

## Bioethnography

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Critical social scientists and scholars in medical anthropology, sociology, geography, science technology studies, and feminist theory had hoped that, by moving past genetic reductionism, DOHaD and allied postgenomic frameworks might become a bridge between life and social sciences [1–5]. DOHaD research, however, especially within biomedical paradigms, has often retained a reductive focus on the behaviour of individuals, especially mothers, instead of on the larger political-economic processes and environments that contribute to poor health and exacerbate inequality [6–10]. Additionally, DOHaD researchers, who tend to reside in high-resource environments, often universalise their own experience as they develop research questions and test hypotheses, rather than identifying the most relevant research questions for people living within circumstances quite different from their own.

DOHaD researchers can counteract this reductionism and universalism by incorporating more open-ended, iterative, observational methods into their investigations. Our multidisciplinary team engaged in an environmental health birth cohort study in Mexico City has been developing one such tool, ‘bioethnography’, which provides DOHaD with an even more powerful and sensitive framework for understanding the relationship of the environment to health outcomes and disease burdens. Our bioethnographic approach combines methods and data from both ethnography and the life sciences to arrive at a better understanding of the larger histories and life circumstances that shape health, disease, and inequality. Unlike most mixed or biocultural methods, where ethnographers are often asked to consult on data after its collection, bioethnography

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makes open-ended ethnography a first step, which provides the capacity to generate better hypotheses and better data about the developmental origins of disease.

Ethnographers usually reside long term with or near the people they are learning from, so that they can observe the dynamic environments that shape research participants' lives. Additionally, ethnography tends to entail a wider aperture than focus groups or interviews, because the ethnographer does not predetermine a list of 'standardised' questions in advance. In its beginning stages, ethnography fosters what can seem like an excessive initial vagueness to scientists who are accustomed to deductively posing hypotheses in advance. By approaching a study population in a non-hypothesis-driven fashion, ethnography allows for deeper insights into how, where, when, and why people do what they do. Open-ended observations about a group can provide the basis for collecting more relevant and accurate environmental, quantitative, and biomarker data. While ethnographic findings are produced from a small sample size, they can guide the development of context-specific epidemiological hypotheses and appropriate data collection procedures to test them. In other words, ethnography can be used to generate empirically grounded theories and hypotheses about environmental causal mechanisms, which can then be tested in larger, population-representative samples [11].

A short example of how we have used bioethnography to understand sleep illustrates the process. In 2016, birth cohort researchers began designing a new adolescent sleep survey that asked cohort participants, now teenagers, about length of sleep, perceived sleep quality, technology use before bedtime, and sleep difficulties, which would be combined with accelerometer data. At the initial survey design meetings, the ethnographer, who had lived near and worked with cohort families, noticed that the life science researchers assumed that participants had their own bedrooms, or at most shared them with one other person. Even though the ethnographer had never explicitly studied sleeping arrangements among project participants, she knew that in most participant homes, bedrooms accommodate up to eight people at once. This insight allowed the researchers to include survey questions about bedroom sharing. When the team analysed the data, they found that adolescents who shared a bedroom had lower levels of mental/emotional sleep disturbances than adolescents who did not share a bedroom, which complicates the assumptions embedded in research conducted among middle-class populations that bedroom sharing negatively impacts sleep quality [12, 13]. This collaborative experience prompted the team to design a new bioethnographic sleep study that seeks to characterise the complex social, chemical, and economic ecology of sleep within households in Mexico City.

## 15.1 Bioethnography's Background

Since 1994, researchers involved in the longitudinal birth cohort study, Early Life Exposures in Mexico to ENvironmental Toxicants (ELEMENT), have carried out chemical or molecular analysis of blood, urine, breast milk, hair, toenails, bone, and teeth, as well as administered questionnaires and psychometric testing on over 1,000 mother-child pairs, mostly living in working-class neighbourhoods in Mexico City [14]. These women and children return for periodic follow-up visits. Initially, ELEMENT researchers focused on the effects of early-life lead exposure on neurological development in childhood (Tellez-Rojo et al., 2002). Over time, ELEMENT expanded to include additional metals, and other chemical exposures, that might affect conditions like diabetes,

obesity, menopause, and sleep. Many ELEMENT researchers deploy a DOHaD framework, investigating whether chemical, dietary, or social 'exposures' during pregnancy, infancy, and puberty impact health outcomes [15]. In 2014, a medical anthropologist (Roberts, first author) began collaborating with ELEMENT to carry out long-term ethnographic observations with ELEMENT participants. Roberts aimed to combine her ethnographic findings about the lives of working-class participants with ELEMENT biomarker data. The goal of this 'bioethnographic' process was to ask questions more specific to the study population and to produce better knowledge about dynamic and situated bodily processes in a highly unequal world.

In 2014–2015, Roberts carried out long-term ethnographic work with a subset of six ELEMENT participant families, gathering extensive qualitative data on their everyday lives. This research involved living in participant neighbourhoods and spending three to six hours at a time with specific families, returning multiple days each week over the course of a year, and then follow-up visits ever since. During these visits, Roberts participated in and documented the families' daily routines, including neighbourhood activities, such as festivals and political events, through field notes, photographs, and recordings, which were later thematically coded [16]. After this initial intensive field work year, Roberts began working with ELEMENT researchers to combine ethnographic and biomarker data in projects focused on nutrition, sleep, and household water infrastructure in order to ask research questions that could not be answered through any one data source alone.

Bioethnography then is the combination of two different methodologies – ethnographic observation and biochemical sampling – in an analysis that understands environment–body interactions as always relational, contingent, and constructed phenomena. This combination of methods might sound like other mixed-methods approaches, but bioethnography is more open-ended than combining focus groups or interviews with quantitative data, where the focus and questions have been decided in advance. Additionally, bioethnography avoids designating biomarker data as 'biological' and ethnographic observations as 'social'. Avoiding these domain designations makes it easier to grasp how phenomena like diabetes are produced together through class hierarchy, epigenetic processes, international trade agreements, household organisation, body mass index (BMI), and zoning laws, which are all parts of an 'environment'.

The team's experience with the iterative design and counter-intuitive results of the sleep study described above also demonstrated that bioethnography can reduce one of the biggest unseen challenges to DOHaD and health science investigations more generally. Euro-American researchers tend to be from middle-class backgrounds, which emphasise individual autonomy, while their study subjects tend to be from communities designated as, in some way, marginalised. Without knowing they are doing so, middle-class researchers tend to universalise their own experience and often do not know how to identify the important environmental drivers of the developmental origins of disease. Instead, many focus on what can be easily measured, like the characteristics of individuals (e.g. mother's education or lack of it) or seemingly individual behaviours like sleep or eating, which, in practice, are deeply social.

Our bioethnographic collaborations have allowed us to develop three principles that guide our ongoing research projects: (1) individuals are not necessarily the most meaningful unit of analysis when, beyond households and neighbourhoods, nation-states and political and economic processes shape bodily conditions [17]; (2) biological conditions

are as dynamic and historically shaped as any other process; and (3) an open-ended, ethnographically inductive stage before narrowing the aperture to a specific and testable hypothesis is a powerful means of generating robust research questions about the relationship of environment to disease. In the next section, we lay out how these principles can be applied to DOHaD-focused research by using examples from our bioethnographic work within ELEMENT, focused on eating and nutrition.

## 15.2 A Bioethnographic Approach to Eating and Nutrition

Throughout its first decades, ELEMENT researchers collected data about the diet and nutritional intake of ELEMENT mothers and children through standard methods, including semi-quantitative Food Frequency Questionnaires (FFQs). ELEMENT researchers published papers analysing prenatal and early childhood consumption patterns with health outcomes in adolescence, including body weight, metabolic markers, and timing of sexual maturation [18–20]. In order to understand what biological mechanisms could explain how maternal nutrition during gestation influences children's health, the ELEMENT team examined links between maternal diet and the epigenome (DNA methylation) of the children [21]. In 2013, this research took on additional urgency when the WHO designated Mexico the world's most obese industrial nation.

Soon after this designation, Roberts commenced ethnographic fieldwork in the households of ELEMENT participants and their neighbours. Much of her research focused on how ELEMENT families and their neighbours purchased, prepared, served, shared, and ate food. Roberts' ethnographic findings affirmed what most ethnographies of food have long demonstrated about many non-elite communities: that eating is intrinsically collective [22, 23]. Few eat alone, and food is rarely measured, controlled, organised, or experienced as pertaining to individual health. Eating and sharing food reinforces collective survival, especially in economically precarious environments [24, 25]. In addition, girth and fat are often valued among groups who have experienced past deprivation, and sharing food is a common and potent way to care for others, especially children [26–28].

In light of the importance of shared eating, public messaging on billboards and public-service announcements decrying junk food, especially soda, as unhealthy seemed particularly tone-deaf to how participant households and their neighbours shared food and ate with others. The ubiquity of soda and the need to demonstrate love outweighed health education messages about the harms of soda. By ethnographically following study participants from their households and neighbourhoods to ELEMENT study visits, it was clear that ELEMENT study participants likely underreported consumption of FFQs, especially soda, because participants knew that soda was considered unhealthy by those administering the survey. Likewise, when sugar-sweetened beverages were banned from schools, women hid soda in their children's lunches by putting clear soda in single-use water bottles [28]. These ethnographic observations demonstrated that questionnaire items, such as 'how much soda did you consume last week?', are not likely to produce accurate data. Instead, researchers might develop surveys and questionnaires that ask respondents to describe the crucial elements of different meals or eating/drinking events throughout the day. Or perhaps: who shares in a meal? What do people ideally drink at meals? Who buys it? How much does it cost? Which household members drink what beverages? All of these questions might provide a better portrait of when, how, and why

soda is consumed. Additionally, if DOHaD researchers built in ethnographic research early on, even before the recruitment of pregnant women, they would know more about the environments of their study participants, which could help them avoid the unintended moralism so common to survey data collection.

Ethnography also made it easier to see how the abundance of pleasurable foods available to share in working-class households in Mexico City is produced through global processes and trade agreements. Retail and census data have demonstrated that the North American Free Trade Agreement (NAFTA) inundated Mexico City's food landscape with cheap, mass-marketed goods. Following NAFTA, Mexico overall registered increases in caloric intake, particularly for low-income households [29]. In addition, government subsidies in the form of tax incentives, sugar subsidies, and water rights have made soda nearly as cheap as purchased water, and Mexico is now one of the largest per capita soda consumers on earth [30]. Public health researchers' response to this rise in soda consumption continues to focus on individual behaviour as driving this change, in effect continuing to designate mothers (i.e. their soda consumption patterns during pregnancy and the amount of soda they provide to their children) as the relevant environment to understand children's health and development. But what if, instead, DOHaD researchers used longitudinal surveys and biomarker data before and after NAFTA to test the hypothesis that trade agreements like NAFTA are environmental processes that impact disease incidence?

Ethnographic findings about study participants' food environments allowed the team to carry out a new ELEMENT diet and nutrition analysis. In one paper, our bioethnographic team compared ethnographic data about eating with the FFQ data of 550 cohort adolescents to reassess assumptions about diet patterns that standard epidemiological studies correlate with the nutrition transition [31]. The nutrition transition tends to be understood as a process in which people 'choose' to forsake traditional diets for Western diets, which are categorised as distinct dietary patterns. Our bioethnographic approach to understanding eating among cohort participants told a different story.

We found that rather than moving from one dietary pattern to another, the patterns we identified likely reflected the economic status of a household. If we had only carried out an epidemiological analysis, we might have characterised participants with a higher score on the plant-based and lean protein dietary pattern as choosing to follow an overall 'healthy' or 'traditional' diet. By including ethnographic data, we found, however, that adolescents with a higher score on this pattern likely lived in more economically stable households, where there were enough resources to prepare a large afternoon meal for sharing, with leftovers remaining for subsequent days. Furthermore, it was evident that in all household diets and meals there were elements of 'Westernised' and 'traditional' foods. This co-occurrence suggests that instead of adopting a more 'Westernised' pattern of eating and living, households may simply be incorporating available and affordable 'Western' foods into their typical meals. In sum, our bioethnographic findings challenged understandings about the nutrition transition as coming from individual preference or that families make clear-cut distinctions between traditional and Western foods. Importantly, our findings allowed us to call for more attention to how economic processes alter eating.

In another paper, we examined the range of other factors besides maternal body mass (understood in DOHaD terms as the outcome of biology and behaviour) that contribute to children's body mass [32]. The rapid worldwide increase in obesity in the last three

decades, particularly in Mexico, suggests that forces beyond the biology and behaviour of mothers are at play in shaping weight. Our ethnographic data showed how transformations in Mexico's food landscape made it easier than ever before for parents to provide children with cheap pleasurable processed foods and that at least 38 per cent of children's BMI is not linkable to heritable factors like mother's BMI. Attempts then at intervening in 'food' choices of mothers and families are less likely to be effective without interventions on the upstream drivers of diet and food availability, such as curtailing tax subsidies to transnational food and beverage corporations.

The bioethnographic findings of these two papers helped elucidate our first two principles for bioethnographic research described above: (1) eating and nutrition must not be understood through the lens of individual choice, and (2) biological conditions are inseparable from social processes. The effect of NAFTA on body mass over time makes it clear that metabolic processes are not separate from political economic processes, and trying to tease out the biological and social determinants of body mass may lead to missing the larger context producing the phenomena under question [33, 34]. In other words, the developmental origins of adult diseases such as obesity are not located solely, or even primarily, in the 'maternal environment'.

Additionally, our initial papers on eating and nutrition provided support for our third principle that ethnography can become a key driver for iteratively producing research questions, collecting data, and interpreting results, which then can generate hypotheses that are locally situated in the lived experiences of the study's participants. In 2017, we commenced a larger scale bioethnographic project – developed through initial ethnographic observations – that in working-class communities in Mexico City, water tends to arrive intermittently, with complex effects. Household members experienced water as unreliable and unhealthy even though state authorities declare that at least 85 per cent of the nation receives water that is safe to drink [35]. We also found that within the context of the advertising, ubiquity, reliability, and palatability of soda, drinking tap water made little sense.

These observations about the complex reality of water in working-class neighbourhoods have formed the basis for the bioethnographic study, 'Neighbourhood Environments as Socio-Techno-Bio Systems: Water Quality, Public Trust, and Health in Mexico City' (NESTSMX). NESTSMX combines ethnographic, environmental health, and environmental engineering methods to better understand the discrepancy between health messaging on the benefits and safety of water and residents' distrust in water. Over the course of three years, we carried out multiple visits in 60 ELEMENT households (a large 'n' by ethnographic standards), collecting water quality, real-time water sensors, biometrics, health biomarkers (epigenetic and cortisol), and ethnographic data pertaining to the household and neighbourhood water environment [36]. So far, our findings demonstrate that within these 60 households, water intermittency and low water pressure compel residents to install domestic water management infrastructure – that is storage units, tubing, and pumps – which can negatively impact water quality. When water stagnates at collection points, chlorine disperses, providing an excellent environment for bacterial growth. There are also indications that specific kinds of water intermittency might impact water quality: for example, receiving water a few days a week might encourage more harmful bacteria growth in storage units. Household residents, especially the adult women who manage water provisioning, are quite familiar with the signs of water quality deterioration, which contributes to their distrust of tap water. These complex

biosocial findings point to how intermittency might contribute to making soda a more sensible choice than water and might contribute to the incidence of chronic diseases, like diabetes. Our team is currently collaborating with the Encuesta Nacional de Salud y Nutrición (ENSANUT) to examine the impact of water intermittency on health, gender, and economic dynamics at a national scale.

Our complex bioethnographic understanding of intermittency has been made possible through our open-ended ethnographic process. If we only carried out surveys about attitudes or beliefs about water, just collected biomarker data, or only conducted an ethnography of eating and drinking, we would have foreclosed the possibility of understanding the complex reasons people drink soda or bottled water. With NESTSMX, we can apprehend how food environments – now dominated by multinational corporations, as well as urban planning and domestic architecture – dramatically shape what and how people drink in Mexico City. NESTSMX's bioethnographic approach demonstrates that taking time to ascertain the *relevant* complex early life environments is a powerful means to understand health and disease over the lifecourse.

### 15.3 Bioethnography and Causal Mechanisms

The open-ended and iterative nature of bioethnography serves as a 'seed bed' for understanding and potentially measuring 'the how and the why'; in other words, what meaningfully shapes early life environments that contribute to later life disease [37, 359]. Most epidemiologically informed DOHaD studies deploy standard regression techniques that attempt to isolate the unidirectional effect of an exposure (e.g. maternal diet during pregnancy) on an outcome (e.g. offspring BMI) [38, 39]. Few pay attention to participants' bodies as dynamically situated in a specific time and space. By providing a means to examine how or why phenomena cause and are caused by more than one variable within a particular context, bioethnography enables the development and testing of context-specific theories behind these complex interrelationships.

Implementing an early open-ended ethnographic period can be used to develop theory-based hypotheses and to test causal mechanisms in specific contexts. For example, it is often assumed that proximity to supermarkets supports healthy diets. With this assumption in place, researchers have developed a suite of tools to measure the relationship of individual dietary intake to contextual factors like supermarket proximity. Ethnographic observations of ELEMENT participants revealed, however, that supermarket access might actually be detrimental to healthy eating patterns among people in working-class neighbourhoods in Mexico City. In these neighbourhoods, women procure fresh produce available from open-air mobile markets and procure sodas and processed food from supermarkets, where they are cheaper compared to their neighbourhood corner stores. In addition to measuring the proximity of supermarkets, which has become standard in food environment research, investigators could deploy ethnographic work early on to make more context-specific measures of food outlets and their role. By also including economic processes such as the displacement of mobile markets with supermarkets as part of the dynamic food environment, researchers can move beyond individual behaviour and develop a more accurate picture of the causal mechanisms behind nutritional intake that develop over time.

Open-ended bioethnographic research can identify more relevant, sensitive measures of behavioural mechanisms and improve upon a standard set of variables that are

otherwise assumed to be universalisable from one context to another. After this open-ended stage, epidemiological methods can be implemented to test the generalisability of ethnographic observations in larger study populations. During survey question development and testing, bioethnographic research teams can test survey validity through cross-referencing responses to survey items with ethnographic observations of daily life on a sample of study participants. Such cross-referencing could also be used to further refine and extend survey instruments. Ultimately, the more comprehensive bioethnographically informed and highly granular data that are specific to the context and population under study can be used to statistically test causal mechanisms using traditional epidemiological methods. Validating and testing theories derived from ethnographic observations of mechanisms in the same population where they were observed can fill critical gaps in studies that associate environments with health and disease over the lifecourse.

## 15.4 Conclusion

As we have detailed elsewhere, there are enormous challenges to proposing, designing, and carrying out bioethnographic research [16, 37, 40]. Investigators in the life and social sciences are situated in radically different research ecologies with different obligations, incentive structures, epistemological assumptions, funding mechanisms, and research models and practices, all of which can pose challenges to interdisciplinary collaboration. Publishing can be difficult because of the specific disciplinary demands of journals around acceptable data sources and writing style. Perhaps the biggest challenge of all is how funding mechanisms are structured. For instance, in the United States, NIH funding requires researchers to narrow their research questions into specific aims and testable hypotheses in advance, which make it difficult to develop a comprehensive understanding of the complex environmental processes that shape the lifecourse. So far, our bioethnographic research within ELEMENT has been funded through the National Science Foundation and internal university sources. These sources, however, do not typically provide enough funds to carry out bioethnographic work with a large enough sample size for validity in life science research.

The challenges to bioethnographic research posed by structural issues like funding result in the exact reductionism and universalism that bioethnographic research seeks to overcome. Addressing these difficult issues is crucial, so that DOHaD researchers can adopt more open-ended and iterative approaches like bioethnography to ask better questions, produce better data, and arrive at more comprehensive knowledge about how environmental processes shape health and disease over the lifecourse.

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