

The Social Epidemiology of Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome

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Abbreviations: AIDS, acquired immunodeficiency syndrome; HIV, human immunodeficiency virus; STD, sexually transmitted disease.

INTRODUCTION

Social epidemiology is defined as the study of the distribution of health outcomes and their social determinants (1). It builds on the classic epidemiologic triangle of host, agent, and environment to focus explicitly on the role of social determinants in infectious disease transmission and progression. These determinants are the “features of and pathways by which societal conditions affect health” (2, p. 697). Early studies of human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS) focused on individual characteristics and behaviors in determining HIV risk, an approach that Fee and Krieger (3) refer to as “biomedical individualism.” Biomedical individualism is the basis of risk factor epidemiology; by contrast, the social epidemiology perspective emphasizes social conditions as fundamental causes of disease (4) (table 1). Social epidemiologists examine how persons become exposed to risk or protective factors and under what social conditions individual risk factors are related to disease. Social factors are thus the focus of analysis and are not simply adjusted for as potentially confounding factors or used as proxies for unavailable individual-level data. Social factors are indeed critical to understanding nonuniform infectious disease patterns that emerge as a result of the dependent nature of disease transmission or the idea that an outcome in one person is dependent upon outcomes and exposures in others (5, 6).

Contact patterns that enhance HIV/AIDS vulnerability may be conceptualized at multiple levels. Figure 1 distinguishes determinants of HIV/AIDS at three levels: individual, social, and structural. Individual factors include biologic, demographic, and behavioral risk factors that may influence the risk of HIV acquisition and disease progression. Social-level factors include critical pathways by which

community and network structures link persons to society. These structures are central to understanding the diffusion and differential distribution of HIV/AIDS in population subgroups. Structural-level factors include social and economic factors, as well as laws and policies. These factors, in turn, affect HIV transmission dynamics and the differential distribution of HIV/AIDS.

Infectious disease epidemiology provides models of the mechanisms through which social determinants affect HIV transmission (7). For example, the basic reproductive number of an infectious disease, R_0 (8), describes secondary infections that arise from a primary infection. In the equation $R_0 = \beta CD$, β is the probability of infection per contact, C is the number of contacts, and D is the duration of infectivity. The goal of intervention efforts is to reduce the empirical value of these terms by modifying the social conditions under which individual risk factors lead to disease. Examples of factors that affect the component terms of R_0 in HIV epidemiology are presented in table 2.

In this review, we present existing evidence linking social and structural determinants to HIV/AIDS. In addition, we discuss the implications of these findings for future social epidemiology research on HIV/AIDS as well as the design of more effective HIV/AIDS interventions.

MATERIALS AND METHODS

We searched the published literature to identify conceptual and empirical research reports on the social epidemiology of HIV/AIDS. Five databases were searched: PsycINFO (American Psychological Association, Washington, DC), PubMed (MEDLINE; National Institutes of Health, Bethesda, Maryland), Social Science Citation Index (Web of Science; Thomson ISI, Stamford, Connecticut), Sociological

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TABLE 1. Comparison of how HIV*/AIDS* epidemiology is examined by using different research paradigms†

Research paradigm	Key research questions	Understanding of risk	Implications for interventions
Risk factor epidemiology	What places persons at risk of acquiring HIV infection? What individual characteristics are associated with development of AIDS and disease progression?	Risk of HIV/AIDS is manifest at the individual level.	Interventions focus on individual behavior change to prevent HIV transmission. Interventions focus on access to clinical AIDS care.
Social epidemiology	What places populations at risk of HIV epidemics? What population characteristics enhance vulnerability to HIV/AIDS epidemics?	Social determinants affect HIV/AIDS risk by shaping patterns of population susceptibility and vulnerability.	Policy and program interventions that address fundamental social determinants will enable large reductions in HIV/AIDS at the population level.
A psychosocial approach	How do social factors influence psychology or behavior to place persons at higher risk of HIV infection? Are psychosocial factors such as social support associated with AIDS disease progression? How are behavioral and social factors interrelated?	Psychosocial factors mediate the effects of social structural factors on individual risk. Psychosocial factors are conditioned and modified by the larger social context in which they occur.	Interventions focus on modifying interpersonal relationships to enable HIV prevention or to improve health outcomes for persons living with HIV/AIDS.
A social production of disease or political economy of health approach	How do economic and political determinants help establish and perpetuate inequalities in HIV/AIDS distribution within and between populations?	Limited access to resources places persons at risk of HIV infection and AIDS disease progression.	Changes to the structure of the social environment through legal, political, or economic intervention are necessary to empower vulnerable groups to protect themselves against HIV/AIDS.
An ecosocial approach	How do factors at multiple levels—from the microscopic to the societal—contribute to the creation of population-level patterns of HIV/AIDS?	HIV/AIDS risk is “embodied” among persons over lifetime exposures to numerous biologic and social factors.	Responsibility for factors that enhance vulnerability may be located at multiple levels; as such, interventions should be targeted to the level specified through ecosocial studies.

* HIV, human immunodeficiency virus; AIDS, acquired immunodeficiency syndrome.

† In this table, a distinction is made between three approaches to studying social epidemiology: a psychosocial approach, a social production/political economy of disease approach, and an ecosocial approach. This table is based on work by Krieger (181).

Abstracts (CSA, Bethesda, Maryland), and Digital Dissertations (ProQuest; UMI, Ann Arbor, Michigan). Searches were designed to include the factors we specified in our framework as social or structural factors (figure 1). Searches were limited to published articles in the English language for the period 1981–2003. The following keywords were included in each search: AIDS/acquired immunodeficiency syndrome, HIV, and epidemiol*. Additional searches were conducted by using combinations of keywords listed in Appendix table 1 corresponding with our framework.

RESULTS: SOCIAL-LEVEL FACTORS AND HIV/AIDS

We identified four categories of social-level factors of importance to HIV/AIDS epidemiology: cultural context, social networks, neighborhood effects, and social capital. Each uses different conceptual and methodological approaches to examine the effects of social forces on population HIV/AIDS vulnerability.

Cultural context

Anthropologist Edward Tylor defined culture as “that complex whole which includes knowledge, belief, art, law, morals, custom, and any other capabilities and habits acquired by man as a member of society” (9, p. 1). Anthro-

pologic and epidemiologic approaches may be integrated in a variety of ways to identify features of the social environment that affect HIV/AIDS risk. One way to explore how the social environment affects HIV/AIDS epidemiology is through the use of mixed research methods. Mixed-methods study designs integrate qualitative and quantitative research methods either sequentially or concurrently (10). In sequential study designs, qualitative methods may be used to explore a topic under study or to explain quantitative epidemiologic findings. Concurrent study designs are meant to confirm, cross-validate, or corroborate findings within a single study. A common type of concurrent mixed methods study is “triangulation,” and this approach has been used extensively in rapid assessments of illicit drug use and HIV/AIDS (11–13). Mixed methods approaches are particularly well suited to the investigation of the often hidden and stigmatizing behavioral and social factors underlying HIV epidemics.

One exemplary study combining qualitative methods with quantitative methods was conducted by Beyrer et al. (14) to examine the role of overland heroin trafficking routes in shaping explosive HIV/AIDS epidemics among injection drug users in Southeast Asia. Piecing together data from a variety of sources, including existing epidemiologic data, key informant interviews, and laboratory data, this study revealed that distinct HIV subtypes emerged and recom-

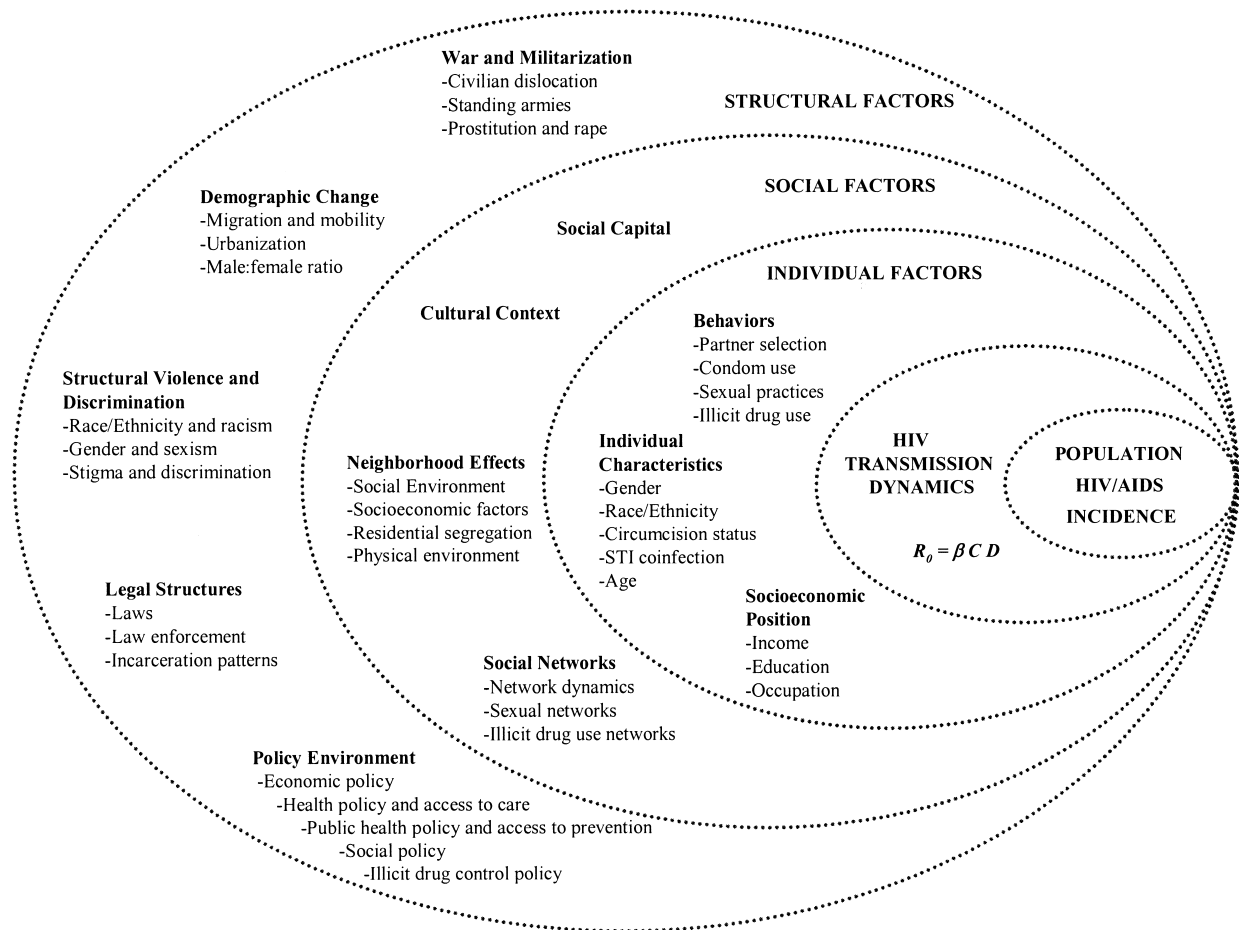


FIGURE 1. A heuristic framework for the social epidemiology of human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS). The dotted lines separating the levels illustrate the porous nature of the distinctions made between levels of analysis. In reality, there are extensive linkages between factors at all levels that give rise to observed epidemic patterns. STI, sexually transmitted infection.

bined along drug trafficking routes originating in Myanmar, one of the world's largest heroin producers. Along these trafficking routes, communities of injection drug users formed, facilitating the spread of HIV into local communities in Laos, Thailand, Vietnam, India, and China (refer, for example, to Panda et al. (15)). This illustration highlights the broader understanding of HIV/AIDS epidemiology that can be achieved by examining the interplay between contextual factors and social and behavioral factors.

Social networks

Investigation of social networks in HIV/AIDS began with the mapping of relationships between one of the first identified AIDS cases, an airline steward, and a large number of his male sex partners in the early 1980s (16). Social network analysis generates measures of the quality, density, position, and structure of relationships between persons, including dyads (partnerships), personal networks ("egocentric" networks), and larger communities ("sociometric" networks)

(17, 18). Social networks can influence health outcomes in direct and indirect ways, including 1) social influence, 2) social engagement and participation, 3) prevalence of infectious disease and network member mixing, 4) access to material goods and informational resources, and 5) social support (19). Researchers have demonstrated that patterns in the structure of relationships—rather than differences in individual risk behaviors alone—explain observed HIV patterns (20, 21).

The theoretical foundation for examining social networks in HIV research is closely tied to advances in sexually transmitted disease (STD) epidemiology. A key concept from STD epidemiology is the notion of the "core group," a small group of disease transmitters responsible for a large proportion of cases (22). Friedman et al. (23) found that individuals' locations within sociometric risk networks were associated with HIV risk among a group of injection drug users in New York City. Other concepts from STD epidemiology, such as partner concurrency, bridging, and mixing patterns, are also important in understanding HIV risk (24—

TABLE 2. Component terms in the equation for the basic reproductive number, and factors that affect the empirical estimates of the terms in the case of HIV*

Term	Definition	Factors affecting the term	Social or structural approaches to reducing the term's value (reference number(s))
β	Transmission efficiency	Condom use	100% condom policies (182–184)
		Low infectivity of HIV	Ensuring access to care treatment for sexually transmitted infections (108, 178, 185, 186)
		Viral load	
		Coinfections	
		Circumcision status	
		Antiretroviral therapy	
C	Contact rate	Sexual practices, such as dry sex	
		Number of sex or injection drug use partners	Needle exchange programs to minimize direct contact between persons sharing drugs (187, 188)
		Rate of sex partner acquisition	Network interventions to reduce the number of risky contacts between persons by promoting harm reduction practices and condom use (36, 189–191)
		Timing of sexual partnerships (concurrency/gap)	Structural interventions to reduce risk (114, 174)
		Mixing patterns (assortative/disassortative)	Increased availability of voluntary counseling and testing programs (192, 193)
		Size of core groups	
D	Duration of infectiousness	Population turnover in core groups	
		Natural history of infection	Ensuring access to care for HIV/AIDS* to reduce infectiousness by decreasing viral load (194)
		Diagnostic interventions	
		Therapeutic interventions	

* HIV, human immunodeficiency virus; AIDS, acquired immunodeficiency syndrome.

29). Specific network characteristics that have been associated with HIV/AIDS include the size of subgroups and their distribution in a network (23), the centrality of HIV-positive persons within networks (30), partner selection patterns (24, 31–33), and concurrent sexual partnerships (28). Inclusion of these variables has been shown to improve transmission estimates in mathematical modeling (34, 35).

Social and normative influences have also been associated with individual HIV risks (36, 37). Network-related social and normative influences are predictive of illicit drug use (38) and condom use behavior (37, 39), highlighting the importance of network-based interventions for HIV prevention (18). Kelly et al. (40, 41) developed a popular opinion leader model that has been effective in reducing HIV risk in several populations, including men who have sex with men and women in low-income housing (42). The success of this model has led to its adaption for international use by the National Institute of Mental Health Collaborative HIV/STD Prevention Trial in China, India, Peru, Russia, and Zimbabwe.

Neighborhood effects

Neighborhoods represent the intersection of social networks and physical spatial locations, a confluence Wallace (43) has called the “sociogeographic networks”

through which infectious diseases spread. Early interest in the role of neighborhood social environment in disease transmission was sparked by a study in Colorado Springs, Colorado, in which researchers found that gonorrhea was highly focused geographically in core residential neighborhoods (44). Both direct and indirect mechanisms may determine how neighborhood-level factors shape population HIV/AIDS patterns. Direct mechanisms are those that increase the likelihood of a person coming into contact with someone who is HIV positive, for example, through residential segregation and the social isolation of marginalized populations. Indirect mechanisms include those that increase population vulnerability to HIV/AIDS, such as exposure to poor socioeconomic conditions, high unemployment, or the proliferation of illicit drug markets. A range of neighborhood-level factors have been examined in relation to infectious disease, including poverty and income (45, 46), residential segregation (47), and neighborhood physical environment (48, 49). Current research in neighborhood and area effects on health emphasizes the importance of moving beyond documentation of associations to analyze the social and epidemiologic mechanisms through which neighborhood effects might operate (50–54).

Increasing concentrations of affluence and poverty are contributing to what demographer Douglas Massey has called “a radical change in the geographic basis of human

society” (55, p. 395). Powerful social and economic forces in US cities are increasing neighborhood segregation by class and race/ethnicity (56, 57). Resulting social disorganization and loss of resources and services in poor neighborhoods are in turn shaping HIV/AIDS patterns at the neighborhood level. In a number of studies in New York City, for example, Wallace (58–63) has examined the complex interplay of public policies such as “planned shrinkage” with HIV epidemic dynamics in the Bronx, documenting the “synergy of plagues” that has accompanied rapid social change and the destruction of essential protective networks in poor communities. Using AIDS surveillance data, ecologic studies conducted in various US cities have also consistently found significant associations between income and poverty measures and neighborhood-level AIDS incidence and prevalence rates, and these findings have been consistent across census block groups (46), census tracts (64), and zip codes (65, 66). Length of survival after an AIDS diagnosis has also been linked with neighborhood measures of income both before and after the introduction of highly active antiretroviral therapy (HAART) (64, 67–69). Income inequality, a powerful predictor of health at the population level (70), may also play a role in shaping HIV/AIDS patterns, although associations between HIV/AIDS and income inequality at the neighborhood level have not been well studied.

Residential segregation by race/ethnicity is another neighborhood-level process that may play an important role in HIV/AIDS disparities (47). Segregation may affect infectious disease patterns through the concentration and isolation of persons in one racial/ethnic group, increasing the probability of transmission within that group. For example, Acevedo-Garcia (71) found that measures of residential isolation were protective against tuberculosis for Whites but placed African Americans at greater risk of disease. Indirect effects of racial/ethnic segregation are associated with low levels of neighborhood political capital and with attenuated life chances for those living in poor neighborhoods (72). While segregation may contribute to understanding racial/ethnic disease disparities, we know of no studies examining neighborhood racial/ethnic segregation in relation to HIV/AIDS that have been reported.

The physical environment of neighborhoods has also been examined in relation to infectious disease. Cohen et al. (48) examined gonorrhea rates and neighborhood physical environment in New Orleans, Louisiana, by using an index of physical deterioration to explore Wilson and Kelling’s (73) “broken windows” theory. According to this theory, the presence of physical incivilities such as graffiti and litter prompt a breakdown in social order, resulting in a cascade of negative community outcomes. Extending this concept to public health, Cohen et al. (49) found a significant association between neighborhood physical deterioration and gonorrhea rates, a finding confirmed by a subsequent ecologic study of 107 US cities. Neighborhood physical environment may heighten HIV risk by influencing illicit drug use practices, such as injection behaviors and needle sharing (74, 75). Further exploration of the mechanisms through which the observed associations may be operating and associations between the physical environment and HIV/AIDS is warranted.

Continued research is needed to support the design of neighborhood-level HIV/AIDS interventions. As Diez Roux has argued, “[n]eighborhood differences are not ‘naturally’ determined but rather result from social and economic processes influenced by specific policies. As such, they are eminently modifiable and susceptible to intervention” (52, p. 518). The current body of evidence demonstrates strong ecologic associations between neighborhood-level factors and infectious disease that need to be explored further to identify points of policy and programmatic intervention.

Social capital

Sociologist James S. Coleman defined social capital as aspects of social structures that facilitate collective action, emphasizing that “social capital is productive, making possible the achievement of certain ends that in its absence would not be possible” (76, p. S98). Social capital may affect health through 1) the presence of health-promoting behaviors; 2) access to services and amenities; 3) levels of mutual trust in a community; and 4) greater political participation, leading to policies that are more likely to benefit all citizens (77).

Two published studies have explicitly examined social capital in the context of HIV/AIDS. In the United States, Holtgrave and Crosby (78) examined poverty, income inequality, and social capital as predictors of state-level STD and AIDS rates; they found social capital to be the strongest predictor of both STD and AIDS rates. In South Africa, Campbell et al. (79) examined one aspect of social capital, civic participation, as a proxy for understanding community influences on HIV infection. They found that participation in certain types of organizations (e.g., churches, sports clubs, and youth groups) was protective, while membership in other social groups (e.g., groups with high levels of social drinking) increased HIV risk. While suggestive, findings from these studies are preliminary and warrant further exploration.

RESULTS: STRUCTURAL-LEVEL FACTORS AND HIV/AIDS

We identified five main categories of structural-level factors relevant to HIV/AIDS epidemiology: structural violence and discrimination, legal structures, demographic change, the policy environment, and war and militarization. Each is discussed in the paragraphs that follow.

Structural violence and discrimination

Structural violence highlights a kind of institutionalized harm “...‘structured’ by historically given (and often economically driven) processes and forces that conspire—whether through routine, ritual, or, as is more commonly the case, the hard surfaces of life—to constrain agency” (80, p. 40). Structural violence is most frequently manifested in patterns of discrimination based on race/ethnicity, gender, sexual orientation, and HIV status. A conceptualization of how structural violence might influence HIV/AIDS risk is presented in figure 2.

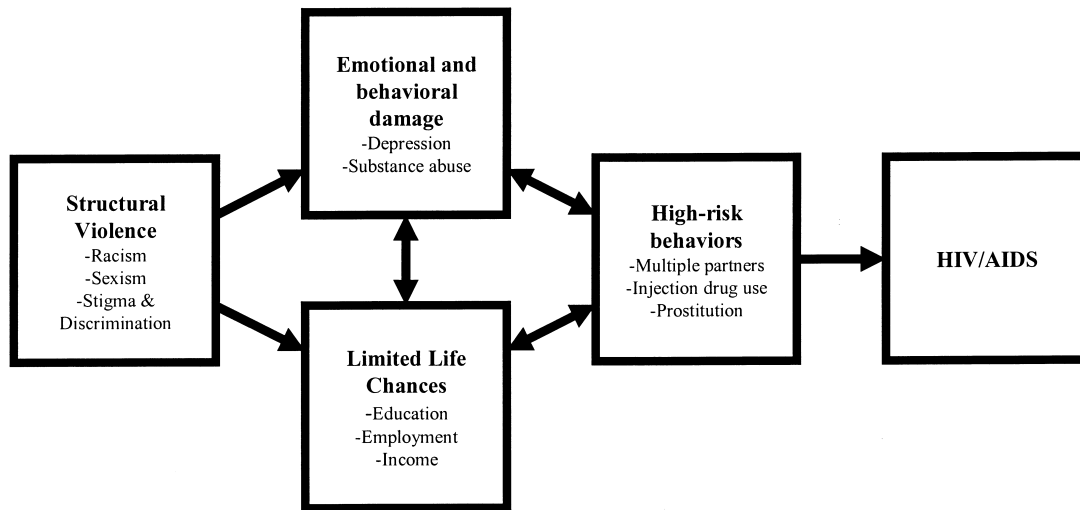


FIGURE 2. Pathways through which various forms of structural violence might influence the risk of human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS).

Race/ethnicity and racism. The meaning and uses of race/ethnicity in epidemiologic research have been the subject of extensive analysis and debate (81–85). Social epidemiologists view race/ethnicity as an indicator of social forces rather than physical difference. LaVeist (81) has argued that race/ethnicity is a proxy for exposure to racism, which may be defined as the “institutional and individual practices that create and reinforce oppressive systems of race relations” (86, p. 195).

The study of racial/ethnic disease differentials is of central importance in the study of HIV/AIDS disparities. In the United States, for example, African Americans experience the highest levels of HIV prevalence, HIV/AIDS incidence, HIV/AIDS-associated mortality, and years of potential life lost (87); Hispanics also experience disproportionately high HIV/AIDS burdens compared with Whites (88–90). Studies of behavioral risk factors at the individual level have not fully explained observed HIV/AIDS or STD differentials by race/ethnicity (91–94). Beyond individual behaviors, pathways by which HIV/AIDS becomes concentrated in a particular racial/ethnic group involve complex processes of economic and social deprivation, socialization patterns, socially inflicted trauma, targeted marketing of illicit drugs, and inadequate health care (95). Social epidemiology is providing new insights and evidence as to what factors and processes underlie these racial/ethnic HIV/AIDS differentials. Laumann and Youm (31) found that sexual networks accounted for racial/ethnic variations in self-reported sexually transmitted infection rates in the National Health and Social Life Survey. Similarly, Kottiri et al. (96) found that risk network structure in a cohort of injection drug users explained variations in racial/ethnic differences in HIV prevalence between African Americans and Whites. Contextual and structural factors play key roles in shaping the socializa-

tion patterns that contribute to racial/ethnic HIV/AIDS disparities. For example, the socially destabilizing effects of low male-to-female sex ratios resulting from the disproportionate incarceration of African-American men may be discouraging monogamous relationships and promoting sexual partnership concurrency (97). Residential segregation by race/ethnicity also appears to shape social and risk networks in ways that contribute to endemic disease patterns. Racial/ethnic residential segregation was strongly and independently associated with endemic gonorrhea rates at the county level in the southeastern United States (98). Similar patterns might be observed for HIV/AIDS.

Gender and sexism. There is considerable heterogeneity in the proportion of women among HIV/AIDS cases around the world. Women accounted for 20 percent of HIV-positive adults in North America through 2002 and for 58 percent of HIV-positive adults in sub-Saharan Africa (99). HIV infections in women are rising at an alarming rate, and women are both biologically and socially more vulnerable to HIV infection. Several theoretical frameworks for understanding gender differentials in HIV/AIDS have been put forth, including feminist, political economy, and human rights frameworks (100). Looking beyond gender as a simple risk category, these approaches seek structural explanations for gender differentials in HIV/AIDS.

Although substantial focus has been placed on women in the roles of sex workers or mother-to-child transmission (101), most women acquire HIV from their sole regular partner (102, 103), and reducing acquisition of HIV among men is key to reducing the spread of HIV to women (104, 105). Women face violence, the threat of rejection, and significantly greater stigma and discrimination than their male partners upon disclosure of HIV-positive test results, in

part because of power differentials of gender and HIV risks experienced by women (106).

Stigma, discrimination, and collective denial. The effects of stigma include individual reluctance to seek HIV testing and a lack of empowerment to enact HIV prevention (107). The Centers for Disease Control and Prevention estimates that approximately one third of those with HIV do not know their HIV status (108). Stigma, discrimination, and collective denial have played central roles in shaping responses to HIV/AIDS epidemics, yet the effects of these social forces on the differential distribution of HIV/AIDS have not been well examined. Stigma has usually been examined at the individual level in studies of perceptions and interpersonal interactions (109). Link and Phelan reconceptualized stigma to apply “when elements of labeling, stereotyping, separation, status loss, and discrimination co-occur in a power situation that allows the components of stigma to unfold” (109, p. 367). Herek et al. have defined stigma as “the prejudice, discounting, discrediting, and discrimination that are directed at people perceived to have AIDS or HIV and at the individuals, groups, and communities with which these individuals are associated” (110, p. 36). Parker and Aggleton have argued that a new conceptual framework for understanding HIV/AIDS-related stigma is needed “to reframe our understandings of stigmatization and discrimination to conceptualize them as social processes that can only be understood in relation to broader notions of *power and domination*” (111, p. 16 (*italics in original*)).

Herek et al. (112) reported that mistaken beliefs about HIV transmission and negative feelings toward people with AIDS remain prevalent. To overcome the negative consequences of stigma, environmental or structural interventions must change the context in which individuals and communities view HIV infection (111, 113–115). The most effective responses have been those in which affected communities have mobilized to fight stigma and discrimination by increasing community awareness of HIV (116–118). Social interventions to overcome stigma and discrimination aim to affect collective community change. The rationale for this action is found in diffusion theory, which focuses on social networks, opinion leaders, and change agents (119). Although these elements are influenced by global cultural trends portrayed through the media, immediate interpersonal interactions occurring in social networks within specific communities are essential for inducing and maintaining behavior change to facilitate productive responses to HIV/AIDS (120).

Legal structures

Legal structures refer to laws, as well as to the institutions and practices involved with their creation, implementation, and interpretation (121). Burris et al. (122) argue that laws can affect health in two ways: 1) they may be a pathway through which social determinants affect health (a direct effect), and 2) they may contribute to social conditions associated with health outcomes (an indirect effect). An example of direct effects of law on HIV risk are legal restrictions on access to sterile injection equipment, which have been associated with higher HIV incidence (123). An example of an

indirect effect of legal structures is the effect of tax laws on income inequality, which may foster social conditions that increase HIV vulnerability. Laws underlie many key social determinants of HIV/AIDS, including housing, poverty and income inequality, racism, and community social organization (124).

Demographic change

Demographic change may affect HIV/AIDS patterns through population mobility and migration, urbanization, and the age and gender structures of subpopulations. Each of these factors may be seen as modifying interactions between susceptible and infected persons in populations.

Mobile populations around the world experience higher HIV infection rates than nonmobile populations, regardless of HIV prevalence in the origin or destination location (125–127). Labor migration, refugee migration, resettlement, internal migration, and commuting may affect HIV transmission rates. Epidemiologic studies of migration have fallen into two main categories: 1) studies of the spread of HIV along transportation corridors, and 2) studies of the migration process that increases vulnerability to HIV/AIDS (125). Molecular techniques can trace the spread of HIV viral subtypes and circulating recombinant forms to document patterns of mobility and migration. Perrin (128) recently reviewed evidence linking travel patterns and HIV. Beyrer et al. (14) found that distinct HIV subtypes were associated with different illicit drug trafficking routes in Southeast Asia. Long-distance truck driving has contributed to the spread of HIV in Africa, India, and South America (129–133). In addition, studies have identified the importance of migrant labor in the creation of markets for prostitution (134).

HIV/AIDS is a classic example of an urban health problem, yet few have directly examined the role of urbanization processes in generating population HIV/AIDS patterns (135). Factors that might account for the effects of urbanization on HIV/AIDS patterns include altered sexual and drug use patterns due to changes in socialization patterns, in- and outmigration of infected and susceptible persons, and increased burdens on the health care system.

Male-to-female sex ratios that favor men have also been associated with high HIV/AIDS prevalence rates at the country level (136). This ecologic association is likely to be modified by the effects of cultural context at the local level because of the varied effects skewed gender ratios might have on partnership formation and network patterns.

The policy environment

Policies guide decisions about the allocation of scarce resources in both the public and private sectors, and the policy environment plays a central role in the emergence and control of HIV/AIDS epidemics. Policy realms of particular importance to HIV/AIDS include macroeconomic policy, health policy, social policy, and illicit drug control policy.

HIV/AIDS is exacting a high toll on the macroeconomic health of many developing nations, and macroeconomic policies are likely to be contributing to increasing HIV/AIDS

burdens. The complex and reciprocal relations between macroeconomic policies and HIV/AIDS are only beginning to be explored. Macroeconomic policies affect health and development by altering absolute poverty levels and/or inequalities in the distribution of wealth (137), thereby affecting household economies and health systems investment (138). Some have argued that World Bank structural adjustment programs designed to stimulate private-sector growth and exports in debtor countries have had a negative impact on the HIV/AIDS pandemic by undermining rural subsistence economies, expanding transportation infrastructure, increasing migration and urbanization, and reducing investment in the health and social services sectors (139). Questions remain as to how macroeconomic policies can be designed to contribute to reductions in HIV/AIDS internationally.

Structural-level health policies governing prevention, treatment, and care can contribute to dramatic reductions in HIV/AIDS incidence. HIV prevention strategies have typically centered on individual behavior change, but the scope of the HIV prevention policy is widening with recognition of the need for multisectoral programs that address the social and economic aspects of HIV/AIDS (140, 141). The Thai 100 percent condom program is an exemplary example of an effective multisectoral structural HIV prevention program intended to alter the environment in which HIV risk behaviors occur (142). Policies governing the provision of antiretroviral therapy may also affect reductions in HIV/AIDS transmission by reducing viral load among HIV-positive persons.

Social policies assume a critical role in the lives of those most vulnerable to HIV/AIDS, such as low-income, marginally housed, or addicted persons. Social policies governing programs such as welfare and public assistance directly affect access to resources and can also affect HIV transmission and access to care. Little quantitative research has linked social policy change to population health outcomes (143), but qualitative research has highlighted the importance of social policy in shaping HIV/AIDS-related risk behavior. In San Francisco, California, for example, Crane et al. (144) documented the harmful effects of the Personal Responsibility and Work Opportunity Reconciliation Act of 1996, which eliminated Social Security Income and Social Security Disability Insurance eligibility on the basis of drug addiction and alcoholism. Participants in this study reported being driven back into the underground drug economy because of income loss, dropping out of methadone treatment because they lost benefits, and engaging in high-risk behaviors in an attempt to acquire HIV to regain lost benefits. Further studies of the associations between social policies and HIV/AIDS are desperately needed to document the human costs of policies out of sync with the needs of those most vulnerable to HIV/AIDS and to identify potential solutions.

Illicit drug control policy also has a significant impact on HIV/AIDS. Injection drug use, particularly of opiates, is driving HIV epidemics in many countries around the world. The global "War on Drugs" has focused primarily on supply control to the neglect of demand reduction, which consists of substance abuse prevention and treatment measures (145). Widespread "zero tolerance" policies promoting strict enforcement for those trafficking or possessing illicit drugs

have resulted in escalating numbers of persons incarcerated for drug offenses. The direct HIV/AIDS-related consequences of enforcement patterns appear to be negative (146–149). For example, Blumenthal et al. (150) found that War on Drugs policies such as the criminalization of syringe possession and disqualification of those with substance use problems from supplemental Social Security Income programs were associated with increases in high-risk behaviors. Incarceration itself is a known risk factor for HIV. HIV risk behaviors have been shown to persist during incarceration (151–157), generally associated with higher rates of needle sharing (158) and HIV risk (159). Despite ample supplies of drugs in many prison settings, inmates rarely have access to sterile syringes.

War and militarization

War can increase HIV/AIDS risk indirectly and directly by disrupting normal social and risk networks, weakening or destroying medical infrastructure, and increasing poverty and social instability in conflict areas (160). Changes in risk behaviors in times of military conflict have been documented. For example, Strathdee et al. (149) found that the war in Afghanistan was associated with increased needle sharing among injection drug users in neighboring Pakistan, possibly because of the disruption of regular heroin trafficking from Afghanistan.

In the absence of open conflict, the degree of militarization has also been associated with country-level HIV/AIDS rates. Military forces are often located near urban centers and consist of young men away from home. In a study for the World Bank, Over (136) found that a reduction in the size of the military from 30 percent to 12 percent as a proportion of total urban population could reduce HIV seroprevalence among low-risk urban adults by 1 percent. Policies to limit the presence of troops in urban areas are likely to reduce HIV risks, especially in conjunction with HIV/AIDS prevention and screening programs for military personnel.

DISCUSSION

The contributions of social epidemiology to the battle against HIV/AIDS have grown in recent years. This finding is due in part to a general trend that Koopman calls epidemiology's "transition from a science that identifies risk factors for disease to one that analyzes the systems that generate patterns of disease in populations" (161, p. 630). Conceptual and methodological developments in the field have facilitated this transition, expanding our understanding of multiple causes of risk (162–167). Advances in multilevel modeling (162), geographic information systems software (168–170), and databases linking public health data with information on social factors (171, 172) all enhance our ability to develop and test hypotheses about causation in ways that more closely match the contours of HIV/AIDS epidemics. Ultimately, social epidemiology research in HIV/AIDS will help determine how we can design more effective sets of interventions at multiple levels of social organization (173–175).

A number of key challenges remain. First, clear, testable hypotheses about which aspects of the larger social environment matter in HIV/AIDS transmission and disease progression are needed, requiring theory-based model specification. Second, complex measurement and analytical issues must be addressed. As Diez Roux has pointed out, these issues include “nested data structures, variables and units of analysis at multiple levels, contextual effects, distal causes, and complex causal chains with feedback loops and reciprocal effects” (52, p. 516). Finally, multisectoral approaches are required for the effective implementation of social-level interventions.

Globally, 40 million persons are now living with HIV/AIDS, and an estimated 5 million new HIV infections occurred in 2003 alone (176). While effective antiretroviral therapies are available, high drug costs and weaknesses in medical infrastructure are obstacles to widespread implementation (177, 178). Development of an efficacious HIV vaccine will take many more years (179, 180). These constraints emphasize the urgent need to address underlying social and structural determinants of HIV/AIDS through sound policies and programs.

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APPENDIX

APPENDIX TABLE 1. MeSH* keywords used to search databases for published literature on the social epidemiology of HIV*/AIDS*

Level	Category	MeSH keywords
Social	Social networks	Community networks; social support
	Cultural context	Anthropology, cultural; ethnology; qualitative
	Effects of neighborhoods	Poverty areas; small-area analysis; residential mobility; residence characteristics; housing
	Social capital	Social capital
Structural	Demographic change	Sex distribution; population dynamics; transients and migrants
	Legal structures	Legislation, drug; legislation; police
	Policy environment	Poverty; public policy; health policy; health care reform; social welfare
	Structural violence and discrimination	Attitude of health personnel; prejudice; stereotyping; fear
	War, humanitarian crisis, violence	Sex offenses; war crimes; violence

* MeSH, Medical Subject Headings (National Library of Medicine, Bethesda, Maryland); HIV, human immunodeficiency virus; AIDS, acquired immunodeficiency syndrome.