

AIDS and Social Networks

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Abstract

During the past 30 years, research on the global AIDS pandemic and on social networks has coevolved. Insights from social networks literature have advanced our understandings of AIDS; simultaneously, key empirical insights from the AIDS literature have furthered the development of social network research—especially methodologically. We elaborate on this reciprocal relationship, identifying some of the key developments and future directions for research on AIDS and on social networks generally. From existing literatures, we discuss how (i) social networks analysis was central to early attempts to understand the spread of HIV through sexual and needle-sharing relationships; (ii) subsequent prevention efforts leveraged similar insights to different ends; (iii) social networks have been crucial in understanding patterns of care for people living with HIV/AIDS; and (iv) the structural composition of networks across international, organizational, and individual levels highlights the epidemic’s global implications in ways that extend far beyond epidemiology. We contend that future research must integrate recent developments from both fields in order to advance understandings. Among these, we identify as most promising: (i) a move from static modeling approaches toward research emphasizing the dynamic properties of networks; (ii) a shifting focus from single networks in isolation (e.g., sexual transmission networks) to the analysis of multiplex networks (i.e., those involving multiple relationship types represented simultaneously); and (iii) an acknowledgment—conceptual and methodological—of the “vertical” embeddedness of networks. Continued advances in this area will require the gathering of high quality social network data specifically designed to address such questions.

INTRODUCTION

The following facts are widely circulating but bear repetition. AIDS is the pandemic of the era. Even with uncertainty about when HIV, the virus that causes AIDS, first emerged, since it first came to broad public attention in 1982, it has been responsible for more than 25 million deaths. A disproportionate number of these deaths have occurred in the sub-Saharan African (SSA) “AIDS belt” that extends from southern into eastern African countries, and that includes populations where more than 20% of adults are HIV-positive. Other significant AIDS clusters have formed around gay

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communities, IV drug-users and prostitutes, in both more and less developed countries. Globally, about 30 million people are infected with HIV.

While AIDS research has been engaged with the social network paradigm since the 1980s, the form that engagement has taken across disciplines has varied dramatically. Epidemiologists have drawn on network approaches to model the spread of HIV; demographers and public health researchers have explored how new information about prevention spreads and whether, if at all, this affects subsequent HIV incidence. Sociologists and economists have described the social support mechanisms used to care for the sick and their survivors; and public policy and international aid scholars have examined the networks among international donors, local nongovernmental organizations (NGOs), and religious organizations that have emerged in response to AIDS. Yet across these disciplines, advances in social networks analysis (SNA) have also been accelerated by this focus on AIDS. In a sense, SNA and AIDS research have “grown up” in parallel, each making important contributions to the other.

In this essay, we outline the foundational and contemporary claims of these literatures at the nexus of AIDS and social networks, and we point to promising avenues for future research. The literature on “AIDS and social networks” is sometimes more focused on HIV than AIDS and throughout we follow scholarly convention using “HIV” when looking at transmission and prevention, and “AIDS” when examining treatment, social support, or policy in general. It should be clear that we are not restricting ourselves to a particular discipline. Rather, we see utility in bridging—as network theorists would describe it—different disciplines. This orientation reflects our collective professional experience. Two of us are social demographers whose primary area of research over the past few years has been AIDS in Africa; the third is a social networks researcher with interests in Africa and the United States. All of us, however, have considerable experience collaborating with scholars trained in sociology, economics, epidemiology, public health, and anthropology—each of which has developed its own approach(es) to understanding and analyzing networks and AIDS.

Notwithstanding our commitment to bridging disciplines, we do not—indeed, cannot—include everything. Most notably, we exclude much research on AIDS where an underlying relational focus that *intimates* a network approach is not reflected in actual analysis of networks. Examples include much of the research on: how religion influences people’s sexual behavior or what people know about AIDS; the consequences of marriage and divorce both for individual risk and population-level epidemics; how trust in partnerships influences condom use; relationship quality and condoms; and the relationships that structure caregiving obligations in the wake of AIDS. The increasing number of papers on topics like these reflects the

spread of a relational paradigm through the social and behavioral sciences, especially in social and behavioral research on health. However, they are not social networks papers in the normal sense of that term.

FOUNDATIONAL RESEARCH

We identify four main streams of foundational research on AIDS and social networks.

Epidemiologists were the vanguard: the first to apply social networks approaches to AIDS. From their earliest attempts to identify “patient zero” in the United States, their goal has been to model **the spread of HIV**. Their underlying proposition and finding: the structure of a social network affects both who you *meet* and what you *do* with that person once you’ve met them. For epidemiologists, this *do* refers primarily to the behaviors that directly influence the likelihood of transmission—in the case of HIV, through one of two principal transmission modes: sex and intravenous drug-use (IDU). Networks profoundly affect whether, under what conditions, and how quickly people proceed from meeting each other to having sex or using drugs; networks further influence the type of sex and kind of drug use—both of which matter for transmission. Concurrency provides one salient example of how structured patterns of behaviors can alter the trajectories of an epidemic above and beyond the constitutive individuals and individual behaviors. In a series of simulations, Martina Morris *et al.* have shown that, at the population level, the arrangement of partnerships is more salient than their mere number. Where even a moderate number of partnerships overlap in time (i.e., are “concurrent”), epidemics are much larger than in populations with the exact same *number* of partnerships, differently arranged to minimize time overlaps (such as in serial monogamy).

In offering better explanations for variation in the shape and magnitude of AIDS epidemics, network approaches have forced an important theoretical turn, with implications that are much broader than the particular case of HIV: they demand that we step back from ideas about “risk” that focus singularly on individuals and their characteristics (both socio-demographic and behavioral) and, instead, emphasize the salience of *relationships* and their characteristics. For example, the simple statement—“even monogamous women had very large sexual networks,” written by Kay Johnson *et al.* about their research in Peru—illustrates this theoretical turn. The idea is virtually incomprehensible where we conceive of, or model, risk as an individual property—an implicit assumption in much research on health behavior. It makes perfect sense, however, when we think about an HIV infection as arising from a series of conditional probabilities associated with one’s own partners and one’s partners’ partners.

Other foundational findings from SNA research on the spread of HIV also bear broader theoretical and practical implications. One concerns the important role of “bridgers” or “bridge populations”—those individuals or groups that link otherwise isolated components of a network. Another challenges traditional “risk factor” models of infection. In conceptualizing the joint effects of multiple risks, early research assumed that each additional risk factor provided an additive effect on infection. In reality, however, risky behaviors often co-occur, and although the joint effects are difficult to disentangle empirically, scholars now agree that their combination is more often multiplicative or exponential rather than linear. The underlying argument is simple but important: simultaneity raises issues about the very meaning of risk and how to target it. For example, it may be less profitable to think of risky behaviors as measurable phenomena than to think of “risk” more broadly—as a fuzzy, latent construct that captures a wide range of associated behaviors.

A second stream of foundational social networks research focused on **HIV prevention**. This followed closely on the heels of the literature on transmission. In sub-Saharan Africa, the epidemic’s epicenter, this approach essentially cut-and-pasted models of diffusion developed in the mid-1990s to track the spread of information and ideas about contraception and family limitation. This new prevention literature stemmed from a theoretical and explanatory literature on the spread of innovative ideas through networks that had roots in early work on communications, anthropological work on social change, and demography’s paradigm-shifting European Fertility Project. Coincidentally, much of this early work was developed in the same areas of Central Africa that would later have the heaviest concentrations of HIV. The prevention literature profited from the rapid publication of a series of papers in the mid-1990s that clarified conceptually muddy terms in two important ways. First, these papers made the important conceptual distinction between two types of network effects—social learning (the flow of information about how to reduce risk) and social influence (moral and political evaluation of those risk-reduction behaviors). Second, in work associated with Hans-Peter Kohler *et al.*, researchers demonstrated that they could leverage measures of network density to distinguish one from the other.

The literature on networks and HIV prevention made a few other important contributions. First was its underlying recognition of a structural parallel between networks that increase transmission risk and networks that facilitate the flow of information that may ultimately prevent infection. This structural parallel helps explain the “first in, first out” rule for understanding the waves of HIV prevalence by social class in developing countries with the worst generalized epidemics: in these settings, the earliest rise *and* fall in HIV

prevalence was associated with the wealthiest, then the middle class, then the poor—note that a somewhat different pattern has persisted in western countries. The insight that HIV infection and prevention networks run in parallel undergirds a key policy effort: “peer-driven intervention,” which is more effective than standard street-based outreach for preventing infection. It also helps explain the highly variable record of African countries in combating AIDS. For example, in their comparative study of Uganda, Kenya, Tanzania, Malawi, Zambia, and Zimbabwe, Daniel Low-Beer and Rand Stoneburner identify unique patterns of communication about HIV through Ugandan social networks. They argue that this reflects important differences in approaches to HIV taken by national political leadership—to which we add religious leadership. Specifically, intensive long-term (vertical) communication about HIV from national leaders in Uganda legitimized and facilitated widespread local (horizontal) communication among community members.

A related contribution has focused on how networks structure perceptions of risk. This has been especially valuable for understanding AIDS-related behaviors in developing countries, where high levels of uncertainty and limited sources of information force people to use networks to both evaluate risk and vet information about ways to minimize it. These network effects can be seen even when controlling for unobserved factors that may affect the structure and composition of the social networks.

A third stream of research on AIDS and social networks has focused on **care and social support** for people living with HIV and AIDS (PLWHA). There has long been a careful distinction in this literature between emotional care and physical or task-related support. A divergence can be seen, however, between the literatures on support in wealthy western settings from support in poor African or Asian settings. In the first it is largely focused on support for PLWHA. In the second, it is equally focused on PLWHA *and their children*. This difference is not surprising. In developed countries, AIDS has disproportionately affected a childless, gay population with small extended families and access to at least a partial publicly funded safety net. In contrast, in most countries in SSA the epidemic was, from the beginning, primarily heterosexual, and it disproportionately affected young parents embedded in much larger extended families, who were active in local religious congregations, and living in settings devoid of any publicly funded safety net.

The existing literature on social support networks reflects these contextual differences in the sociodemographic characteristics of PLWHA. In the US, support networks tend to be constituted by a constellation of activists and other PLWHAs—though more recent literature notes the fragility of this type of network where people are increasingly affected by age-related comorbidities. In SSA, both emotional and physical support for PLWHA and their

dependents is sourced from within the extended family or from religious congregations, as documented by Jenny Trinitapoli and Alexander Weinreb. These same networks make arrangements to support survivors—typically children—when the PLWHA dies.

A fourth stream of research on AIDS and social networks has focused directly on **network composition and characteristics**, with implications for prevention, treatment, and social support. There are two quite different strands of literature here. The first builds on a long tradition in the social sciences that seeks to identify the effects of larger structural characteristics on the behavior of individuals (e.g., from Durkheim's *On Suicide*) and on networks. In addition, relevant here is the emerging discourse in modern medicine, which reframes disease as a biosocial phenomenon rather than simply an outcome of molecular changes. In both cases, larger structural characteristics and arrangements act as “distal determinants” of infection—types of “structural violence”—that affect HIV transmission and treatment by influencing the size and composition of networks. An example: high risk behavior, including sexual mobility and IV drug use, can be a predictable byproduct of social disintegration and residential instability and landholding patterns, or of discriminatory labor market or incarceration practices. When network stability is compromised, HIV spreads more easily through one of two mechanisms: (i) older authority structures (i.e., hierarchical networks) are undermined, freeing youth from community sanctions that may have protected them by proscribing high levels of sexual mobility and (ii) new peer-driven (i.e., horizontal networks) behavioral models diffuse alongside new inequalities in wealth, new patterns of consumption-driven behavior, and the higher-risk activities associated with both.

CUTTING-EDGE RESEARCH

The first 30 years of research on AIDS and social networks established the contours of engagement across a number of disciplines. Part of this groundwork involved rapid improvements in modeling the spread of the HIV (the virus), the spread and adoption of new information, ideas and behavior associated with HIV prevention, and of modes of social support for those infected with HIV or affected by AIDS. There is a notable, but often overlooked, consequence here: by boosting the amount of methodological and empirical research on networks, AIDS changed disciplines. Recent advances in epidemiological models of infection, for example, are rooted in a network paradigm. Moreover, in demography and sociology, HIV reinvigorated and accelerated the movement of social networks toward the disciplinary center.

One stream of contemporary cutting-edge research—focused on sampling and response error in networks data—cuts across these disciplinary boundaries. This is connected to a long-standing concern in the networks literature with data quality. It also builds on the recognition that as important a role as formal models and simulations have played in many key SNA developments that have emerged from the AIDS literature, their underlying claims are best tested empirically.

A characteristic difficulty with AIDS in this regard is that people at greatest risk of HIV infection (e.g., sex workers and IV drug users) tend to be in “hidden” or “hard-to-reach” populations: they are more mobile and marginalized and thus are rarely found in household samples. They are also less trusting of authorities in general and are, therefore, reluctant to be interviewed even when they are found. The greater the magnitude of each of these problems during data collection, is the less representative the resulting data are.

To address this sampling problem, researchers have developed alternative sampling strategies. One is time-location sampling. By allowing researchers to target recruitment in geographically defined hotspots (e.g., bath houses, and red-light districts) where risky behaviors are concentrated, time-location sampling directly addresses longstanding critiques of aspatial modeling paradigms used in the AIDS literature and empirical social science in general. Another approach is to use a link-tracing-based design, long used in collecting data on infectious diseases. One recent adaptation of these strategies—respondent-driven sampling (RDS)—leverages network-based referral approaches to approximate random sample characteristics. Developed by Douglas Heckathorn *et al.*, RDS explicitly acknowledges the unequal and non-random tendency of how individuals form social connections. It argues that, by following referral chains through a series of iterations, researchers can reach an equilibrium in which the sample composition is independent of the characteristics of initially sampled “seeds.” RDS has important weaknesses, such as the inability to tap into portions of the population that are completely isolated from the seeds—this is less problematic in time-location sampling—and potentially dramatic fluctuations in sample characteristics from seemingly minor violations of the model’s assumptions. Despite these, RDS has become *de rigueur* for sampling hidden and hard to reach populations, including those at high risk for contracting HIV.

The second strand of methodological research to have emerged in the past few years reflects growing anxiety about data quality. Because the smallest units of analysis in social networks focus on relationships—which necessarily include two individuals—social network data are uniquely situated to evaluate the validity of self-reported information in ways other types of data cannot explore. For example, some have used such multiply reported data to demonstrate how reliably individual partnerships are reported both by

members of those relationships and even by other individuals not part of the relationship, but connected (directly or indirectly) to the people who are. Given that small local changes in networks can have substantial implications for global connectivity of networks among the full population, researchers must critically evaluate ways to improve reporting. A variety of technological, passive and active participatory strategies have begun to do exactly that: some use new types of survey instruments such as relationship histories; others are focusing more on new types of self-interviewing (eliminating survey error associated with interviewers); still others are using new forms of observational data, for example, by mapping network connections using cell-phone data.

A second stream of cutting-edge research examines a completely different type of AIDS network: *vertical* institutional networks extending from donors to local NGOs involved in the “global governance of AIDS.” There are two important contextual factors here; the first is global. Since the 1970s, a new institutional configuration has emerged involving funders, development professionals, international non-governmental organizations (INGO), and their local agents (NGO). In more general social science this is a particular type of “transboundary formation.” The second contextual change is specific to poorer countries with generalized AIDS epidemics: the massive mobilization of international donors around AIDS over the past decade. The United States President’s Emergency Plan for AIDS Relief (PEPFAR), for example, was established in 2004 and committed to spending US\$15 billion over its first 5 years. Its reauthorization in 2008—to run from 2009 to 2013—increased its budget to a maximum of US\$48 billion (though some of those resources are devoted to malaria and TB). The global fund to fight AIDS, tuberculosis, and malaria—known simply as the *global fund* (GF)—was founded in 2002. By December 2009, the GF had approved proposals totaling US\$19.2 billion, virtually all of it for HIV and TB. Billions more AIDS-designated dollars have been disbursed by the Bill and Melinda Gates Foundation, by the World Bank’s Multicountry AIDS Program (MAP), and by many other bilateral agencies.

In settings with limited access to capital, these new institutional configurations have made available massive amounts of resources and have attracted considerable attention from international and local NGO entrepreneurs, and from local technocratic elites. The result has been the emergence of new vertical networks that link these major bilateral organizations and global donors to: (i) INGOs to whom the actual running of programs is subcontracted, (ii) national NGOs, and (iii) local NGOs and development committees, including those run by religious organizations. Recent work by Susan Watkins and Ann

Swidler on how policies filtered through these networks demonstrate enormous differences between their design at the “top” and their implementation on the ground.

This body of work further shows how these resources are used as “instruments of patronage” and as opportunities to further other parochial interests. Notably here, in the case of AIDS, the “institutional isomorphism” imposed by funders is offset by a reshaping or “translation” process. That is, policies may be nearly identical in their original form, but as they diffuse down through a network they are repeatedly modified rather than being directly reproduced. There is an ironic structural parallel here between, on the one hand, the mutations that have changed HIV over time, resulting in an ever-growing array of HIV subtypes and recombinations and, on the other hand, the way that information is transmitted but constantly reconfigured as it works its way through the network. Cumulatively, these changes lead to dramatically different modes of implementation and outcomes on the ground, some of them much more apposite to local setting.

The ways in which vertical networks both distribute resources and (usually informally) reshape policy is both interesting and important. First, it points to a unique type of AIDS network that has come into being for one of two reasons. One is the international commitment to combating AIDS. Another—as cynical as it sounds—is because the magnitude of resources available to AIDS has allowed for the full expression of development professionals’ scavenger instincts, enabling them to use AIDS to perpetuate both their institutions and their own livelihoods. A second reason the vertical networks are important is that they hold out the tantalizing promise of integrated analyses of different types of networks: networks through which viruses and information move; networks through which social support is provided; and networks through which policy responses are channeled. We return to this promise below.

KEY ISSUES FOR FUTURE RESEARCH

As work on AIDS and social networks moves into its fourth decade, a number of areas are primed for important contributions. Some of these reflect recent advances in the social networks literature that have not yet been translated into work on AIDS. Others address things the networks literature could productively adapt from AIDS research, and still others reflect perspectives and tools that are new to both fields.

Perhaps the most important developments in social networks literature over the past decade center on the (re)introduction of temporal dynamics into network analytic strategies and the development of statistical models for handling network data. While each of these have some roots in literature on HIV/AIDS, the latest developments, associated especially with James

Moody, have yet to be fully embraced by AIDS researchers. The network positional characteristics that we know influence an individual's chance of contracting HIV (e.g., centrality) are constantly changing. For example, a person cannot contract HIV from their current partners' future partners, and s/he cannot transmit HIV to a current partner's former partners. Recent modeling developments clearly show that these dynamic patterns substantially alter networks' epidemic potential, providing a serious caution against thinking about networks as fixed structures, even for the purposes of modeling short-term trends. Parallel temporal dynamics exist within the extended family structures that underlie social support systems in developing countries. That is, people choose to maintain ties with *certain* cousins, uncles and aunts, not all of them; and the absence of one of these favored network relationships may both increase the likelihood of making connections to someone else, but also reduce connections to others in the family once maintained through the now absent bridging tie.

The introduction of statistical models for static or dynamic networks—known respectively as p^* or *exponential random graph models* (ERGM) and *stochastic actor-based models* (SABM) or *SIENA models*—has moved the analysis of networks from a purely descriptive endeavor to one with the empirical wherewithal to emphasize processes. Developed by Tom Snijders *et al.*, these models allow for the simultaneous estimation of individual and network-endogenous effects in observed network patterns. For instance, while early research relied on single snapshots of a network and inferred processes of influence from across those networks (e.g., in the dissemination or adoption of strategies for HIV prevention), SABM are being used to disentangle processes of influence (e.g., people adopting the ideas/behaviors of those to whom they are connected) from those of selection (e.g., individuals forming ties to others with whom they hold similar views). New implementations of this approach will be especially beneficial to future efforts to understand whether and how people's strategies for avoiding infection "work." The dynamic and statistical advances from the modeling literature on HIV have not yet been fully incorporated into strategies for gathering the high-quality data we described above as necessary for advancing both fields. Each stands to benefit substantially from future data collection efforts that target the gathering of longitudinal data on risk-bearing and knowledge-sharing networks within the observed populations.

AIDS-salient networks tend to be "multiplex" in nature, that is, they involve more than one type of relationship at a time. This seemingly simple insight has been a critical contribution of AIDS literature from early days when, for example, it became clear that "risk" carrying networks (i.e., those involving sexual or needle-sharing contact) can also effectively carry prevention efforts or can be converted into sources of support and care for

PLWA. The formal models within SNA literature, however, still tend to focus on a single tie type at a time (e.g., only on sexual networks *or* social support networks). Yet including multiple networks has important implications for understanding network effects in general. For example, analyses of sex ties or needle-sharing ties alone underestimate the risk network as a whole and misestimate how sex ties or drug ties themselves shape individual risk patterns; tracing risk-relevant ties to the exclusion of other “social” network ties can misrepresent the full extent of the population at risk; and treating a social support network (in a developing country) as isomorphic with an extended family misses crucial non-familial support from friends or local religious organizations.

Future work should focus more explicitly on the myriad ways in which these different types of networked relationships can combine to influence HIV/AIDS, in part by systematically building on this idea of multiplexity. After all, enough is now known about different types of networks, about analyzing dynamic processes, and about how to collect high-quality data, that we can envisage collecting and combining data that enable researchers to estimate individual and network-endogenous effects, but this time across multiplex networks. Only this combination of data would allow us to directly address AIDS-related questions that lie in the *social* networks. For example: What is the relationship between the structure of nuclear and extended family, social and sexual networks, local support networks, and how do these collectively influence HIV transmission, subsequent treatment and social support? How do these structures change over time (or how do *people* change them over time)? What happens when a best friend—or some other key node in a friend, family, or social support network—moves or dies? What happens to sexual networks and informal support networks as access to antiretroviral drugs, especially the latest fixed-dose combinations, increases?

Important vertical elements should also be included in this new dynamic, multiplex SNA frame. One would focus on structural determinants of networks themselves: from residential patterns and conditions to the quality and intensity of connections to kin and nonkin; from involvement in institutions that facilitate new network connections (e.g., schools, churches, and employment outside the home) to deeply entrenched cultural practices that limit physical movement and network freedoms (e.g., gender differences in free movement through public space embodied in *purdah*). Another vertical element would extend into dynamic organizational networks. Among these are local and national NGOs that interact with community and family-based networks in promoting HIV prevention or organizing social support for those directly or indirectly affected by AIDS.

A final element is related to spatial dynamics. Understanding HIV’s movement through space has been a goal of researchers since early attempts to

trace “patient zero” and map truckers’, soldiers’, and other migrants’ routes in Africa. However, spatial modeling of AIDS networks in general has not been at the forefront of research agendas. This is unfortunate since there are a number of interesting spatial puzzles. Examples include: clustering of AIDS orphans in Malawi that is completely orthogonal to HIV prevalence; clusters of AIDS support networks around particular religious congregations; irregular diffusion of stories and ideas about AIDS within and across communities. Future research should incorporate each of these contextual layers (e.g., network-informed spatial measures or spatially informed network measures), in order to look at the intersection of network and spatial processes and, subsequently, to directly address the ways in which they impact outcomes of interest.

In summary, it is widely known that the social epidemiology of AIDS, from transmission to its long gestation, is complicated. What has become increasingly clear over the past decade is that single subsets of networks, no matter how seemingly well circumscribed, cannot proxy for full systems if our intention is to fully understand and document the relationship between social networks and AIDS, whether in terms of HIV transmission, prevention, or care. Future research should reflect this awareness. AIDS and social networks should be treated empirically as things that occur within a temporally dynamic, multilevel, and spatially combustible setting. Excluding any one of these dimensions, or using instruments that artificially limit scholars’ attention to a single type or subset of behaviorally specific networks, or to a single period of time, misses a substantial part of the relationship between AIDS and social networks. We need a more holistic approach.

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SHORT BIOGRAPHY

Alexander Weinreb (UT-Austin), **jimi adams** (American University), and **Jenny Trinitapoli** (Penn State) are social demographers who think about networks not only in relation to AIDS but also in relation to a variety of other topics including religion, family structures, political processes and outcomes, the development of disciplinary fields, and social cohesion generally. They have lived and worked in multiple countries but as field researchers have largely focused on collecting and analyzing network-based data in Kenya and Malawi. Some of their work on these subjects appears in *Religion and AIDS in Africa* (OUP 2012) and scholarly journals such as *American Sociological Review*, *American Journal of Public Health*, *Social Networks*, *Social Science and Medicine*, *Population and Development Review*, *Demographic Research*, and *Field Methods*.

RELATED ESSAYS

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