-American Illness and Suffering during the Civil War and Reconstruction* (New York: Oxford University Press, 2012). A classic study in this vein, now fifty years old, is Charles E. Rosenberg, *The Cholera Years: The United States in 1832, 1849, and 1866* 2nd ed. (Chicago: University of Chicago Press, 1962, 1987).

²⁷ For a sample of works that exemplify this emerging synthesis, see Christopher C. Sellers, “Thoreau’s Body: Towards an Embodied Environmental History,” *Environmental History* 4, no. 4 (October 1999): 486-514; Gregg Mitman, Michelle Murphy, and Christopher Sellers, eds., “Landscapes of Exposure: Knowledge and Illness in Modern Environments” *Osiris*, 19 (Chicago: University of Chicago Press, 2004); Conevery Bolton Valenčius, *The Health of the Country: How American Settlers Understood Themselves and Their Land* (New York: Basic Books, 2002); Mark Harrison, *Climates and Constitutions: Health, Race, Environment and British Imperialism in India* (New York: Oxford University Press, 2002); Linda L. Nash, *Inescapable Ecologies: A History of Environment, Disease, and Knowledge* (Berkeley: University of California Press, 2006); Mitman, *Breathing Space*; Londa Schiebinger, *Plants and Empire: Colonial Bio-prospecting in the Atlantic World* (Cambridge, MA: Harvard University Press, 2007); Harold J. Cook, *Matters of Exchange: Commerce, Medicine, and Science in the Dutch Golden Age* (New Haven: Yale University Press, 2008); Warwick Anderson, *The Collector of Lost Souls: Turning Kuru Scientists into Whitemen* (Baltimore: The Johns Hopkins University Press, 2008); Nancy Langston, *Toxic Bodies: Hormone Disruptors and the Legacy of DES* (New Haven: Yale University Press, 2010); and Janet Ore, “Mobile Home Syndrome: Engineered Woods and the Making of a New Domestic Ecology in the Post-World War II Era,” *Technology and Culture* 52, no. 2 (April 2011): 260-86. For one assessment of this synthesis see Rosenberg, “Epilogue: Airs, Waters, Places. A Status Report.”

²⁸ Although numerous historians challenged the idea of Native Americans as ecologically innocent, the idea found its most forceful expression in Shepard Krech III, *The Ecological Indian: Myth and History* (New York: W.W. Norton and Co., 1999). For one of many assessments of this idea, see Michael E. Harkin and David Rich Lewis, eds., *Native Americans and the Environment: Perspectives on the Ecological Indian* (Lincoln: University of Nebraska Press, 2007), especially the essay by Darren J. Ranco, “The Ecological Indian and the Politics of Representation: Critiquing *The Ecological Indian* in the Age of Ecocide,” 31-51. Debates among historians over the scope and virulence of virgin soil epidemics in the Americas points to this analytical impasse. In the 1970s, William H. McNeill and Alfred Crosby popularized the idea that Native peoples were “immunologically defenseless” against disease-hardened European invaders and their African slaves. In the subsequent years, this idea has become accepted wisdom. As Jared Diamond concluded in his popular and Pulitzer Prize-winning *Guns, Germs, and Steel*, because Indians had “neither immune nor genetic resistance” to “Old World germs,” Europeans triumphed in their conquest of the New World. But historian and physician David S. Jones questions the “intuitive appeal of natural selection to the demographic history of the Americas.” By attributing depopulation to “irresistible genetic and microbial forces” without considering the forces of “poverty, social stress, and environmental vulnerability that cause epidemics in all other times and places,” he contends, scholars may inadvertently support “racial theories of historical development” and thereby “dodge the question of historical responsibility.” See David S. Jones, “Virgin Soils Revisited,” *William and Mary Quarterly* 3rd ser., 60, no. 4 (October 2003): 703-06. Jones expands on his argument in *Rationalizing Epidemics: Meanings and Uses of American Indian Mortality since 1600* (Cambridge, MA: Harvard University Press, 2004). Surprisingly, few historians to date have taken up Jones’s challenge to reconsider virgin soil epidemics. One notable exception is Paul Kelton, *Epidemics and Enslavement: Biological Catastrophe in the Native Southeast, 1492-1715* (Lincoln: University of

biomedical research and clinical practice as well. Consider diabetes, for example. By the early twentieth century, a broad swath of physicians, sanitarians, and nurses in Western Europe and North America noticed increasing diabetes incidence rates and prevalence among their nations' aging populations. Many attributed the rise to longer life spans, but others believed changes in diet, body size, and the increased stresses of modern civilization were to blame. As the British physician Robert Saundby wrote in 1900, diabetes was "one of the penalties of advanced civilization."²⁹ It was a widely echoed sentiment.

Yet some physicians retreated into racial explanations to explain further the early-twentieth century surge in diabetes. Against the backdrop of shifting ideas about race as a biological category, many physicians on both sides of the Atlantic insisted diabetes was predominantly an affliction of unassimilated immigrants, primarily Jews. Some clinicians, like the famed William Osler, suggested that collective temperament and cultural practices were at fault; others pointed to a racial tendency toward obesity or overconsumption of food, sugar in particular, for the purported prevalence among Jews. Despite rejoinders from other prominent physicians, notably the diabetes specialist Elliott Joslin, that the evidence was unpersuasive the images of diabetes as *Judenkrankheit*, a Jewish disease, persisted well into the mid-twentieth century. As historian Arleen Tuchman concludes, the historic effect of this determinism may be, in part, behind visualizing the current diabetes epidemic in racial terms.³⁰

Racial attitudes have long influenced the study of chronic diseases among Native peoples as well. Ideas about nature further directed the course of research and the conclusions drawn from such work. On the one hand, many physicians believed well into the twentieth century that Indians rarely suffered the ravages of chronic or malignant diseases. For example, in 1908, the Smithsonian Institution published a report by physician-anthropologist Aleš Hrdlička on the health conditions of Indians in the Southwestern United States and Northern Mexico. Hrdlička argued that Indian health, with the exception of "possibly weaker resistance... to a few of the contagions" like smallpox and influenza, was "superior to that of the whites living in larger communities." He based his findings on six expeditions to the region and cursory examinations of nearly two thousand Indians, finding that "malignant diseases if they exist at all—that they do would be difficult to doubt—must be extremely rare." Cardiovascular disease was uncommon as were ulcers, appendicitis, or "any grave disease of the liver." Despite the limitations of Hrdlička's methods and assumptions, his work became a widely cited benchmark for subsequent studies of indigenous peoples and chronic disease. Later reports of Native communities across the globe through the 1950s suggested that cancer in particular was proportionally rare compared to populations in the developed world.³¹ Conversely,

Nebraska Press, 2007), who argues that the devastating effects of epidemic disease cannot be understood apart from the violent processes of European imperialism and settler colonialism.

²⁹ Robert Saundby, "Diabetes Mellitus," in *The International Medical Annual: A Year Book of Treatment and Practitioners Index* (New York: E.B. Treat & Co., 1889), 163.

³⁰ Arleen Marcia Tuchman, "Diabetes and Race: A Historical Perspective," *American Journal of Public Health* 101, no. 1 (January 2011): 24-33; see also Aaron Pascal Mauck, "Managing Care: The History of Diabetes Management in Twentieth Century America" (Ph.D. diss., Harvard University, 2010), 140-46. For Joslin's rejoinder to racial theories, see Elliott P. Joslin, "The Diabetic Problem of Today," *Journal of the American Medical Association* 83, no. 10 (September 6, 1924): 727-29.

³¹ Aleš Hrdlička, *Physiological and Medical Observations among the Indians of Southwestern United States and Northern Mexico* (Smithsonian Institution, Bureau of American Ethnology, Bulletin 34 (Washington, DC: Government Printing Office, 1908), 187-90. Hrdlička did find "rheumatic conditions were quite common," however, but rarely serious. He also dismissed the idea that chronic diseases were uncommon because Indian life expectancy was short since they lived as long as neighboring non-Indians. For two other early studies on cancer and Native peoples, see Isaac Levin, "Cancer Among the North American Indians and its Bearing Upon the Ethnological Distribution of Disease," *Zeitschrift für Krebsforschung* 9, no. 3 (1910): 422-35; and Frederick L. Hoffman, *The Mortality from Cancer Throughout the World* (Newark, N.J.: Prudential Press, 1915). For a summary of this research, albeit written from a strong position regarding contemporary debates over diet and disease, see Taubes, *Good Calories, Bad Calories*, especially 89-99, 235-51.

with infectious diseases, even illnesses like tuberculosis that had become endemic in many Native communities, Indians were defined as highly vulnerable. As Christian McMillen argues, epidemiological studies of tuberculosis in the early twentieth century suggested that “[American] Indians possessed a uniquely high risk of infection not necessarily associated with poverty or behavior, but a risk embedded in their bodies.” Whether it was chronic or infectious disease, the idea that Native peoples were different by nature shaped subsequent research.³²

By the post-World War II era, chronic diseases were becoming commonplace across all American communities and Indian communities in particular. By the 1970s, epidemiologists developed their own explanation for the rise of these afflictions: the so-called “epidemiologic transition,” in which chronic diseases eclipsed infectious diseases in the developed world beginning in the early twentieth century. It is this transition that helps to explain why some observers suggested diabetes did not emerge as a major public health concern until twentieth century. Yet this concept also became what Aaron Mauck has called the “ironic fruit of success” for the profession of epidemiology. The transition simplified the very real challenges facing health care professionals as they tried to launch more studies, create new methods for diagnosis, and create novel and robust statistical methods to evaluate morbidity—a diseased condition or state—as well as simple mortality to halt the spread of chronic disease.³³

The advent of social epidemiology as a distinct subfield beginning in the late 1970s also challenged the assumptions behind mainstream epidemiology, including the idea of the epidemiological transition. Instead of pinning disease distribution to biomedical differences between particular populations, or the retreat of infectious disease with the simple progress of science, social epidemiologists asked instead how unequal social and environmental conditions yielded particular health and disease patterns within vulnerable or marginal communities.³⁴

Across Indian Country, the eponymous name for sovereign lands inhabited by Native peoples, there was arguably was no decisive epidemiological transition until the late twentieth century. The incidence of infectious diseases such as tuberculosis, trachoma, and rheumatic fever among Indians on federal reservations remained significantly higher than the general population well into the late twentieth century even as the prevalence of cardiovascular disease, cancer, and diabetes continued to mount among Indians as well. The persistence of such health disparities calls into question received wisdom about the association between environment, persistent social and economic inequality, and inherited or acquired Indian vulnerability to disease. Ironically, it may be the relative absence of such an epidemiological transition that also shaped prevailing ideas of Native peoples as valuable as medical subjects. At once seemingly modern and timeless, vulnerable and resistant, Native Americans provided potential opportunities for researchers to tease apart these

³² Christian W. McMillen, “‘The Red Man and the White Plague’: Rethinking Race, Tuberculosis, and American Indians, ca. 1890-1950,” *Bulletin of the History of Medicine* 82, no. 8 (Fall 2008): 608-45 (quotation at 609-10). Stegman also suggests this last point.

³³ Mauck, 136-91 (quotation at 136). For the origin of the “epidemiologic transition” see Abdel R. Omran, “The Epidemiologic Transition: A Theory of the Epidemiology of Population Change,” *Milbank Quarterly* 49 (1971): 509-38.

³⁴ For a historical survey of epidemiology, with a focus on social epidemiology and other challenges to the mainstream discipline, see Nancy Kreiger, *Epidemiology and the People’s Health: Theory and Context* (New York: Oxford University Press, 2011). Kreiger argues that the first textbook on epidemiology was Lisa F. Berkman and Ichiro Kawachi, eds., *Social Epidemiology* (New York: Oxford University Press, 2000), although the ideas and concepts later gathered in that book had been circulating since the early 1970s. See Kreiger, 163-201. For specific critiques of the epidemiologic transition rooted in social epidemiology, see Julio Frenk, José L. Bobadilla, Jamine Sepúlveda, and Malaquias Loópez Cervantes, “Health Transition in Middle Income Countries: New Challenges for Health Care,” *Health Policy and Planning* 4, no. 1 (March 1989): 29-39; and George Weisz and Jesse Olszynko Gryn, “The Theory of Epidemiologic Transition: The Origins of a Citation Classic,” *Journal of the History of Medicine and the Allied Sciences* 65, no. 3 (July 2010): 287-326.

knotty puzzles. And no puzzle was more complex by the late twentieth century than the connection between race, genetics, and environment to explain chronic diseases like diabetes.³⁵

One of the first sustained efforts to help explain how and why diabetes had become so prevalent in the entire United States began by studying the first Americans. The Southwestern United States, with its large Native population, was perhaps the initial largest laboratory in which to conduct what researchers call “natural experiments” on disease etiology, diagnosis, and treatment.³⁶ Prior to the 1963 arrival of the NIH team in Phoenix, however, two larger historical developments had converged to make the region an epicenter for such studies.

The first was the importance of the Southwest as a site for medical research with Native subjects to assist federal Indian policy. Concerns over Indian health emerged soon after the federal government imposed direct rule over its purported wards. Beginning in the 1880s, freed from the burdens of the Civil War and Reconstruction, the Department of Interior’s Office of Indian Affairs turned its full attention to the diverse Indian nations populating the continent’s interior. Propelled by public outrage at the mistreatment of Indians under the reservation system and buttressed by the rising power of anthropological theory to justify political reform, federal officials pursued the so-called “assimilation policy” to civilize Indians. The primary instruments of assimilation were boarding and day schools designed to strip Indians of their culture and legislation, like the infamous 1887 Dawes Severalty Act, to break apart their communal tribal lands.³⁷

One area of particular concern for white reformers was Indian health, which they saw as being threatened by primitive superstition and inadequate facilities. Infectious diseases ravaged Indian communities weakened by warfare, disease, relocation, and confinement. Efforts to ameliorate Indian health faced still other obstacles. As the collective wreckage of the assimilation policy accumulated, many Indian communities, unable to access traditional sources of sustenance, soon fell into dependency and relied upon federal food commodity supplies to survive. An inadequately funded and structurally unsound system for providing health care, modeled on the problematic Medical Division of the Freedmen’s Bureau to assist freed slaves during Reconstruction, exacerbated declining health conditions.³⁸

During the Progressive Era, frustrated federal officials turned toward the power of science to help explain and fix what was widely seen as a broken health system. The new discipline of anthropology seemed to offer the best answers, and the most influential line of research at the time focused on the effect of environment on Indian behavior and health. Despite resistance to

³⁵ David S. Jones, “The Persistence of American Indian Health Disparities,” *American Journal of Public Health* 96, no. 12 (December 2006): 2122-34.

³⁶ Simply defined, a natural experiment is an empirical study where experimental conditions are determined by nature or by other factors out of the control of the investigators and any interventions (e.g., treatments) are outside of the system or exogenous. The most famous example of a natural experiment within epidemiology was John Snow’s famous 1854 analysis of cholera infection patterns in London’s Broad Street neighborhood. See Steven Johnson, *The Ghost Map: The Story of London’s Most Terrifying Epidemic—and How it Changed Science, Cities, and the Modern World* (New York: Riverhead, 2006). For a critique of the “natural experiment” idea in biomedical research, see Daniel Callahan, *What Price Better Health?: Hazards of the Research Imperative* (Berkeley: University of California Press, 2003), 133-64.

³⁷ For an overview of federal Indian assimilation policy, see Frederick E. Hoxie, *A Final Promise: The Campaign to Assimilate the Indians, 1880-1920* (Lincoln: University of Nebraska Press, 1984).

³⁸ The degree and process by which some, but not all American Indian reservation communities fell into dependency is a contentious topic. A classic study is Richard White, *The Roots of Dependency: Subsistence, Environment, and Social Change among the Choctaws, Pawnees, and Navajos* (Lincoln: University of Nebraska Press, 1983). For early health care systems on Indian reservations, see David H. DeJong, “If You Knew the Conditions”: *A Chronicle of the Indian Medical Service and American Indian Health Care, 1908-1955* (Lanham, MD: Lexington Books, 2008), 1-64; James P. Rife and Alan J. Dellapenna, Jr., *Caring and Curing: A History of the Indian Health Service* (Lanham, MD: Public Health Service Commissioners Officers Foundation for the Advancement of Public Health, 2009), 2-19. For the connections between the Freedmen’s Bureau and the U.S. Indian Service, see Downs, *Sick From Freedom*, 171-78.

environmental explanations for social evolution, led primarily by anthropologist Franz Boas and his students, who championed cultural factors instead, this line of inquiry shaped early anthropological surveys (like Hrdlička's 1908 study) of Indian health conditions.³⁹ And many of the first comprehensive surveys were conducted in the Southwest. Unlike Indian communities elsewhere in the Western United States, most of which were forcibly relocated, often at great distance from their historic homelands, federally recognized tribes in Arizona and New Mexico were seen as relatively proximate to their traditional homelands. The expansion of rail and road networks connecting the burgeoning cities of the region with California and Texas also made for easier travel for anthropologists and U.S. Indian Service physicians flocking to the Southwest. Most investigations focused on the two prevalent and damaging diseases at the time: tuberculosis and trachoma, an eye disease that is the leading cause of infectious blindness. Despite surveys to track and control TB and trachoma, little headway was made other than documenting poor sanitary and health conditions.⁴⁰

By the New Deal, thanks to reforms spurred by Commissioner John Collier, the Bureau of Indian Affairs (BIA) began to enhance conditions and emphasize collaborative approaches to Indian health. Collier also supported new and renovated hospitals and clinics staffed by qualified physicians and nurses. These efforts met with mixed success. Researchers emphasized collecting data without sufficient attention to cultural differences, while clinicians and nurses struggled with inadequate funding and personnel. Nonetheless, these reforms had an unintended effect. They put Arizona on the map as an important site for American Indian medical research. By 1955, when the U.S. Public Health Service assumed control of Indian health care, Arizona had more dedicated facilities for clinical care and research than any other state in the lower forty-eight. The result was the beginning of dense and robust scientific and clinical networks that promoted and circulated emerging ideas about Native susceptibility to diabetes.⁴¹

The second trend was the rise of the Sunbelt as a destination for health seekers. Beginning in the late-nineteenth century, legions of asthmatics and consumptives sought relief in the arid and elevated climes of the interior West. Cities like Phoenix and Tucson marketed themselves as destinations for health. Only with the region's explosive growth during and after World War II did those health resorts, spas, and sanatoriums yield to a new generation of medical facilities, often tied to major universities maintained by federal grants, dedicated to clinical and laboratory research. Even as urban sprawl and industry befouled the region's skies and waters, the Sunbelt still touted its supposed healthfulness to investors and homebuyers.⁴²

It was the combination of these two trends that spurred the first studies of diabetes among American Indians in the Southwest. Elliott P. Joslin, one of the leading diabetes clinicians of the twentieth century, was one of many lured to Arizona. He arrived in early 1940 and made a brief

³⁹ Hoxie, 115-45.

⁴⁰ Stegman, 33-36; Shannen K. Allen and Richard D. Semba, "The Trachoma 'Menace' in the United States, 1897-1960," *Survey of Ophthalmology* 47, no. 5 (September-October 2002): 500-09. For the broader conditions of Indian health and healthcare at the time, see Diane T. Putney, "Fighting the Scourge: American Indian Morbidity and Federal Policy, 1879-1928," (Ph.D. diss., Marquette University, 1980) and Todd Benson, "Race, Health, and Power: The Federal Government and American Indian Health, 1909-1955," (Ph.D. diss., Stanford University, 1994).

⁴¹ For reforms and conditions, see DeJong, "If You Knew the Conditions," 65-84; and Stegman, 47-48. For a prominent example of a problematic experiment on the Navajo Reservation, see David S. Jones, "The Health Care Experiments at Many Farms: The Navajo, Tuberculosis, and the Limits of Modern Medicine, 1952-1962," *Bulletin of the History of Medicine* 76, no. 4 (Winter 2002): 749-90.

⁴² For Arizona as health destination turned health disaster, see Gregg Mitman, *Breathing Space: How Allergies Shape our Lives and Landscapes* (New Haven: Yale University Press, 2007), 89-129; see also Andrew Ross, *Bird on Fire: Lessons from the World's Least Sustainable City* (New York: Oxford University Press, 2011), 104-47. For the growth of postwar Phoenix and environs, see Todd Andrew Needham, "Power Lines: Urban Space, Energy Development, and the Making of the Modern Southwest, 1945-1975" (Ph.D. diss., University of Michigan, 2006); and Bradford Luckingham, *Phoenix: The History of a Southwestern Metropolis* (Tucson: University of Arizona Press, 1989), 136-268. For an earlier history of the region as health haven, see Billy M. Jones, *Health-Seekers in the Southwest, 1817-1900* (Norman: University of Oklahoma Press, 1967).

survey of diabetes in the state, hypothesizing that the low mortality rate (10/100,000) and incidence was due, in part, to its “particularly diversified...climate, altitude, and composition of its population.”⁴³ Joslin delivered his findings as the 1940 Frank Billings Lecturer of the American Medical Association, published later that year in the *Journal of the American Medical Association* (*JAMA*). Joslin also proposed that incidence among Native Americans in Arizona was lower at the time than in the national population as a whole. He made broad distinctions, however, that framed future research in the state, suggesting that more sedentary Indians, like the Pimas, who “depend on agriculture and...harvest their crops on shares, allowing the Papagos to do most of the work” had higher frequency than nomadic Navajos and Apache herdsmen.⁴⁴

It is important to note that Joslin relied primarily upon anecdotal evidence, gathered from interviews with physicians and nurses, cursory chart reviews, and vital statistics provided to him during his visit. Nonetheless, he decided that diabetes in Arizona was probably as common among Indians as among the general population, restating a prediction he had made in an earlier 1921 *JAMA* article that incidence rates were climbing across the nation despite being hidden from physicians’ view. Joslin’s visit may have also helped him design his famed Oxford, Massachusetts study in 1946, a twenty-year prospective cohort study to track diabetes and its complications. Some scholars suggest that the Oxford experiment may have influenced the famed Framingham Heart Study, launched two years later, which yielded concept of “risk factor” to describe potential susceptibility to disease.⁴⁵

Before the advent of the risk factor, however, Joslin already had strong opinions as to what predisposed individuals to adult or maturity-onset diabetes: obesity.⁴⁶ As he wrote in his 1921 *JAMA* article, while “the association between obesity and diabetes has long been noted,” it was the relationship between height and weight that mattered in defining obesity. Joslin would play an important if still unheralded role in establishing this connection through his collaboration with Louis Dublin, a biologist turned statistician working for the Metropolitan Life Insurance Company, or MetLife. Dublin was deeply concerned that chronic diseases like diabetes had become a major problem for MetLife’s policyholders, but lamented that little had been “done to date” to evaluate such diseases statistically. Beginning in the 1920s, Dublin and Joslin began collaborating to establish a clearer statistical picture. Joslin relied upon Dublin’s statistical skills to help him revise material on diabetes mortality and incidence in his popular textbook on treating diabetes, as well as improve his thriving clinical practice in Boston. Dublin used Joslin’s medical expertise to study and define diabetes mortality and later diabetes morbidity in actuarial terms for MetLife. The precise role Joslin played in helping Dublin to create MetLife’s famed height and weight tables, first

⁴³ Elliott P. Joslin, “The Universality of Diabetes: A Survey of Diabetic Morbidity in Arizona,” *Journal of the American Medical Association* 115, no. 24 (December 14, 1940): 2033-38 (quotation at 2033).

⁴⁴ Joslin, “The Universality of Diabetes,” 2036.

⁴⁵ Joslin, “The Universality of Diabetes,” 2035-36. For Joslin’s original prediction, see “The Prevention of Diabetes Mellitus,” *Journal of the American Medical Association* 76, no. 2 (January 8, 1921): 79-84. For the Oxford study and the universality of diabetes, see Mauk, 184-88; and Hugh L.C. Wilkerson and Leo P. Krall, “Diabetes in a New England Town: A Study of 3,516 Persons in Oxford, Mass.,” *Journal of the American Medical Association* 135, no. 4 (September 27, 1947): 209-16. The now-common term “risk factor” was originally coined in 1964 by the Framingham Heart Study’s principal investigator, William B. Kannel. See William B. Kannel, Thomas R. Dawber, Gary D. Friedman, William E. Glennon, and Patricia M. McNamara, *Annals of Internal Medicine* 61, no. 5, part 1 (November 1964): 888-99. For a critical history of risk factor in public health, see William G. Rothstein, *Public Health and the Risk Factor: The History of an Uneven Medical Revolution* (Rochester, NY: University of Rochester Press, 2003). I’m grateful to conversations with Donald M. Bartlett, M.D. of the Joslin Diabetes Center to help explain the possible connection between the Oxford and Framingham studies.

⁴⁶ Joslin, “The Prevention of Diabetes Mellitus,” 79.

released in 1942, remains unclear. What is clear, however, was the growing and now measurable correlation between obesity and diabetes.⁴⁷

Curiously, Joslin never cited previous studies that noted obesity may have been commonplace among the Pima. In addition to Hrdlička's 1908 examination, the Harvard University anthropologist Frank Russell lived among the Pima from November 1901 to June 1902 studying the tribe's culture, history, language and foodways. Although Russell offered no systematic medical analysis, he observed that the Pima, living in "the semitropical climate of the Gila Valley...are noticeably heavier than individuals belonging to the tribes of the Colorado Plateau." Moreover, many "old persons exhibit a degree of obesity that is in striking contrast to the 'tall and sinewy' Indian conventionalized in popular thought."⁴⁸ Hrdlička also noticed that obesity among the Pima was commonplace and dedicated an entire subsection of his study to the subject. Although "real obesity" could be found "among the Indians on reservations" throughout the Southwest, it seemed to be "largely but not exclusively" a Pima trait, predominantly among the women. He speculated that "sedentary" habits played a role, as did increased life span, but he also noted in a 1906 article that the Pima diet now included "everything obtainable that enters into the dietary of the white man."⁴⁹ Yet neither scientist concretely argued that Arizona Indians' health was compromised by their diet, lifestyle, or body mass, nor did Joslin in his 1940 article.

Well before the early Epidemiology and Field Studies Branch studies, other scientists and physicians had already associated diet and environmental conditions with Indian health. By the early postwar decades, clinicians working across the Southwest had started tracking the prevalence of chronic diseases like diabetes among American Indians. Most worked for or were affiliated with the BIA or the U.S. Public Health Service (PHS)—the former agency charged with protecting Indian welfare, the latter responsible for the wellbeing of all Americans. As researchers for both agencies collected data, some began to speculate on the reasons why Native peoples might be at greater risk for diabetes and its numerous complications.

One such physician was Burton M. Cohen of the Public Health Service. Cohen reviewed records from the Phoenix Medical Center over two fiscal years from 1950 to 1952 with two questions in mind: what was the prevalence of diabetes among Indians, and whether clinical presentations were different between Indians and non-Indians. Focusing on the Phoenix hospital allowed him to sample a broad geographic region since it was the largest hospital serving reservations in a four state area: California, Utah, Nevada, and Arizona. By reviewing patient charts, Cohen provided detailed accounts of what was then called "maturity onset" diabetes, along

⁴⁷ The best account of Joslin and Dublin's collaboration is Mauck, 146-91. Joslin co-authored three studies with Dublin and Herbert H. Marks, another MetLife statistician, to publicize their findings. See Elliott P. Joslin, Louis I. Dublin, and Herbert H. Marks, "Studies in Diabetes Mellitus I: Characteristics and Trends in Diabetes Mortality throughout the World," *American Journal of the Medical Sciences* 186, 6 (December 1933): 753-773; "Studies in Diabetes Mellitus II: Its Incidence and Factors Underlying its Variations," *American Journal of the Medical Sciences* 187, 4 (April 1934): 433-457; "Studies in Diabetes Mellitus III: Interpretation of the Variations in Diabetes Incidence," *American Journal of the Medical Sciences* 189, 2 (February 1935): 163-194; "Studies in Diabetes Mellitus IV: Etiology, Parts 1 and 2," *American Journal of the Medical Sciences* 192, no. 6 (July 1936): 9-40; "Studies in Diabetes Mellitus V: Heredity," *American Journal of the Medical Sciences* 193, no. 1 (January 1937): 8-22; and "Studies in Diabetes Mellitus VI: Mortality and Longevity of Diabetics," *American Journal of the Medical Sciences* 193, no. 5 (May 1938): 596-604. For more on the MetLife tables, see Peter N. Stearns, *Fat History: Bodies and Beauty in the Modern World* (New York: New York University Press), 106-34.

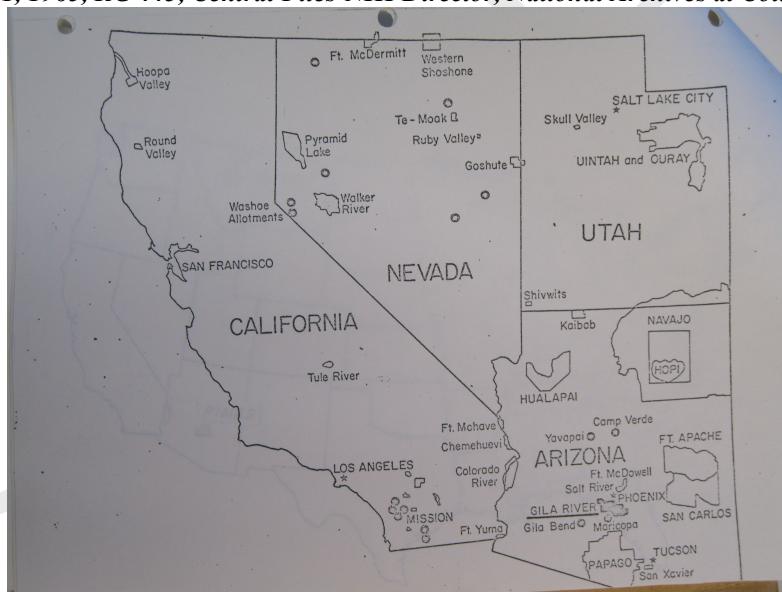
⁴⁸ Frank Russell, "The Pima Indians," in *Twenty-sixth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1904-1905* (Washington, DC: Government Printing Office), 66.

⁴⁹ Hrdlička, *Physiological and Medical Observations*, 156-57; and "Notes on the Pima of Arizona," *American Anthropologist*, 8, no. 1 (January-March 1906): 45.

with information on its vascular lesions (or complications), frequency and severity, the presence of obesity and family history of the disease.⁵⁰

But Cohen did more than merely document the prevalence of diabetes and its complications at the Phoenix hospital. He speculated on how differences between populations and their particular environments might explain the uneven distribution of diabetes across all Indian communities served by the Phoenix IHS Medical Center. With significant caveats, he noted that diabetes was most prevalent among tribes residing in “recently-irrigated, low-altitude areas of high average year-round temperatures,” like the Pima, as compared to lower prevalence among Indians “in high-altitude plains and timberlands.” Like many non-Indian physicians and researchers at the time, however, Cohen made a key assumption about Indian identity: he assumed all Indians were alike. He relied upon BIA records to determine tribal affiliation in his chart review, yet agency designations did not always correlate accurately with individual tribal identities.⁵¹ Nonetheless, Cohen’s paper, if incomplete, laid the groundwork for future studies on the association between race and environment within American Indian populations.

[Fig. 2: Reservations in the Phoenix IHS Hospital service area. Source: “Epidemiology and Field Studies in Phoenix Area,” July 21, 1965, RG 443, Central Files-NIH Director, National Archives at College Park, MD]



Two other studies in the 1950s further cemented, if incompletely, that same foundation. Both surveyed the diets and health status of Arizonan Indians and the Pima in particular, but neither focused on chronic disease. In 1954 Bertram Kraus and Bonnie M. Jones stated how “scientifically conducted surveys of nutritional status among Indian populations of the Southwest have been almost totally lacking.” Nonetheless, they found that the diet many of the tribes in southern Arizona and the Papago in particular (Tohono O’odham) revolved around tortillas, beans, potatoes, coffee and some meat—most of which were introduced after contact with Europeans and became commonplace beginning with the reservation system.⁵² Five years later, Frank G. Hesse, building

⁵⁰ B. M. Cohen, “Diabetes Mellitus among Indians of the American Southwest: Its Prevalence and Clinical Characteristics in a Hospitalized Population,” *Annals of Internal Medicine* 40 (1954): 588-99.

⁵¹ Cohen, “Diabetes Mellitus among Indians,” 596-97; Stegman, 56.

⁵² Bertram S. Kraus, with Bonnie M. Jones, *Indian Health in Arizona: A Study of Health Conditions among Central and Southern Arizona Indians* (Tucson: University of Arizona Press, 1954), 102. For an earlier study of diet on another Indian reservation—the Crow Creek Reservation (Sioux) in South Dakota—see Jessie Anderson Stene and Lydia J. Roberts, “A Nutrition Study on an Indian

upon his two-year assignment as an intern at the PHS hospital in Sacaton on the Gila River Reservation conducted a dietary survey. Hesse found the Pima's diet corresponded to Kraus and Jones's earlier findings, but he also stressed the confounding factors behind his own research. Because he relied upon subject recall, he stated "accurate measurements of food consumed" could not be verified because "cultural differences preclude the invasion of the Indian homes for such a study." Yet Hesse did not find diabetes to be highly prevalent among the Pima, although he did note a "low incidence of arteriosclerotic heart disease" alongside high incidence of gallbladder disease."⁵³

Seven years later, in 1961, the focus returned to diabetes as Arizona physicians John H. Parks and Eleanor Waskow built upon Cohen's foundation. They examined the creation of a public health program for the Pima during the transition of Indian medical care from the BIA to the Indian Health Service of the PHS, calling the Pima "a natural group for the critical study of diabetes."⁵⁴ Concentrating on basic epidemiology as well as structural and cultural obstacles to treatment, they concluded that a community program of education, home visits, and patient empowerment, modeled after the pioneering work in developed at Elliott Joslin's various Boston clinics for diabetic care, would promote proper control of the disease during a patients' life course.⁵⁵ Parks and Waskow commented favorably on the Pima Health and Welfare Committee, created by the tribal government at Gila River, as providing a higher level of care. As physicians, they noted proudly (and perhaps naively) how "the patient, having learned to trust the doctor in the hospital, could trust the same doctor in the classroom."⁵⁶

As epidemiologists, however, it was outpatient records from state-operated mobile diabetes screening clinics and patient charts from the Indian Health Service hospital at Sacaton that interested them the most. According to their interpretation, the incidence of diabetes among the Pimas was 4.1 percent, much higher than the 1.4 percent in Joslin's Oxford study. The key factors they listed were "marked familial history, high carbohydrate diet, body type of the obese endomorph, and inbreeding." Almost 88 percent of patients were overweight according to MetLife Insurance actuarial tables. The reason for tribe's weight gain, they concluded, was the switch from a "traditional diet" of beans, squash, and meat to "starches, lard, and sugar."⁵⁷

While nutrition was a key environmental factor in the unusually high diabetes incidence among the Pima, Parks and Waskow suggested that genetics was the true origin. They argued that the "inbred Pima tribe makes it possible to trace a single gene back through all branches of the family—something that is impossible in a larger, more diffuse population."⁵⁸ They were not alone

Reservation," *Journal of the American Dietetic Association* 3, no. 4 (March 1928): 215-22. Stene and Roberts's leaned heavily on Hrdlička's work and found that patterns among the Crow largely matched those of Indians in the Southwest.

⁵³ Frank G. Hesse, "A Dietary Study of the Pima Indian," *American Journal of Clinical Nutrition* 7 (September-October 1959): 532-33. For an overview of the Pima's changing diet, which emerged out of the PECRB's research and cites Hesse's paper, see Cynthia J. Smith, Elaine M. Manahan, and Sally G. Pablo, "Food Habit and Cultural Changes among the Pima Indians," *Diabetes as a Disease of Civilization: The Impact of Culture Change on Indigenous Peoples*, Jennie R. Joe and Robert S. Young, eds. (New York: Mouton de Gruyter, 1994), 407-33.

⁵⁴ John H. Parks and Eleanor Waskow, "Diabetes among the Pima Indians of Arizona," *Arizona Medicine* 18, no. 4 (April 1961): 99-106 (quotation at 99-100).

⁵⁵ For an overview of Joslin's treatment and prevention regimen, which he developed with his collaborator, Pricilla White, M.D., see Donald M. Barnett, *Elliott P. Joslin, M.D.: A Centennial Portrait* (Boston: Joslin Diabetes Center, 1998); Mauck, 74-132; and Presley, 320-81. Presley notes that Joslin's belief in strict control may have emerged out of the earlier pre-insulin dietary regimen popularized by Frederick Allen, another leading physician specializing in diabetes and metabolism, who was widely known for his near-starvation diets to regulate metabolism in insulin-dependent diabetics.

⁵⁶ Parks and Waskow, "Diabetes among the Pima Indians of Arizona," 100.

⁵⁷ *Ibid.*, 99.

⁵⁸ *Ibid.*, 105. Current prevailing theory is that diabetes in both variants may be polygenetic, something that meshes with environmental factors. It is an idea that has gained traction with recent studies emerging from the international Encyclopedia of DNA Elements

in searching for genetic explanations in combination with environmental changes to explain in disease etiology. But Parks and Waskow's language also exposed an unpleasant stowaway hiding within modern human genetics: eugenics.⁵⁹

Nowhere was this more apparent than in the work of James V. Neel, a physical anthropologist and geneticist at the University of Michigan and a founding member of the American Society of Human Genetics. At the Society's first meeting in 1948, Neel's proposed in inaugural address that "genetic carriers" were behind many diseases from sickle-cell anemia to diabetes. Fourteen years later, Neel was still pushing this hypothesis in an article for the society's journal. His argument in the now well-known article, "Diabetes Mellitus: A 'Thrifty Genotype' Rendered Detrimental by 'Progress'?",⁶⁰ was hardly novel. Physicians had long suspected heredity in juvenile-onset and maturity-onset diabetes, and Elliott Joslin had counseled diabetics not to marry and have children based upon his own observational twin studies at his Boston clinic. What was unique, however, was how Neel grafted eugenicists' obsession with race and disease onto the new stock of evolutionary biology. He argued that periods of famine or under-nutrition acted as a selective pressure within hunter-gatherer societies, where metabolic efficiency was an advantage. With modern society and sedentary lifestyles, abundant food was transforming an evolutionary advantage into a disadvantage. Neel didn't know then the "precise physiologic basis for this 'thriftness,'" but he suggested that dieting and exercise, which could often mitigate or reverse maturity onset diabetes, was a potential proof of his hypothesis.⁶⁰

Neel's "thrifty genotype" remains controversial and has been amended several times. When scientists reclassified juvenile onset or Type 1 diabetes as an autoimmune disease in the early 1970s, Neel's hypothesis became restricted to Type 2 or maturity onset diabetes. Later researchers suggested that Neel had the mechanism wrong, arguing instead for a "thrifty phenotype" or "fetal origins" hypothesis instead: in utero under-nutrition could also produce insulin resistance, obesity, and diabetes. Neel's ideas nevertheless set the terms of further investigation into the causes of what would later be called Type 2 diabetes.⁶¹ Thus, to borrow Charles Rosenberg's classic concept of framing disease, by the early 1960s diabetes had been reframed in the biomedical literature. The emerging conceptual picture resembled a diptych. One frame was environmental: nutrition and diet, plus other changes to the physical landscape affecting health, such as the lack of exercise. The second was genetic: heredity. Long-term studies of the Pima and other Native groups would join these two frames into one, if incompletely.⁶²

Institutional politics and financing also mattered in constructing the frames. When the NIH researchers arrived in Arizona in 1963, the Institutes' funding for metabolic and gastrointestinal diseases lagged only behind support for cancer research. Moreover, because inflammation and

(ENCODE) project. For example, see Matthew T. Murano, *et al.*, "Systematic Localization of Common Disease-Associated Variation in Regulatory DNA," *Science* 337, no. 6099 (September 7, 2012): 1190-95.

⁵⁹ For a penetrating overview of the role of genetics in modern biomedicine and life sciences during this era, see Daniel J. Kevles, *In the Name of Eugenics: Genetics and the Uses of Human Heredity* (New York: Alfred A. Knopf, 1985), 193-301.

⁶⁰ James V. Neel, "Diabetes Mellitus: A 'Thrifty Genotype' Rendered Detrimental by 'Progress'?", *American Journal of Human Genetics* 14, 4 (December 1962): 353-362; Stegman, 107-09. Neel was later accused by journalist Patrick Tierney of exacerbating epidemic measles among the Yanomami (also Yanomamö) of Brazil's Amazon River basin with his colleague, Napoleon Chagnon, another anthropologist, in violation of research ethics. After an investigation, the American Anthropological Association and the University of Michigan later cleared Neel posthumously of the charges. Chagnon, however, remains a controversial figure. See Emily Eakin, "Who are the Real Savages?", *The New York Times Sunday Magazine*, February 17, 2012, MM32 and www.nytimes.com/2013/02/17/magazine/napoleon-chagnon-americas-most-controversial-anthropologist.html [accessed February 13, 2013].

⁶¹ For one proponent of the thrifty phenotype hypothesis, see Daniel C. Benyshek, John F. Martin, and Carol S. Johnson, "A Reconsideration of the Origins of the Type 2 Diabetes Epidemic among Native Americans and the Implications for Intervention Policy," *Medical Anthropology* 20, no. 1 (2001): 25-64.

⁶² Rosenberg, "Disease in History: Frames and Framers," *Milbank Quarterly* 67 (1989, Supp. 1): 1-15.

hormones were understood at the time as key components of rheumatoid arthritis and diabetes, it made sense to group them together within the National Institute of Arthritis and Metabolic Diseases, or NIAMD. The two initial lead researchers in Phoenix—Thomas A. Burch, an NIH rheumatologist, and Peter H. Bennett, a visiting British immunologist and rheumatologist at the NIH—were well suited to study these diseases because of their focus on inflammation and hormone action. So by the early 1960s, federal funding for and scientific understandings of metabolic diseases had combined to create the conditions that made the NIH studies in Arizona possible. As researchers fanned out across the Gila River and Blackfeet reservations, it was diabetes that ultimately captured the their attention.

The first surveys conducted in 1963 found 30 percent of subjects thirty years and older had elevated levels of postprandial blood sugars. This was almost ten times higher than the general population. A follow up study two years later reported on a glucose tolerance test given to ten percent of the Pima population aged ten years and older. Researchers also reexamined half of their 1963 study group for diabetic complications. The preliminary results, published in a 1965 issue of the journal *Diabetes*, confirmed earlier findings. Among the entire tested group, 34 percent had diabetes. Among adults thirty or older, 49 percent tested for diabetes—a rate ten to fifteen times higher than the general population and the highest prevalence ever reported for the disease.⁶³

The Pima study coincided with rising national concern over diabetes and scientific explanations into its origins and consequences. One of the principal investigators of the 1965 Pima study, Dr. Max Miller of Western Reserve University, had started the University Group Diabetes Program (UGDP) in Cleveland. The UGDP, the first major multi-center clinical trial sponsored by the NIH, tried to explore the relationship between strict blood sugar control and diabetes complications, specifically vascular disease. UGDP researchers tried to compare different therapies—diet only, single versus regulated insulin dosage, and oral hypoglycemic drugs called sulfonylureas. While the UGDP ended in controversy in 1970 over possible increases in cardiovascular disease and premature death after administering the oral hypoglycemic tolbutamide (Orinase), it marked the arrival of major, longitudinal studies into the causes and therapies of chronic diseases like diabetes.⁶⁴

The authors of the 1965 *Diabetes* study already grasped the significance of their much more modest work on the Pima. And increased funding for basic biomedical research and community development under the Johnson administration helped them to expand their project. The first four preliminary investigators—Miller, Burch, Bennett, and geneticist Arthur G. Steinberg—suggested the Pima were a “stable population” and their high rates in such a small group provided “ideal circumstances” for future research. While the arthritis studies found no evidence for genetic factors, the diabetes investigations pointed to “the genetic pattern of distribution of diabetes in families.”⁶⁵ The Epidemiology and Field Studies Branch scientists (later the Phoenix Epidemiology and Clinical Research Branch or PECRB) now ramped up their ambitions, proposing to explore inheritance, natural history, the effect of diet and other environmental factors, the relationship between diabetes and pregnancy, the etiology of diabetes and its pathogenesis and the effects of various therapies.

⁶³ Max Miller, *et al.*, “Prevalence of Diabetes Mellitus in American Indians.” Diagnosis was based on a two-hour glucose level of over 160 mg/100 ml.

⁶⁴ The history and consequences of the UGDP looms large in history of modern U.S. medicine. For two cogent analyses, see Harry M. Marks, *The Progress of Experiment: Science and Therapeutic Reform in the United States, 1900-1990* (New York: Cambridge University Press, 1997), 197-228; and Jeremy A. Greene, *Prescribing by Numbers: Drugs and the Definition of Disease* (Baltimore: The Johns Hopkins University Press, 2006), 81-148.

⁶⁵ For the RA studies, see William M. O’Brien, *et al.*, “A Genetic Study of Rheumatoid Arthritis and Rheumatoid Factor in Blackfeet and Pima Indians,” *Arthritis and Rheumatism* 10, no. 3 (June 1967): 163-64; and Bennett and Burch, “The Distribution of Rheumatoid Factor.” For DM prevalence, see Miller, *et al.*, “Prevalence of Diabetes Mellitus.”

The PECRB researchers also drew support for their expanded efforts from growing concerns over diabetes among IHS physicians and nurses, plus tribal leaders, across the Western United States. After securing the assent of the Pima Tribal Council, the team established a Clinical Field Studies Unit in 1966. Their efforts also benefitted from other community-wide developments at Gila River, notably a 1968 Model City planning grant from the Department of Housing and Urban Development, plus close collaboration with Indian Health Service physicians at hospitals in Sacaton and Phoenix. Yet throughout the IHS Phoenix Service Area, physicians and nurses seemed to see more diabetes cases than counterparts elsewhere in the Western United States. They also documented ongoing cases of nutrition deficiency—diets inadequate in calcium, Vitamins A and C, and riboflavin—that possibly contributed to health problems and diseases, including obesity and diabetes. Even by the late 1960s, however, diabetes was far from the direst problem facing IHS physicians. Accidents and TB took more lives, infant mortality remained high, and problems with sanitation, utilities, infectious disease, alcohol abuse, and health education commanded attention. Teasing apart the actual increase in the disease from better detection revealing new cases was another challenge for epidemiologists had to address.⁶⁶

By the late 1960s, however, the cumulative effect of increased awareness and further studies suggested diabetes was now commonplace among Natives across the nation. A 1966 study by Maurice Sievers, the senior clinician and research director of the Phoenix IHS Hospital, surveyed disease patterns based on hospital records and found that the comparative morbidity of diabetes was highest for the Pima and Papago (Tohono O’odham) and lowest for the Navajo.⁶⁷ Within the next few years, other prevalence studies using medical records and retrospective chart reviews revealed Native communities from Oklahoma to Montana with significant diabetes prevalence and morbidity from complications.⁶⁸ These studies benefitted from the continued refinement of diagnoses and nomenclature that made researchers work easier to complete in the laboratory or in the field. New technologies like measuring insulin in the bloodstream through radioimmunoassay, for example, were easier to use and more accurate than older urine analyses, helping to further distinguish between juvenile-onset or insulin-deficient diabetes (now Type 1) and maturity-onset or insulin-resistant diabetes (now Type 2) and the therapies used to treat both.⁶⁹

These new technologies reinforced what many researchers saw as the inherent advantages in studying the Native Americans in general and the Pima in particular. Better measurement and sampling could not overcome the problem of population heterogeneity typical of many federally recognized Indian tribes. One specialist in diabetes epidemiology, Kelly M. West of the University of Oklahoma Medical Center, found comparing diabetes prevalence by “tribal variation” to be exceedingly frustrating. Other researchers felt the same. Collecting random samples from mobile and mixed populations made screening procedures and study design daunting at best.⁷⁰ By comparison, the Pima were a clearly defined population proximate to a major urban medical center. The Pima were as close to a prospective cohort study in nature—a natural experiment—as researchers could hope to find.

⁶⁶ Stegman, 75-81.

⁶⁷ Sievers, “Disease Patterns Among Southwestern Indians.”

⁶⁸ For salient examples, see Curtis C. Drevets, “Diabetes Mellitus in Choctaw Indians,” *Journal of the Oklahoma State Medical Association* 58 (July 1965): 322-29; and George J. Mouratoff, “Diabetes Mellitus in Eskimos,” *Journal of the American Medical Association* 199, no. 13 (March 1967): 962-66.

⁶⁹ Stanley Blumenthal, “The Insulin Immunoassay After 50 Years,” *Perspectives in Biology and Medicine* 52, no. 3 (Summer 2009): 343-354; Adam M. Hedgecoe, “Reinventing Diabetes: Classification, Division and the Geneticization of Disease,” *New Genetics and Society* 21, no. 1 (2002): 7-27; Stegman, 88-92; and Mauck, 245-349.

⁷⁰ Jay H. Stein, Kelly M. West, J.M. Robey, D.F. Tirador, and G.W. McDonald, “The High Prevalence of Abnormal Glucose Tolerance in the Cherokee Indians of North Carolina” *Archives of Internal Medicine* 116, no. 6 (December 1965): 842-45.

As the PECRB team began publishing its results, scientists worked closely to insure the long-term success of the project by integrating research within both the Gila River Indian Community and the Phoenix IHS Medical Center. Founded in 1908 as a wing of the Phoenix Indian School, the original hospital and sanatorium became the central medical facility for Native Americans in the Southwest by the 1960s, as well as one of the busiest in the entire IHS system as measured by patient visits. With bed space at a premium and staff overstretched, IHS staff and tribal representatives lobbied Arizona's powerful congressional delegation—led by Senator Carl Hayden and Representative Morris Udall—to secure funding for a long-needed expansion that included a new NIH lab and clinical facility. For its part, the Nixon administration referenced the Pima studies in a July 1971 statement affirming the President's commitment to American Indian health. Indeed, the Phoenix researchers undoubtedly benefitted from rising interest in promoting Indian self-determination, which included improving health services, across all sectors of the federal government.⁷¹

Meanwhile, the PECRB team continued its research and published more on their speculations about diabetes epidemiology. In a 1967 paper for the journal *Metabolism*, they confirmed again rising rates of obesity among the Gila River Indian Community older than thirty years of age: 68 percent for men, 92 percent for women. Comparing diabetic and non-diabetic groups by measuring blood insulin levels through radioimmunoassay, they concluded that “mild” or adult-onset diabetes in the Pima was associated with obesity.⁷² Moreover, it underscored two important if seemingly contradictory points that would drive future research: the universality of diabetes among all populations as well as the Pima as a special case. The authors concluded “since no feature has thus far been found to distinguish the diabetes of the Pima Indians from that of the much larger and heterogeneous reservoir of obese diabetics, it seems fairly reasonable to conclude that broader and more intensive study of the evolution of diabetes in the Pima Indians may produce information applicable to the general problem of obesity diabetes.”⁷³ Here was the power of the NIH's observational epidemiology studies on full display.

By this time the findings of the PECRB were attracting international attention. At the 1968 meeting of the Pan American Health Organization Advisory Committee, a special session was convened titled “Biomedical Challenges Presented by the American Indian.” At this panel, chaired by James Neel, father of the “thrifty genotype” hypothesis, PECRB scientists presented two papers on gallbladder disease and hyperglycemia. As Max Miller argued in his session, future studies would help to define further “the geography of the disease in the southwestern American Indian” and help to refine “our understanding of the etiology of diabetes mellitus.” In a nod to the uniqueness of the Pima as research subjects, he urged that studies be undertaken soon since “these emerging groups are likely to be subjected to radical and rapid change.” Updating the trope of the vanishing Indian, Miller wanted to capture and analyze the Pima before their unique physiology and

⁷¹ Stegman, “Taking Control,” 93-102; Robert Q. Marston, Director, NIH, to Charles M. Cooke, Jr., Director, Office of Special Concerns, Re: NIH Efforts to Carry Out President Nixon's July 8 Commitment to American Indians, June 17, 1971, NA-CP, RG 443, CF-NIH Director, Box 102, Folder RES 9-13:NIAMD/NIAMDD, 1948-1972. For federal Indian policy at the time, which was often driven by Arizona's own Morris and Stewart Udall, see George Pierre Castille, *To Show Heart: Native American Self-Determination and Federal Indian Policy, 1960-1975* (Tucson: University of Arizona Press, 1998).

⁷² S. M. Genuth, P. H. Bennett, M. Miller, and T. A. Burch, “Hyperinsulinism in Obese Diabetic Pima Indians,” *Metabolism* 16, no. 11 (November 1967): 1011. The researchers did not specify how they defined obesity at the time.

⁷³ Genuth, *et al.*, 1013-14.

genetics were erased by modern civilization and the conditions for this natural experiment disappeared.⁷⁴

The Arizona studies were now reshaping the entire landscape of diabetes research and treatment nationally and globally. Indeed, the timing of the Pima studies was remarkably propitious, coinciding with increased federal funding for diabetes research and public awareness. Bennett in particular emerged as a leading expert on diabetes epidemiology. Following the passage of the National Diabetes Mellitus Research and Education Act of 1974, the NIH established a National Commission on Diabetes to prepare a long-term plan to combat the disease modeled on President Richard Nixon's "War on Cancer." Bennett chaired the working group on epidemiology and pushed for better data collection and sharing, more enhanced statistical tools to analyze that data, and standardization of diagnostic criteria and treatment. When the commission submitted its report in 1975, it cited the Pima studies as the best example of a comprehensive, multifaceted community study for its long-term plan to vanquish the disease.⁷⁵ In a separate section, the Workgroup on Epidemiology reviewed the latest research at the time on the incidence and prevalence of diabetes and its complications. An entire appendix to the workgroup's report, authored by Bennett and his Phoenix colleagues, summarized the Pima Indian studies to date, concluding that their work had "considerably enhanced our knowledge of the distribution and determinants of diabetes and its complications." These findings were important for more than the Pima alone because they had "general applicability."⁷⁶

In the same appendix, however, the PECRB acknowledged the limits of their knowledge at the time. The "etiologic factors in diabetes" remained "ill-understood" and while there was "unequivocal evidence of familial aggregation" of diabetes among the Pima, the sample size was still too small and recent "to allow a meaningful genetic analysis to determine the mode of inheritance." Despite these caveats, the group believed "the importance of genetic determinants" was "likely quite strong" although they did not know the mode or the genetic mechanisms involved.⁷⁷ The following year, in 1976, the group published a version of their National Commission on Diabetes report in *Recent Progress in Hormone Research*. The authors repeated their caution over the precise role of genetics in diabetes etiology. In both documents, however, they hypothesized that Neel's "thrifty genotype" could explain how the Pima's initial evolutionary advantage of "hyperinsulinemia," which afforded them the opportunity "to lay down energy stores" in anticipation of famine in the past, was now an evolutionary disadvantage.⁷⁸ Reflecting on evidence about Southwest's distant past, with extended periods of severe drought and want, they

⁷⁴ M. Miller, P.H. Bennett, and T.A. Burch, "Hyperglycemia in Pima Indians: A Preliminary Appraisal of its Significance, in *Biomedical Challenges Presented by the American Indian*, Publication 165 (Washington, DC: Pan American Health Organization, 1968), 103.

⁷⁵ National Commission on Diabetes, Report of the National Commission on Diabetes to the Congress of the United States, vol. 1, *The Long-Range Plan to Combat Diabetes* (Bethesda, MD: U.S. Dept. of Health, Education, and Welfare, Public Health Service, and National Institutes of Health, 1975), 15.

⁷⁶ National Commission on Diabetes, Report of the National Commission on Diabetes to the Congress of the United States, vol. 3, part 1, *Reports of Committees, Subcommittees, and Workgroups: Scope and Impact of Diabetes (I)* (Bethesda, MD: U.S. Dept. of Health, Education, and Welfare, Public Health Service, and National Institutes of Health, 1975), 162. In addition to Bennett, the other investigators from the NIH-Phoenix Epidemiology and Field Studies Branch listed in the appendix were Norman B. Rushforth, Max Miller, and Philip M. LeCompte.

⁷⁷ National Commission on Diabetes, *Reports of Committees, Subcommittees, and Workgroups: Scope and Impact of Diabetes (I)*, 153.

⁷⁸ Peter H. Bennett, Norman B. Rushforth, Max Miller, and Philip M. LeCompte, "Epidemiologic Studies of Diabetes in the Pima Indians," *Recent Progress in Hormone Research*, Proceedings of the Laurentian Hormone Conference, Roy O. Greep, ed., vol. 32 (New York: Academic Press, 1976): 365-66. Hyperinsulinemia (alternatively hyperinsulinaemia) is an excess level of insulin in the blood relative to the level of blood glucose. While it is often associated with early Type 2 diabetes, it is part of a wider range of metabolic disorders and is only one possible symptom of the disease.

implied the Pima perhaps shared characteristics with other “animal models” adapted for desert environments. When these animals, which included “the Egyptian sand rat, Chinese hamster, [and] tuco-tuco” were fed “a constant laboratory diet” they became “obese and hyperinsulinemic, and develop hyperglycemia.” Whether these animal studies might reveal similar mechanisms at work in the Pima was “not yet known.”⁷⁹

The comparison of the Pima and desert mammals highlighted an important point about diabetes epidemiological research in the 1970s: the relationship between environment and genetics as understood at the time was murky at best yet constantly asserted. And many researchers remained unconvinced that genetics trumped environment entirely. Kelly West, later hailed as another father of modern diabetes epidemiology alongside Peter Bennett, was one of these skeptics. In 1974 West compiled the first systematic review of all published papers on prevalence of diabetes among Indigenous groups throughout the Americas. He found high proportions of diabetic Indians across almost all communities.⁸⁰ The following year, in an article for *Diabetes*, he noted that despite the widespread acceptance of the glucose tolerance test as the leading diagnostic tool for detecting diabetes, definitions of a diabetic state still varied widely.⁸¹ Without common nomenclature and measurements, making comparisons to determine common genetic origins was difficult at best. As a biostatistician who also did clinical research, West was particularly skeptical of simple genetic explanations. Some of his doubt stemmed from his efforts to study adiposity, obesity, and diabetes among the diverse Indian communities of Oklahoma. As third-generation Oklahoman, West likely knew that many of the state’s tribes had been forcibly relocated there thanks to federal policies in the 1830s, when Oklahoma was known as Indian Territory. As a clinician who saw a wide range of diabetes patients in his private practice and work at the University of Oklahoma Medical Center, he also knew that many Indians were neither fat nor diabetic.

Yet West was convinced that there was a relationship between obesity and diabetes, and that something environmental, perhaps in combination with genetics, had triggered the rise in both the Native and general population. He, too, was also not immune to occasional generalizations and stereotyping. In a 1974 correspondence with a Stanford University colleague, West began by noting he was “in the field now working with some very fat Indians.” From there, however, the letter charted new territory. He explained that “obesity was rare before the nineteenth century,” and he wanted to launch a “more systematic study of attitudes and notions of our Indians with respect to food, diet, weight, body configuration, etc.” to explain this change: a cross-cultural comparison adjusting for age, sex, and location.⁸² In contrast to the NIH studies, West wanted to broaden his analytical aperture to consider social, historical, and cultural questions alongside basic biology and physiology. By the mid-1970s, he had partnered with a multinational project sponsored by the World Health Organization to study vascular disease in diabetes while trying to secure funding for a

⁷⁹ Bennett, *et al.*, “Epidemiologic Studies of Diabetes in the Pima Indians,” 365-66. Indeed, until the advent of restriction fragment length polymorphism testing in the 1980s and polymerase chain reaction testing in the 1990s, genetic explanations tended to collapse into expected comparisons between putative racial groups.

⁸⁰ Kelly M. West, “Diabetes in American Indians and Other Native Populations of the New World,” *Diabetes* 23 (1974): 841-55. Notable exceptions at the time were Alaskan Eskimos (Inuit) and Athabaskan Indians.

⁸¹ West, “Substantial Differences in the Diagnostic Criteria used by Diabetes Experts,” *Diabetes* 24, no. 7 (July 1975): 641-44.

⁸² West to Albert J. Stunkard, Stanford University Medical Center, July 3, 1974, Box 65, Correspondence, Kelly M. West, M.D. Collection (hereafter abbreviated KMW Collection), Robert M. Bird Library, University of Oklahoma Health Sciences Center (hereafter abbreviated Bird Library-OUHSC).

comparative multi-site study among Plains Indian communities in Oklahoma, possibly with contrasts to other groups across the globe.⁸³

West never got the opportunity to launch his project. In 1980 he died from a cerebral aneurysm while on a research trip to the People's Republic of China. Two years earlier, however, he published what remains one of the most comprehensive surveys of its kind: *Epidemiology of Diabetes and its Vascular Lesions*, with over 2,500 references from recent studies and historical literature. It received numerous glowing reviews in top journals and remains a foundational work in the field.⁸⁴

In the introduction, West predicted how “present incidence rates [in many societies] suggest that a majority [of the population] may expect to become diabetic!”⁸⁵ West was of course referring to Type 2 diabetes, and he had no doubt as to the primary cause—obesity—and what had triggered it—environmental change, possibly in conjunction with genetics. Obesity was more than simply “a ‘precipitating’ factor in those persons genetically disposed to diabetes,” however, because fatness alone was “quite capable” of producing the disease and often did, echoing what Elliott Joslin had written in his 1921 *JAMA* article. Epidemiologic and laboratory investigations confirmed beta-cell function often returned when diabetics controlled obesity through weight loss. Just as environmental factors were responsible for obesity and diabetes, West argued that other epidemiologic studies suggested the same linkages behind the disease’s vascular lesions or complications. By changing the environment, one could “mitigate the vast toll exacted by these lesions” and perhaps reduce or eliminate diabetes altogether.⁸⁶ Since obesity was “the most important environmental risk factor,” perhaps equaling or exceeding “the strong influence of diabetes-related genetic factors,” the growing epidemic could be thwarted and even reversed if obesity could be managed.⁸⁷

West’s skepticism of strictly genetic explanations came before technological advances allowed researchers to examine the role that individual genes and their sequencing might play. Even with the advent of these powerful new tools, however, many researchers began to return to environmental factors, in conjunction with genetics, to study the rising prevalence and incidence of diabetes among Native communities and across all American populations. More than any other research cluster, the Pima studies had helped to set the initial terms. The work by the PECRB and

⁸³ For background on his work with the WHO study, see West to Maggie Moore, American Medical Association, Division of Foods and Nutrition, October 4, 1974, Box 12, Folder 6-1; for proposed multi-site comparative studies, see West to KMW to Gilles E. Sarault, International Sugar Research Foundation, Inc., August 20, 1973, Box 15, Folder 10; and West to C.F. Gastineau, Endocrinology and Internal Medicine, Mayo Clinic, July 16, 1974 and Gastineau to West, June 24, 1974, Box 65, Correspondence, KMW Collection, Bird Library-OUHSC. For West’s involvement with the WHO study and his influence on the subsequent follow-up, see oral history interview with Elisa T. Lee, Ph.D., by Matthew Klinge, December 5, 2012; and Elisa T. Lee, Harry Keen, Peter H. Bennett, J.H. Fuller, and M. Lu, “Follow-up of the WHO Multinational Study of Vascular Disease in Diabetes: General Description and Morbidity,” *Diabetologia* 44, supp. 2 (September 2001): S3-13.

⁸⁴ Advertisement brochure for *Epidemiology of Diabetes and its Vascular Lesions* (c. 1978), KMW Collection, Bird Library-OUHSC, Box 62, Letters. For reviews see *New England Journal of Medicine* 305, no. 5 (August 2, 1979): 279; *The Lancet* 312, no. 8096 (October 28, 1978): 923; *British Medical Journal* 1, no. 6162 (February 24, 1979): 539. West’s colleagues and friends posthumously established an award in his honor through the American Diabetes Association to recognize “significant contributions to the field of diabetes epidemiology.” In 1986, Peter Bennett was the inaugural recipient of the ADA’s Kelly M. West Award for Outstanding Achievement in Epidemiology. See <http://www.diabetes.org/about-us/national-achievement-awards/national-scientific-health-care-achievement-awards/kelly-m-west-award.html> [accessed September 29, 2012].

⁸⁵ Kelly M. West, *Epidemiology of Diabetes and its Vascular Lesions* (New York: Elsevier North-Holland, 1978), x.

⁸⁶ West, *Epidemiology of Diabetes*, x; Elliott P. Joslin, “The Prevention of Diabetes Mellitus,” *Journal of the American Medical Association* 76, no. 2 (January 8, 1921): 79-84. Current research suggests that there is an environmental and heritable link to obesity and the distribution of visceral fat on the torso and belly, which is correlated to higher risk for cardiovascular disease, hypertension, and Type 2 diabetes. For example, see K. Samaras, P.J. Kelly, M.N. Chiano, T.D. Spector, L.V. Campbell, “Genetic and Environmental Influences on Total-body and Central Abdominal Fat: The Effect of Physical Activity in Female Twins,” *Annals of Internal Medicine* 130, no. 11 (June 1, 1999): 873-82.

⁸⁷ West, *Epidemiology of Diabetes*, 273.

its collaborators was influential in the 1979 international reclassification and diagnosis of diabetes that yielded our present-day nomenclature of Type 1 and Type 2. It helped generate new research on the etiology of obesity and its links to obesity metabolism. And it underscored the consequences of promoting diet and exercise as therapies for controlling diabetes, especially Type 2, as well as the importance of early detection.⁸⁸

In the subsequent decades, further studies coming out of the PECRB, often in conjunction with collaborators at the across the continent, further emphasized the connection between environment and genetics to explore diabetes etiology, morbidity, and mortality. Specific studies evaluated how higher energy expenditure, thanks to insulin resistance, predicted earlier death from diabetic complications; explored differences in leptin concentrations (a hormone critical to energy intake and expenditure) between Pima Indians in Arizona and Sonora, Mexico; or traced the overall rise in birth weight among all Pima since World War II.⁸⁹ Other studies examined the connections between birth weight, diabetes during pregnancy, and later insulin resistance and diabetes in young Pima. Indeed, Bennett and his colleagues were among the first to investigate the epidemiology behind the now-infamous rise childhood obesity and the increase of Type 2 diabetes among children and adolescents.⁹⁰

In a 1999 article for *Nutrition Reviews*, Bennett gave his most expansive and holistic assessment of the environment-gene connection. He argued that “environmental risk factors must be responsible” for the marked increase incidence and prevalence of diabetes among the Pima in the previous 30 years “because the genetic constitution of the population cannot change over such a short period of time.” Diabetes was instead “a clear example of genetic-environmental interaction,” but genetics need not be destiny if the Pima could reduce their weight and increase their physical activity to “levels that prevailed at the beginning of the century.” Bennett was not sure to “what degree this would be acceptable” so “alternative strategies...to control the epidemic of type 2 diabetes” were under investigation as well.⁹¹ In summarizing the challenges of prevention for the Pima, Bennett could have been speaking for all Americans as well.

While research continued into the causes and extent of the diabetes epidemic, the NIH celebrated the Pima’s contributions to biomedical science by invoking an historical analogy. In a 1996 publication *The Pima Indians: Pathfinders for Health*, the authors compared the Pima’s willingness to participate in the PECRB studies to their ancestors’ roles as U.S. Army Calvary scouts during the Mexican-American War, or as guides for emigrants during the California gold rush. Written for a popular audience, the publication highlighted how researchers continued to look for genetic answers by testing the “thrifty gene” theory even as they tried to account for environmental factors such as diet and nutrition. Read another way, *Pathfinders for Health* blurred

⁸⁸ For example, see Peter H. Bennett and William C. Knowler, “Early Detection and Intervention in Diabetes Mellitus: Is it Effective?,” *Journal of Chronic Diseases* 37, no. 8 (1984): 653-66.

⁸⁹ Reiner Jumpertz, Robert L. Hanson, Maurice L. Sievers, Peter H. Bennett, Robert G. Nelson, and Jonathan Krakoff, “Higher Energy Expenditure in Humans Predicts Natural Mortality,” *Journal of Clinical Endocrinology and Metabolism*, 96 no. 6 (June 2011): E972-76; Caroline Fox, Julian Esparaza, Margery Nicolson, Peter H. Bennett, Leslie O. Schulz, Mauro E. Valencia, and Eric Ravussin, “Plasma Leptin Concentrations in Pima Indians Living in Drastically Different Environments,” *Diabetes Care* 22, no. 3 (March 1999): 413-17; and R. Arlen Price, Marie Aline Charles, David J. Pettitt, and William C. Knowler, “Obesity in Pima Indians: Large Increases Among Post-World War II Birth Cohorts,” *American Journal of Physical Anthropology* 92 (1993): 473-49.

⁹⁰ For representative studies, see D. Dabelea, R. L. Hanson, P. H. Bennett, J. Roumain, W. C. Knowler, D. J. Pettitt, “Increasing Prevalence of Type II Diabetes in American Indian Children,” *Diabetologia* 41 (1998): 904-10; Dana Dabelea, David J. Pettitt, Robert L. Hanson, Giuseppina Imperatore, Peter H. Bennett, and William C. Knowler, “Birth Weight, Type 2 Diabetes, and Insulin Resistance in Pima Indian Children and Young Adults,” *Diabetes Care* 22, no. 6 (June 1999): 944-50; and Paul W. Franks, Robert L. Hanson, William C. Knowler, Maurice L. Sievers, Peter H. Bennett, and Helen C. Looker, “Childhood Obesity, Other Cardiovascular Risk Factors, and Premature Death,” *New England Journal of Medicine* 362, no 6 (February 11, 2010): 485-93.

⁹¹ Bennett, “Type 2 Diabetes Among the Pima Indians of Arizona: An Epidemic Attributable to Environmental Change?,” *Nutrition Reviews* 57, no. 5 (May 1999): S53.

the boundaries between biomedicine, human history, and environmental history in startling ways. The Pima were neatly folded into one of America's foundational national myths: the frontier story. They were depicted as pioneers on the advancing edge of two frontiers: the expanding nineteenth-century American empire that had tried to assimilate Native peoples like the Pima, and the brave new world of cutting edge scientific research. The irony was that but for the first frontier, the Pima could not have been pathfinders for explorations into the second.⁹²

Two years later, with the publication of Malcolm Gladwell's 1998 article in *The New Yorker*, the link in popular culture between obesity, genetics, and environment became even stronger.⁹³ His article also underscored what the PECRB's research goals had been since it was launched in 1965: to generate research on a specific population that could be generalized to other populations. Bennett candidly claimed as much in a 2005 interview, saying "there's no way the NIH would have invested all this money in this study if it hadn't been generalizable [and not] for the Pimas alone."⁹⁴ Likewise, William Knowler, another PECRB scientist, said in a 1999 interview with the *Arizona Republic* "a lot of the way diabetes is treated throughout the country and the world is based on things that we learned with the Pima Indians."⁹⁵

While some Pima may concur with such sentiments, there are misgivings in the community as well. In her 2006 study of diabetes among the Pima, anthropologist Carolyn Smith-Morris argued that while the community has "shared both the benefits and the labels associated with almost four decades of this research," it also struggles with the reputation of being "arguably the most studied ethnic group in the world." Pimas often resist the preaching and moralizing of "the biomedical community and society at large" because they feel near constant pressure "both individually and communally" to change their behaviors even as they contribute to ongoing research and clinical trials. In the clinic and throughout the community, the enormous "pressures of biomedicine" have often taken on "on a moral character" that collides with longstanding cultural beliefs about health, death, and individual autonomy.⁹⁶ Thus while "the world owes a huge debt of thanks to the Pimas for the knowledge of diabetes they made possible," the Pima would prefer to be known for "their resilience, their adaptability, and the strength of cultural and family ties unities them against this common predator."⁹⁷

Type 2-diabetes is preventable in a strictly clinical sense, yet a half-century of research into the etiology and pathogenesis of the disease among the Pima has not substantially checked its rise at Gila River—or across the nation. The implications of the Pima studies are important as scientific evidence continues to suggest that the interaction between genetics and environmental change is behind the present-day diabetes epidemic among all populations and within communities of color in particular even as scientists cannot yet define the exact genetic mechanisms.⁹⁸ What was once a

⁹² *The Pima Indians: Pathfinders for Health*, National Institute of Diabetes and Digestive and Kidney Diseases, Department of Health and Human Services, Public Health Service, National Institutes of Health Publication 95-3821 (1996), see also <http://diabetes.niddk.nih.gov/dm/pubs/pima/index.htm> [accessed September 2, 2012]. For the frontier myth, see Richard White and Patricia Nelson Limerick, *The Frontier in American History*, James Grossman, ed. (Berkeley: University of California Press, 1994).

⁹³ Gladwell, "The Pima Paradox."

⁹⁴ Oral history interview with Peter H. Bennett, by Rachel Winer, December 20, 2005, quoted in Rachel Winter, "Diabetes, the National Institutes of Health, and the Arizona Pima Indians: A Study of Ethics and Experimentation in American Medicine, 1965 to the Present," (Honors thesis, Yale University, Department of History, 2006), 34.

⁹⁵ Graciela Sevilla, "Diabetes Ravaging Tribe Despite Decades of Study: Miscalculations Delayed War for Control of Illness," *Arizona Republic* (Phoenix, AZ), October 31, 1999, A1.

⁹⁶ Carolyn Smith-Morris, *Diabetes Among the Pima: Stories of Survival* (Tucson: University of Arizona Press, 2006), 144-45, 147.

⁹⁷ Smith-Morris, 161.

⁹⁸ For example, see Jeanette S. Carter, Jacqueline A. Pugh, and Ana Monterrosa, "Non-Insulin-Dependent Diabetes Mellitus in Minorities in the United States," *Annals of Internal Medicine* 125, no. 3 (August 1, 1998): 221-32; Robert Sladek, Ghislain Rocheleau, Johan Rung, Christian Dina, Lishuang Shen, David Serre, Philippe Boutin, Daniel Vincent, Alexandre Belisle, Samy Hadjadj, Beverley Balkau, Barbara Heude, Guillaume Charpentier, Thomas J. Hudson, Alexandre Montpetit, Alexey V. Pshezhetsky,

disease largely associated with affluence and over-eating, stereotyped as an affliction of Jews and the wealthy, has morphed into an affliction of minorities and the poor. We know how to prevent diabetes; what remains unanswered is how and why it has become a collective scourge.

Community-based clinical studies such as the NIH-Phoenix project bare the importance of answering such questions historically. As Stephanie Stegman argues, the resulting knowledge “established a complex web of causation that entangled race, culture, environment, and genetics under a single umbrella of ‘risk,’ even as rates of diabetes continued to escalate.”⁹⁹ The research benefits have been inestimable, but they come with other risks. Characterizing Type 2 diabetes as a particularly unique problem for Native communities has become something of a caricature. As medical anthropologist Michael Montoya contends, data collected and compiled by medical researchers on Mexican Americans and diabetes can become part of a process he calls “bioethnic conscription.” Mexican bodies, he claims, are marshaled for the advancement of state-sponsored research and corporate science to promote therapies and behavioral interventions. Other scholars suggest that the way racial and ethnic categories drive clinical diagnosis and treatment inadvertently perpetuates biological determinism while diverting attention from structural inequities such as access to quality health care or healthy food.¹⁰⁰ Thus an environmental frame for diabetes and other chronic diseases is reemerging, albeit in a new form.

I want to briefly reflect on some of these changes, and to broach some questions emerging from my research. Previously, the environmental factors associated with diabetes were nutrition, diet, and physical activity, and how each separately or in combination influenced metabolism. These were interpreted on the scale of the individual, and management was largely a question of regulating personal behavior. It was a question of adjusting human nature to adapt to an altered physical nature. Beginning in the 1990s, however, some researchers asked whether environmental changes on broader scales were increasing the prevalence and incidence of obesity and Type 2 diabetes. The advent of social epidemiology and environmental justice led some to question whether landscape changes were to blame.

One popular argument placed the blame at the feet of agribusiness and the federal government for flooding the marketplace with subsidized simple carbohydrates, particularly high fructose corn syrup. Michael Pollan’s *The Omnivore’s Dilemma* blamed the transformation of the Midwest from breadbasket into food additive basket.¹⁰¹ Other arguments connected landscape change to disease in less straightforward but equally damning ways. In the case of the Pima, this

Marc Prentki, Barry I. Posner, David J. Balding, David Meyre, Constantin Polychronakos and Philippe Froguel, “A Genome-wide Association study Identifies Novel Risk Loci for Type 2 Diabetes,” *Nature* 445, no. 7130 (February 22, 2007): 881-85; Johan Eriksson, Anja Franssila-Kallunki, Agneta Ekstrand, Carola Saloranta, Elisabeth Widén, Camilla Schalin, and Leif Groop, “Early Metabolic Defects in Persons at Increased Risk for Non-Insulin-Dependent Diabetes Mellitus,” *New England Journal of Medicine* 321, no. 6 (August 10, 1989): 337-43; Jose C. Florez, “The Genetics of Type 2 Diabetes: A Realistic Appraisal in 2008,” *Journal of Clinical Endocrinology and Metabolism* 93, no. 12 (December 1, 2008): 4633-42; and Eleanor Wheeler and Inês Barroso, “Genome-wide Association Studies and Type 2 Diabetes,” *Briefings in Functional Genomics* 10, no. 2 (March 2011): 52-60.

⁹⁹ Stegman, 208.

¹⁰⁰ Michael J. Montoya, “Bioethnic Conscription: Genes, Race, and Mexican/o Ethnicity in Diabetes Research,” *Cultural Anthropology* 22, no. 1 (2007): 94-127; see also Montoya, *Making the Mexican Diabetic: Race, Science, and the Genetics of Inequality* (Berkeley: University of California Press, 2011). For the challenges of race in medical practice, see Lundy Braun, Anne Fausto-Sterling, Duana Fullilove, Evelyn M. Hammonds, Alondra Nelson, William Quivers, Susan M. Reverby, and Alexandra E. Shields, “Racial Categories in Medical Practice: How Useful Are They?,” and Maggie Brown and the PLoS Medicine Editors, “Defining Human Differences in Biomedicine,” *PLoS Medicine* 4, no. 9 (September 25, 2007): e271-e288. doi:10.1371/journal.pmed.0040271 and doi:10.1371/journal.pmed.0040288.

¹⁰¹ Michael Pollan, *The Omnivore’s Dilemma: A Natural History of Four Meals* (New York: Penguin, 2006), especially Chapter 6: “The Consumer: A Republic of Fat,” 100-08. For a variation on this theme that lays the blame as well at the over-specialization within modern medical science and the consequent effects upon research and its application for nutrition and disease prevention, see Taubes, *Good Calories, Bad Calories*.

theory found its widest audience in the documentary *Unnatural Causes: Is Inequality Making Us Sick?*, which aired nationally on PBS in spring 2008. In Episode 4, titled “Bad Sugar,” the producers claimed that diverting water to benefit white farmers tore apart the traditional agrarian economies of the Pima and Tohono O’odham, making them dependent upon government commodities to avoid starvation.¹⁰²

In the case of the Pima, this has merit. Prior to the reservation era, the Pima were renowned for their agricultural prowess. They cultivated and sold melons and corn to the earliest Spanish and Mexican colonists, later adding wheat to their rotation, which they traded along with other goods to American emigrants bound for California in pursuit of gold. Beginning in the late nineteenth-century, however, after the establishment of their original reserve in 1859, the Pima were in a near-constant struggle with upstream farmers who tried to capture the Gila for agricultural and industrial development. By the 1890s, the Pimas were losing the battle as the Gila River, diverted and dammed upstream, was reduced to a mere trickle during the dry summer months. In the summer of 1900, the plight of the Pima, who were facing famine, captured the attention of the nation. Behind the media frenzy were irrigation boosters who stoked concern for the Pima to promote federal legislation for developing arid states like Arizona. The Pima’s tragedy became the vehicle for their political success.¹⁰³

After the passage of the 1902 National Reclamation Act, the Pima continued resisting with only partial success. Even after the U.S. Supreme Court ruled in 1908 that Indian claims to water supplied were reserved rights in what became known as the “Winters Doctrine,” the Pima did not benefit because their upper river adversaries had followed local prior appropriation laws that privileged first claimants as having the highest use. Additional water projects, culminating with the Florence-Casa Grande Project in 1922, effectively deprived the Pima of their primary water source, sending the community into a state another state of near starvation averted only by charitable donations and BIA welfare. The San Carlos Project and Coolidge Dam, completed in 1930, did alleviate the Pima’s water shortage, but only partially. The larger damage had already been done. As historian David DeJong argues, if the Pima had had not been deprived of their rights and access to the Gila River, they might have successfully adapted their centuries-old agricultural subsistence farming for a modern market economy.¹⁰⁴ Implied in his statement is a more damning indictment: if the Pima had not lost access to their historic water source, they might not have slid into dependency, obesity, and diabetes.

Since the broadcast of *Unnatural Causes*, the Pima example has been applied to other Native communities. A May 2011 special issue of *High Country News*, titled “Ripple Effects,” had two articles that noted the parallels. One explored how the Fort Peck Dam in North Dakota flooded farmland and transformed diets for the worse on the Fort Berthold Reservation, home to the Mandan, Hidatsa, and Arikara Nation. The other traced how water diversion projects in Oregon’s Klamath Basin ended salmon runs that had once sustained several Indian tribes and whites alike.

¹⁰² “Bad Sugar,” from *Unnatural Causes: Is Inequality Making Us Sick?* Produced by California Newsreel in association with Vital Pictures (San Francisco: California Newsreel, 2008).

¹⁰³ David H. DeJong, *Stealing the Gila: The Pima Agricultural Economy and Water Deprivation, 1848-1921* (Tucson: University of Arizona Press, 2009), 1-109.

¹⁰⁴ DeJong, *Stealing the Gila*, 181. For the Winters doctrine, see *Winters v. United States* 207 U.S. 564 (1908); see also John Shurts, *Indian Reserved Water Rights: The Winters Doctrine in its Social and Legal Context* (Norman: University of Oklahoma Press, 2000). For Pima perspectives on the capture of the Gila River by upstream users and the subsequent effects on their community, see DeJong, *Forced to Abandon our Fields: The 1924 Clay Southworth Gila River Pima Interviews* (Salt Lake City: University of Utah Press, 2011).

The result in both cases, the authors argued, was a spike in chronic diseases, notably diabetes.¹⁰⁵ According to the authors, ultimate cause of the diabetes outbreak in these communities was not just genetics but a conversion in diets and nutrition due to landscape transformation. In this framing of chronic disease, large scale alterations to landscapes that generate ill health are form of what Rob Nixon calls “slow violence,” a kind of “delayed destruction that is dispersed across time and space.”¹⁰⁶

Others speculate that changes to our bodies as well as our landscapes are responsible for widespread obesity and one of its outcomes, the diabetes epidemic. Again in the early 1990s, endocrinologists and public health scientists began to publish studies linking exposure to chemicals broadly called endocrine disruptors that mimicked the functions of human hormones to a host of health problems that included diabetes, a disease connected to the action of a particular hormone: insulin. These toxicants include pesticides, herbicides, pharmaceuticals, and plasticizers such as bisphenol-A or BPA. One researcher, Bruce Blumberg, a developmental biologist at the University of California at Irvine, coined the term “obesogen” in 2006 to describe chemicals that promote fat storage in animals with consequent health effects, including diabetes.¹⁰⁷ In the two decades since, numerous studies have suggested causal links between endocrine disruptors and human health. Drawing from the still-emergent field of epigenetics, these researchers worry that low dose exposure to such chemicals may not transform DNA but rather affect which genes are switched on or off in present and immediate future generations with devastating health effects. While this research remains disputed, the leading professional association of hormone experts, The Endocrine Society, has publicly criticized the U.S. Food and Drug Administration for failing to ban BPA in food or study the effects of other potential endocrine disruptors.¹⁰⁸ Such concerns have now seeped into public discourse. Over the past year and a half, *New York Times* columnist Nicholas Kristof has complained repeatedly how “serious scientists” studying endocrine disruptors “don’t often have the ear of politicians or journalists.”¹⁰⁹

Fifty years ago, the same could have been said of a group of obscure researchers working on a misunderstood disease in a remote corner of the country with a stereotyped population of marginalized Americans. Now, the Pima studies are a cornerstone of scientific understandings about diabetes and its complications. But I also realize that there are particular challenges in exploring the origins and consequences of this larger story about diabetes in American history. One is methodological. Unlike other recent syntheses of environmental and medical history, connecting the reciprocal relationship between environmental change, social change, and health is far more complicated with chronic or complex diseases than with infectious disease.¹¹⁰ Confounding factors abound, evidence is contradictory, and contemporary science remains in flux. Questions of cause,

¹⁰⁵ Lisa Jones, “Three Tribes, a Dam, and a Diabetes Epidemic,” and Diana Hartel, “Doctor’s Orders: Undam the Klamath,” *High Country News*, May 16, 2011; see also Jodi Peterson, “Editor’s Note: Diabetes Isn’t Destiny,” same issue. The Klamath Basin tribes include the Yurok, Hoopa Valley, and Karuk Tribes, and the Quartz Valley Indian Community.

¹⁰⁶ Rob Nixon, *Slow Violence and the Environmentalism of the Poor* (Cambridge, MA: Harvard University Press, 2011), 2.

¹⁰⁷ Felix Grün and Bruce Blumberg, “Environmental Obesogens: Organotins and Endocrine Disruption via Nuclear Receptor Signaling,” *Endocrinology* 147, no. 6 suppl. (June 2006): S50-S55. Grün and Blumberg’s article was part of an entire *Endocrinology* supplement: “The Endocrinology of Endocrine Disrupting Chemicals,”

¹⁰⁸ R. Thomas Zoeller, T.R. Brown, L.L. Doan, A.C. Gore, N.E. Skakkebaek, A.M. Soto, T.J. Woodruff and F.S. Vom Saal, “Endocrine-Disrupting Chemicals and Public Health Protection: A Statement of Principles from The Endocrine Society,” *Endocrinology* 153, no. 9 (September 2012): 4097-4110.

¹⁰⁹ Nicholas D. Kristof, “Big Chem, Big Harm,” *New York Times*, National Edition, August 25, 2012, SR11; see also “How Chemicals Change Us,” *New York Times*, National Edition, May 3, 2012, A31 and “Warnings from a Flabby Mouse,” *New York Times*, National Edition, January 19, 2013, SR11.

¹¹⁰ Take, for example, two important works on malaria: James L.A. Webb, Jr., *Humanity’s Burden: A Global History of Malaria* (New York: Cambridge University Press, 2008) and J.R. McNeill, *Mosquito Empires: Ecology and War in the Greater Caribbean, 1620-1914* (New York: Cambridge University Press, 2010).

effect, and correlation are often second order relationships. Another is ethical. Because chronic diseases as historical subjects, at least as framed here, are recent phenomena, research often requires greater sensitivity to the ethical challenges of working with living human beings who are historically (and justifiably) skeptical of academic research.¹¹¹

To conclude, the Pima studies have yielded untold benefits for all Americans—Natives and non-Natives alike. Yet the emphasis on basic biomedical research conducted in Native communities has sometimes obscured the ways in which those same communities have tried to change their environments, alter behaviors, and reorient medical research to address diabetes on their own terms.¹¹² A November 2012 special section of *Indian Country Today*, the largest weekly periodical devoted to Native American news in North America, highlighted the ways tribal communities across the United States, including the Akimel O’odham, are addressing the diabetes crisis, often successfully, despite limited funds and structural barriers. As Sharon Stanphill, director of the health center for the Cow Creek Band of the Umpqua Tribe of Indians, stated in one article: “Indian Country knows diabetes. We know what to do.”¹¹³ Stanphill’s comment leaves me with two other questions: how did Indian Country come to know diabetes, and how is that knowledge the product of other kinds of histories that grow out of traditional knowledge responding to persistent patterns of underdevelopment, environmental change, and biomedical research?

Rethinking diabetes as environmental history might help us to reframe the stories we tell about this dread malady. Telling new histories may also, in turn, reshape how we might address diabetes, past and present, as a disease of longstanding inequities—embodied in place and over time and in our bodies.¹¹⁴

¹¹¹ For an overview of these challenges specific to Native communities, see Linda Tuhiwai Smith, *Decolonizing Mythologies: Research and Indigenous Peoples* 2nd ed. (London: Zed Books, 2012); and Devon Abbott Mihesuah, *So You Want to Write about American Indians: A Guide for Writers, Students, and Scholars* (Lincoln: University of Nebraska Press, 2005).

¹¹² For two overviews of these efforts, see Diane Weiner, “Ethnogenetics: Interpreting Ideas about Diabetes and Inheritance” and Brooke Olson, “Applying Medical Anthropology: Developing Diabetes Education and Prevention Programs in American Indian Cultures,” *American Indian Culture and Research Journal*, 23, no. 3 (1999): 155-203. See also Carolyn-Smith Morris, “Community Participation in Tribal Diabetes Programs,” *American Indian Culture and Research Journal*, 30, no. 2 (2007): 85-110.

¹¹³ Bill Graves, “No Sugar Coating Allowed,” *Indian Country Today* (November 28, 2012): 33. The story originally ran as “Portland-area Natives Take on a Diabetes Epidemic,” *The Oregonian* (Portland, OR), May 26, 2012.

¹¹⁴ The importance of narrating disease as part of the history and practice of medicine has a rich literature. One of the primary works among many for humanities scholars remains Elaine Scarry, *The Body in Pain: The Making and Unmaking of the World* (New York: Oxford University Press, 1985). The links between development (or underdevelopment) and health are increasingly drawing attention from governmental and non-governmental agencies alike. The recent publication of the Global Burden of Disease Study underscores this trend. For an assessment of the study, funded by the Bill and Melinda Gates Foundation, see Richard Horton, “GBD 2010: Understanding Disease, Injury, and Risk” and Margaret Chan, “From New Estimates to Better Data,” *The Lancet* 380 (December 13, 2012): 2053-54 and <http://www.thelancet.com/themed/global-burden-of-disease> [accessed February 2, 2013]. For works that suggest how to integrate the history of medicine with Native history and environmental history, see Liza Piper, “Chronic Disease in the Yukon River Basin, 1890-1960,” in *Locating Health: Historical and Anthropological Investigations of Health and Place*, Erika Dyck and Christopher Fletcher, eds. (London: Pickering and Chatto, 2011): 129-49, and Liza Piper, “Nutritional Science, Health, and Changing Northern Environments,” in *Big Country, Big Issues: Canada’s Environment, Culture, and History*, Nadine Klopfer and Christof Mauch, eds. (Munich: Rachel Carson Center Perspectives Series, 2011/4): 60-85.