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ORIGINAL PAPER

A Dynamic Social Systems Model for Considering Structural Factors in HIV Prevention and Detection

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Abstract We present a model for HIV-related behaviors that emphasizes the dynamic and social nature of the structural factors that influence HIV prevention and detection. Key structural dimensions of the model include resources, science and technology, formal social control, informal social influences and control, social interconnectedness, and settings. These six dimensions can be conceptualized on macro, meso, and micro levels. Given the inherent complexity of structural factors and their interrelatedness, HIV prevention interventions may focus on different levels and dimensions. We employ a systems perspective to describe the interconnected and dynamic processes of change among social systems and their components. The topics of HIV testing and safer injection facilities (SIFs) are analyzed using this structural framework. Finally, we discuss methodological issues in the development and evaluation of structural interventions for HIV prevention and detection.

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Introduction

Structural interventions have had a profound impact on public health. Even a casual observer of history can see the connection between structural changes such as water purification or highway safety and reductions in morbidity and mortality. Structural interventions can have a tremendous effect on individual-level health behaviors as well. Legislative changes such as regulating tobacco sales and usage have led individuals to modify their health behaviors and dramatically reduced smoking rates [1].

Although structural approaches to health promotion are clearly effective, they are often viewed as outside the purview of behavioral interventionists. Prevailing conceptions of "cause" as immediate and necessary antecedents of health outcomes consider factors that affect outcomes in more indirect and indefinite ways as less important or less relevant [2, 3]. Structural factors have also been neglected because researchers in the field of HIV prevention are often unprepared to develop and evaluate strategies to change laws, social organizations, or physical structures. Moreover, because of the scope and focus of structural interventions, randomized controlled trials (RCTs), the gold standard to evaluate interventions' impact, are not always the appropriate approach for testing the efficacy of efforts to change structural influences on health. Unfortunately, alternative evaluation approaches are often considered inadequate to produce valid results.

After more than 20 years of HIV prevention research it is clear that insufficient attention to structural influences on

behavior has hampered efforts to end the HIV epidemic. HIV incidence is greater where structural factors like poverty, stigma, or lack of services impede individuals from protecting themselves [4, 5]. Incidence is also greater where structural factors such as movement of populations encourage or even force persons to engage in risk behaviors [4, 6, 7]. Thus, without examining distal levels of influences on behaviors, it is difficult to understand how and under what circumstances individuals can (and conversely cannot) change their behaviors. Without this knowledge we will be unable to produce sustainable, large scale reductions in new cases of HIV infection.

In this paper, we present a heuristic model that accounts for the dynamic and interactive nature of structural factors that may impact HIV prevention behaviors. We demonstrate how structural factors influence health from multiple, often interconnected social levels and how, through the application of principles of systems theory, we can better understand the processes of change among social systems and their components. This model provides a way to delineate various structural intervention mechanisms, anticipate potential direct and mediated effects of structural factors on HIV-related behaviors, and provides a framework to evaluate structural interventions. We apply this model to two significant behaviors in HIV intervention as case illustrations, namely, HIV testing and safer injection facilities (SIFs). Finally, we discuss ongoing challenges in the development and evaluation of structural interventions for HIV prevention, detection, and treatment.

Structural Models of HIV Prevention

Discussions of HIV-related structural intervention models provide numerous perspectives from multiple disciplines on structural influences on health [8, 9]. Some models focus on institutional structures [10]. Others focus on economic factors and policies [11] or population-level dynamics and change [12]. Despite these various perspectives, most descriptions of structural-level influences on health share four common characteristics. First, most agree that structural-level factors are forces that work outside of the individual to foster or impede health [10, 13–15]. For example, although individuals may have negative feelings or beliefs about people living with HIV, stigmatizing forces operate regardless of the feelings and beliefs of particular persons. Second, structural factors are not only external to the individuals but also operate outside their control. In most cases, individuals cannot avoid or modify structural influences unless they leave the area or group within which structural factors operate [16].

Third, the influence of structural factors on health can be closer or more removed from health behaviors or outcomes [2, 17–20]. Sweat and Denison [9] distinguish four tiers of factors based on the more distal or proximal levels at which structural elements operate. Barnett and Whiteside [17] organize structural factors on a continuum based on their distance from the risk behavior. Finally, many definitions of structural factors describe them as distal causes of health that impact behavior and health outcomes in diffuse and indefinite ways. Rose [21] posits that, because structural factors are often more removed from individual behavior, their influence on behavior is less certain and specific. Gupta et al. [22] suggest that structural factors influence risk through a more extended and more variable series of causes and effects and thus have less certain and less specific influences on it. A frequently cited example of this characteristic of structural forces is the relationship between poverty and health [2, 23]. Although poverty impacts health outcomes, it does not "cause" any disease. This is because multiple factors and mechanisms affect how and when poverty influences health outcomes. For instance, Senegal is significantly poorer than South Africa, but HIV prevalence in Senegal is about twenty times lower than that in South Africa [24]. Whereas Senegal rapidly allocated resources to tackle the HIV epidemic [25], South African leaders took several years to respond effectively [26]. Thus, other factors such as public health priorities may moderate the relationship between poverty and the number of cases of HIV.

Although there is relative agreement on these four characteristics of structural factors, previous models more often classify factors rather than considering how factors influence outcomes. Exceptions are a few models that differentiate the way structural levels may shape behavior. For example, Glass and McAtee [2] propose that distal structural factors (such as policies on drug use or population movements) manifest themselves in health outcomes by creating conditions that regulate or shape more proximal causes of health outcomes (risk factors). However, Glass's model does not integrate changes in individual, social, and structural factors into a system where each influences each other and the context of risk.

We present a model of structural influences on HIV-related behavior that builds on previous models. Key components are integrated into a social dynamic system that emphasizes the dynamic links among structural levels and the more immediate social processes that lead to risk and prevention behaviors. Our model views individual, dyad, and structural factors as part of a system in which none function in isolation. The model also emphasizes the social aspects of structural factors on multiple levels of analyses. To reflect the likely relationships and interactive influences among structural factors and health behaviors and outcomes, we apply several key constructs from systems theory [27–29].

A Dynamic Social Systems Model for Considering Structural Factors in HIV Prevention and Detection

Model Overview and Assumptions

The proposed model (Fig. 1) includes a matrix of multi-level structural dimensions constituting attributes of the structural context, processes that represent the interaction among structural factors and between individuals and their environments, processes and attributes that occur within individuals, and specific HIV behavioral outcomes. The model organizes structural factors into six categories that may influence or be influenced at any or all of three conceptual levels. The categories involve material and social forms of power as well as the social and physical context where power is produced and operates. The levels are defined on the basis of their relative proximity to outcomes, namely the behaviors related to the transmission and prevention of HIV.

To reflect the dynamics and organization of structural influences and their impact on behavior, our model combines a constructivist approach and a systems approach [30, 31]. A system constitutes an arrangement of elements (e.g., organizations, people, materials, and procedures) that interact linearly or nonlinearly producing a particular function or outcome. Systems integrate inputs, which in our case can be resources and information, elements such as individuals and institutions, relationships or processes, and outcomes, which for our purposes here refer to HIV-related behaviors. Systems vary in size and complexity (e.g., society, neighborhood, risk group). However, the boundaries of systems involving structural influences on HIV-related behavior are permeable and flexible, and therefore, the observers' perspective ultimately establishes the system's limits and scope. Importantly, the limits and scope of the system of structural influences on behavior determines the breadth and level of detail the observer will identify and explain. Overall, analyses conducted at higher levels are less detailed about relationships at lower levels, which may result in the creation of "black boxes" [32] (i.e., observing inputs and outputs without attention to internal processes). For example, many epidemiological studies forgo examination of cognitions or self-regulation processes that affect risk behavior. Instead, epidemiologists tend to observe outputs such as actual behaviors or incidence rates of diseases even when the outputs depend on such psychological processes.

In systems, elements influence each other at different levels and forms. The probability that an element will influence another and the intensity of the ensuing influence depends on the quantity and type of connections between them. Connections among a system's elements can be random and either loose or tight. Loose connections occur when there is a higher number of mediating factors, or weak or infrequent connections between two or more elements [28]. In these cases, elements do not influence each other or they influence each other only occasionally, negligibly, or eventually [33]. Depending on the objective, interventions can increase the frequency of connections among structural elements and outcomes, eliminate steps or intermediate factors, or increase barriers to impede connections. For example, because the criminalization of drug use has forced drug users to go underground, interventionists have created connections (e.g., outreach workers, media, peer educators) to reach these groups. Harm reduction approaches such as SIFs have further helped to reduce the distance between services and risk groups by eliminating barriers to accessing services.

Relationships within a system are characteristically very diverse. Contrary to deterministic linear approaches, from a

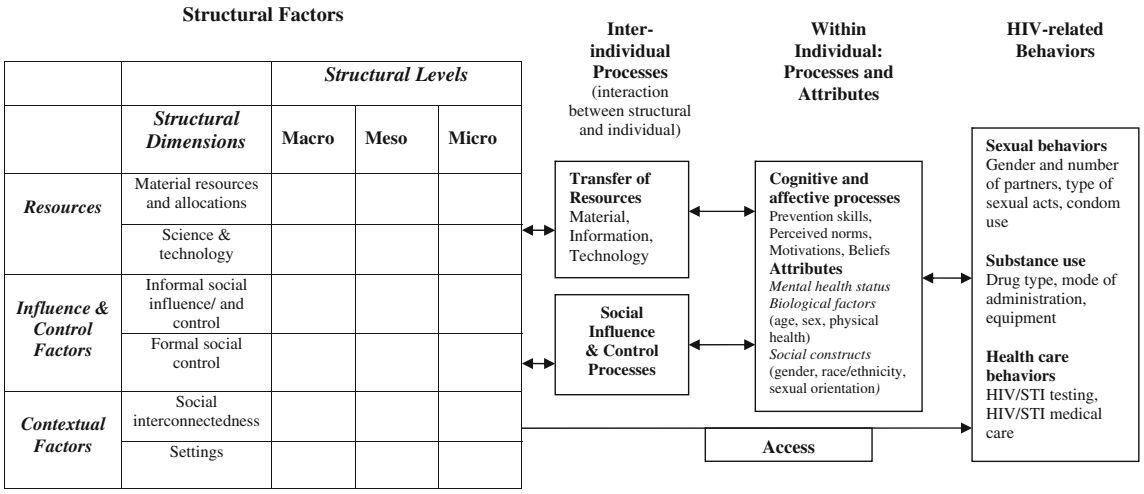

Fig. 1 Conceptual dynamic structural model

systems approach, outcomes may result from emergent properties that cannot be reduced to the sum of the processes the system integrates [34]. Thus, HIV-related outcomes are not only the effect of individuals' motivations and behaviors but also the result of patterns of interactions among other individuals in the system [3]. For example, risk of HIV infection largely depends, not only on risk behavior, but also on the prevalence of HIV infection in the community.

Relationships in a system may be recursive with positive feedback loops (in which an element exerts an influence that amplifies a prior deviation) and negative feedback loops (in which an element exerts an influence that corrects a prior deviation and leads to the initial state). They may contain butterfly effects (a weak input that reverberates throughout a whole system) and random coupling (unexpected processes and outcomes from an input). Considering these processes facilitates the development of interventions that produce synergistic positive effects (e.g., providing combined services potentiates the effect of each service to reach individuals) and avoid negative homeostatic effects (e.g., individuals returning to baseline risk behavior after receiving repeated negative HIV test results). Systems tend toward entropy, that is, outputs diminish over time without additional inputs. Thus, most interventions produce diminishing effects without the allocation of additional reinforcement or resources.

Finally, many complex changes are difficult to reverse. Irreversibility does not imply that structural factors cannot be adjusted to benefit the affected communities. Rather, it means that once a structural property in a complex system develops, interventions should provide alternative configurations rather than trying to "un-develop" it. This principle has implications for intervention design. For example, socially disadvantaged communities may not recover from the effects of poverty by simply receiving material resources. As another example, HIV prevalence rates in a community can be reduced but not reversed. That is, interventions can help to reduce incidence rates, assist those already affected, and work with communities to help them to reorganize and cope with the effects of the AIDS epidemic in the long term.

To summarize, in using a systems approach to analyze structural factors and develop interventions to affect behavioral outcomes, key questions may include how the *relationships* among elements in the system (i.e., organizations, individuals) influence those elements, and how *structural factors* (e.g., resources, social organization and controls, material culture and settings) intersect with those elements to affect HIV-related behaviors. Specifically, what are the feedback loops that can potentiate the results of an intervention; what is the strength of coupling between connections or within and across systems elements; and what systems configurations are irreversible and how can new configurations be created to reduce risk?

Model Levels

Structural models of health outcomes describe "levels" of factors to refer to the breadth, immediacy, and degrees of individual control or influence [35, 36]. These levels are typically labeled "macro," "meso," and "micro" levels. "Macro" level structures refer to socio-political, economic and cultural context, and social institutions that shape social organizations with the broadest reach [8, 15, 21], such as by changing political structures and policies or redistributing resources. Examples of macro-level HIV-related structural interventions have included legislative changes (e.g., efforts to allow over-the-counter sales of sterile syringes without a prescription or allocation of millions of dollars for ART treatment or social mobilization efforts like Thailand's 100% condom campaign) [37–40], and national decisions to allow and finance harm reduction efforts (e.g. opiate replacement treatment programs like methadone or suboxone) for injection opiate users.

"Meso-level" structural factors refer to systems within the more immediate institutions in which individuals or groups are involved and the contexts of those institutions [36]. These factors link macro elements with elements that influence health from more proximal levels. Meso-level influences can include neighborhood context (e.g., deteriorated housing or transportation systems), community organizations such as facilities that provide access to health care, and features of the environment that may facilitate and impede risk such as the presence of bathhouses or "shooting galleries" in an area. Meso-level factors also include broad social networks (sometimes referred to as macro-networks) of particular groups, ranging from drug users or men who have sex with men (MSM) to organized community action groups, electronic networks of "friends," and the social capital that comes with these networks. Structural interventions designed to address meso-level influences on HIV risk and susceptibility include network diffusion models [41–44], at-risk community mobilization efforts [45–47], and development of housing for chronically homeless drug users and others at risk for or infected with HIV [48].

The term "micro" level, when used to describe structural factors, often refers to the immediate social and physical context in which interactions among individuals and small groups take place. Micro-level factors include immediate space and setting and group norms. Examples include personal social networks and the norms and expectations within those networks, as well as the conditions of physical spaces in which small groups interact and

may engage in risk (e.g., availability of running water and prevention supplies in shooting galleries and other places drug users gather to use drugs). Micro-level structural interventions have included efforts to change the environments of risk in high-risk settings by increasing the presence of prevention information and materials and by developing programs targeting social norms that support harm reduction practices [44].

In our model, macro, meso, and micro levels of structural influences cannot be defined a priori and may not follow a macro to micro order of influence. Events on a macro level may have direct influences on the meso and micro levels, and some events on the macro level may have direct influence on the individual through the availability of resources or incentives to perform or avoid a behavior. For example, an economic crisis on the macro level may lead to devalued currency, leaving individuals with fewer economic resources. Individuals' perceptions of the national economic situation through the media and micro-social networks may also have indirect influences on their behaviors.

Despite the fact that some factors are clearly more distal and broader than others, our model does not propose an empirical demarcation between one level and another. Depending on the perspective of the observer and the specific question or behavior, a social organization can be viewed as situated at the "micro" or "macro" levels. Further, identification of levels does not preclude recognizing bidirectional influences (e.g., meso on micro and micro on meso), which in some cases are a source of structural change. In our model, identifying and delineating "levels" of structural influence is a heuristic tool to organize complex environmental factors in order to begin to model and then test their influences on HIV prevention behaviors. Considering structural factors as functioning at a variety of levels allows us to reflect on any number of influences on risk and to develop structural interventions to respond to scale in each arena.

Model Dimensions

In addition to levels, our model organizes the structural domains that affect HIV risk, transmission, and treatment among individuals and couples. As with levels, relevance and limits of domains cannot be established a priori; they are dependent on the objectives of the observer, with levels of influence and relevant factors changing over time.

The proposed dimensions are based on prior theoretical models of structural factors. However, we place a greater emphasis on social theories of interconnectedness, such as the work of Simmel [49]; the internalization of social factors [50]; formal and informal social control mechanisms, social diffusion [50–55]; and the perpetuation of social structures through the reciprocal influences of individuals within their social environments [56]. We define here the components of the model and then discuss its implications for the design and evaluation of structural interventions for HIV prevention and detection.

The first four structural dimensions in the matrix, resources and social influence, can be considered forms of power. The contextual factors at the bottom of the matrix, social interconnectedness and organization, which includes social networks and settings or physical spaces, are the contexts through which the top four factors tend to operate. The relationship is reciprocal, however, because the structure of social organizations, networks, and settings influence how and if individuals obtain resources and the type, amount, and stability of social influences. Each element in the model can influence and be influenced by other elements (e.g., through tight or loose connections, feedback loops, and other dynamic systems processes.) Informal social influences may impact formal control mechanisms, such as the enforcement of existing laws and the establishment of new ones. Formal and informal control factors can affect the distribution of resources, which also empowers resource holders to exercise control over others.

Each of the six structural dimensions can operate at macro, meso, and micro levels. As described below, the conditions of resources, influence and control, and social/physical context are formulated in social institutions, relationships, and practices through distal social constraints as well as immediate social interactions and conditions. For example, economic resources at the macro level may include available wealth in a state or the class structure of a social organization that determines access to wealth; on the meso-level, economic resources may include regional economies and job availability; and on the micro level, they may include sharing of subsistence, housing, and other material resources among family and network members. Likewise, organizations may exist at different structural levels. A large multi-national organization may contain or have links to hundreds of smaller organizations, which in turn contain or have smaller organizations such as departments, divisions, and offices. Organizations can be viewed as a network of individuals with formal and informal rules that are endowed with resources and technologies.

In the proposed model, it is not anticipated that all six structural factors must be intervention targets or need to be assessed in detail. Rather, investigators should determine which of the six factors are most relevant for a specific problem, program, behavior, or population. Similarly, we do not expect that interventionists focus on the highest possible level of intervention. The level of the intervention is a function of the research question, available resources, appropriate methods, and planned outcomes of the intervention.

Description of Structural Dimensions

Material resources and their allocations may be economic, social, cultural, and infrastructural. The amount of resources available and how these resources are distributed are both critical. Individuals within formal and informal organizations with greater access to resources tend to have greater power to influence others. Among networks of injection drug users, for example, those who contribute more resources to purchase drugs decide who will inject first. On the macro level, governmental entities differ on their resources, as well as on resource distribution and methods of allocation. At the national level, allocation of HIV prevention and treatment resources in low resource countries may have unanticipated consequences including diminishing health resources for non-HIV medical conditions. Resource allocations for the scientific discovery are usually determined by governmental organizations and the private sector, whereas a wider set of actors and organizations are involved in the distribution and adaptation of new technologies.

Science and technology, for our purposes, includes scientific knowledge and technological innovations related to HIV prevention, diagnosis, and treatment. These include vaccines, HIV testing, condoms, and evidence-based behavior change interventions. Some technologies require considerable infrastructure, such as the development of vaccines or the acquisition of laboratory equipment necessary for diagnosing recent seroconversion; other technologies such as condoms and syringes require less infrastructure. Efforts have focused on methods of distributing existing low-tech HIV prevention equipment. Pharmacological methods of treatment are an ongoing area of research that involves high levels of scientific sophistication; however, low-tech methods of producing illicit drugs, such as methamphetamine, are also actively pursued at the meso and micro levels.

Informal social influence and control involve non-institutionally sanctioned social influence. Often informal social control is manifested through normative influence of the micro social networks of referent groups. It is likely that the most immediate micro-level referent group has the strongest influence on HIV-related behavior; however, higher structural levels can also impede or facilitate the detection and prevention of HIV.

Social norms, a key component of social influence and control, are maintained on the meso and macro levels. Social norms at the macro level, such as those regarding drug use, same sex behaviors, gender roles, and condom use, have a major impact on risk behaviors and transmission of HIV. Also on the macro level, media is a form of social influence that is often mediated by meso and micro level social networks. Informal social influence and control additionally occurs through opinion leaders and their social networks and through community monitoring of behaviors.

Formal social control involves institutionally sanctioned social influence. On the macro level, this includes laws and policies and involves the organizations whose mandate it is to address specific public issues. The interpretation, implementation, and enforcement of laws and polices occurs at all structural levels. In many countries, the criminal justice system has much more power than the public health system. Structuring policies so that the public health sector is primarily responsible for drug use issues is likely to have different consequences than if the criminal justice sector is the primary agency. Ideally, the criminal justice and health ministries collaborate. In Taiwan, the formal and informal linkages between the criminal justice and health sectors have lead to comprehensive needle exchange and methadone maintenance programs throughout the country [57].

Social interconnectedness refers to the structure of social relationships. On the micro and meso levels, social networks are a key component of social interconnectedness. Social networks may be located within a micro-setting such as a bar, a meso-setting such as a neighborhood, or a macro-setting such as a social media and information network. Networks can be face-to-face or electronic. Social networks have structural properties, such as density of ties, centrality of key members, and size. They also have functional attributes, such as material or emotional support, and role relationships, including family members, co-workers, and drug and sex partners. There are also higher level networks, such as those between formal organizations and political groups. Social interconnectedness at the macro level may be shaped by national policies that specifically address segregation by race, gender, and social economic status. Often macro-level policies have significant consequences on social relationships. The legality of gay marriages is a macro level policy that may have major influences on the social relationships of couples and families and their interactions with larger social institutions.

Settings have geographic, spatial, or social boundaries. On the micro level, these may be risk settings such as bars, brothels, and shooting galleries, or resource access points, like HIV testing centers and STI and HIV medical clinics. The locations and layout of resource settings may effect whom they attract and reach [58]. The design of a clinic may influence the perception of suitability for women, couples, families, and stigmatized groups. At the meso level, relevant settings may include neighborhoods or schools. Several studies have examined how neighborhood factors are linked to HIV risk behaviors and numerous interventions have targeted schools [59, 60]. Still, few prevention interventions target whole neighborhoods and

few studies have examined school-level differences in HIV risk behaviors.

Macro-settings comprise larger geographic areas such as cities, states, or countries. Within macro level settings, HIV prevalence, laws and policies on drug use and commercial sex, economic conditions, and political leadership may have significantly influenced HIV incidence rates. The "success" stories of HIV prevention in Uganda and Thailand exemplify efforts at the macro level, but the achievements of these programs were also due to the allocation of resources and the activation of concerted influence and control processes at other levels. Though policies and resources were prescribed at the macro level, the programs were successful in reaching micro social environments [61].

Inter-Individual Processes

Inter-individual processes in the model can be viewed as the direct interaction of people with their immediate physical, social, and societal environments. Through these processes, material resources and information flow from larger social structures to individuals [62] and from individuals to their micro-structural contexts. Further, individuals within small networks may influence the macro level through organized efforts to demand changes in policies and allocations of resources. These macro level changes will in turn influence meso and micro level factors and eventually change the immediate social context where individuals interact.

Key factors in the interaction between structural factors and individuals are social influence and control processes. Social influence and control may include enforcement of laws and policies. Arresting drug users for carrying syringes or clients and commercial sex workers for carrying condoms are social control mechanisms that may increase risk behaviors [63]. Other factors such as the behaviors of social network members, including their reactions to other individuals' behaviors, their modeling of behavior, and their provision of information, social rewards, threats of punishment and breaking ties all greatly influence individuals' cognitive and affective processes and subsequent behaviors. Social influences are not unidirectional. Usually, partners and peer groups negotiate resources and risk behaviors. Patients or clients and health providers negotiate HIV testing. Disclosure of HIV status and sexual orientation among dyads and families is often a negotiation process. These negotiations may be overt or more subtle forays to determine how others will react to disclosure or risk reduction practices [64].

The ties between individual and structural factors by way of inter-individual processes are bidirectional. They can involve loose or tight connections, emergent properties, feedback interactions, or diminishing returns through entropy.

Within-Individual Cognitive and Affective Processes and Individual Attributes

The proposed model acknowledges that cognitive and affective processes of the individual are malleable. These processes involve cognitive constructions and affect regulation. Key cognitive constructions for the individual that shape identity and social roles include gender, ethnicity, and sexuality. Perceived norms and social identities are constructed with constant feedback from the social environment. The same occurs with risk perceptions and definitions of safer practices. The meanings developed through these processes influence motivations to maintain or alter behaviors, which may also be sustained or changed in interaction with the social environment and the resources expended and received from this interaction.

Affective regulation processes also shape the relation between individuals' behavioral outcomes and the dynamics and components of structural systems. Coping with depression and dysphoria and the physical and psychological impact of withdrawal from opiates, alcohol, and stimulants involve affective regulation processes that may affect risk practices [65]. Further, both affective and cognitive processes are shaped by other attributes of the individual such as biological sex, age, mental health, HIV status, and physical disabilities. Risk reduction skills can be viewed as both an attribute of the individual and as an ongoing process based on the mental and in situ practice of skills and the feedback derived from the proximal social environment when enacting those skills.

Access

A key factor linking HIV-related behavioral outcomes to multilevel structural factors is access. This includes access to risk reduction technologies, such as condoms and syringes, as well as access to information, subsistence, and sources of power or influence. Access to prevention tools is influenced by prices, laws, and distribution infrastructure. The enhanced access provided by needle exchange programs has had a dramatic influence on syringe sharing [66]. Access to HIV testing is a function of technology, resources, and policies; however, access alone does not necessarily lead to increased uptake of HIV testing. In addition to resources to prevent or mitigate HIV risks, access also includes availability of illicit drugs, alcohol, and sexual partners, including main, casual, and exchange partners who may or may not be infected with the virus.

Application of the Model

Safer Injection Facilities

Safer injection facilities are sanctioned physical settings where injection drug users can inject pre-obtained drugs under the supervision of health care professionals. One of the main goals of SIFs is HIV prevention by providing access to clean injection equipment and ensuring that injection equipment is not shared. Health care professionals are also available to address drug overdoses and other health needs such as treating injection site abscesses. Many SIFs also have staff to address other needs, such as drug treatment, HIV testing, and housing. To be viable, SIFs need to be explicitly or tacitly sanctioned by criminal justice officials in countries where injection drug use is illegal. According to the European Monitoring Centre for Drugs and Drug Addiction, more than 60 of these facilities operate in Europe [67]. There are also several SIFs in Australia and one in Vancouver, Canada [68]. Table 1 presents an analysis of SIFs from a structural perspective.

SIFs require *allocation of material and financial resources* at multiple levels (e.g., state and local) to staff and equip the facility. Allocation of resources for social services, particularly services of a controversial political nature, may be highly contested, resulting in under-resourced facilities and potential reductions in the effectiveness and the impact of the programs. *Scientific knowledge* about medical treatments can be viewed as an input, and through research studies to test the program's efficacy or impact, an output of SIFs.

SIFs are shaped by various, potentially conflicting sources of *influence and control*. In addition to reducing morbidity and mortality among drug users, a goal of SIFs is to change social norms through *informal social influence*. SIFs legitimize the treatment of injection drug use as a medical concern and the involvement of health care workers in the process of injection of illegal drugs. However, controversies over the appropriate interactions with drug users in the community are likely to generate a backlash despite efforts to change popular opinion. Establishing SIFs also requires *formal systems of influence*,

Table 1 Structural analyses of SIFs

	Macro	Meso	Micro
Material resources and allocations	Budget (city, province, country) devoted to HIV prevention & drug treatment; price of drugs as a function of laws, enforcement, and competition	Cost of rent in the neighborhood; public transportation for access to SIF; social services in the community (food, shelter, economic opportunities, drug treatment facilities)	Hours of operations; services provided at the SIF; on-site staff and equipment; level of poverty among clients; provision of sterile equipment and other harm reduction prevention supplies
Science & technology	Use of scientific evidence to support funding and policy decisions for SIFs; research on HIV prevention & drug treatment	Study of the impact of SIFs on the community; scientific knowledge level of community on substance use & HIV	Research study of SIFs; Narcan for overdose response; type of syringes available; availability of other innovative prevention and treatment technologies on site
Informal social influences	Informal leadership of city, province, country, including advocacy efforts; norms of legal jurisdiction (city, province, country) on how drug users are treated and how drug use is viewed; cultural redefinition of addiction as medical issue	Community norms; neighborhood monitoring or harassment; neighborhood opinion leaders; selective law enforcement by local police	Social norms of the setting regarding HIV risk behaviors; types and frequency of drug use; presence of peer interventionist modeling prevention practices
Formal social control mechanisms	Establishment of drug use laws and policies, and laws pertaining to the role of medical providers; formal leadership of city, province, & country; political party in power; police power/authority	Interpretation and enforcement of laws; policing patterns; arrest of drug users in neighborhood	Formal rules of drug use in SIFs; monitoring of clients; management of SIFs
Social interconnectedness	Interaction of drug users and residents; networks of those involved in SIF; drug policy—both those supporting and opposing	Networks of drug users within the community and links of drug users to family and non-users; networks of community members	Networks within the SIFs; interactions between clients and staff; organizational/management structure of SIFs
Settings	Legal geographic boundaries of city, province, country; local geo-spatial characteristics of the area (e.g., urban, rural, suburban)	The neighborhood that houses SIF; proximity of other local services	The rooms where the injections occur; organization of space for specific activities (privacy, group interaction, sterile facilities)

including community support and a political system that allows for public health concerns to influence a socially sanctioned behavior, which is usually viewed as the purview of the law enforcement system.

Contextual factors are highly relevant to the success of a SIF. An important goal of SIFs is to change the *social relationships* in the injection process. Health professionals or paraprofessionals become involved in the injection process, and the social norms of these settings foster HIV prevention. Potential consequences of SIFs may be to alter the drug network structure or the social norms of drug networks to discourage the sharing of injection equipment. The *physical locations* of SIFs are also critical. To be effective, SIFs need to be located in geographic areas near a large number of injection drug users. However, areas that can provide drug users with easy access may encounter resistance if they are perceived to be too visible.

Beginning in 2003, the regional health authority in Vancouver, Canada was granted by the federal government a legal exemption to pilot a SIF program. The Vancouver SIF survived because the Supreme Court of the Province of British Columbia granted the SIF in Vancouver constitutional immunity from Canada's drug laws. As a condition of the initial approval of the Vancouver SIF, an innovative scientific evaluation was integrated into the program. Mixed methods were used, including qualitative and quantitative interviews of drug users (some of whom used the SIFs and some of whom did not) and analyses of community data sets on crime and drug overdoses. The Urban Health Research Initiative of the British Columbia Centre for Excellence in HIV/AIDS produced over 30 peer-reviewed studies on the SIF. These studies document the benefits to the users [69–74]. Moreover, several of the research studies document the absence of significant negative consequences for the SIF participants or the adjacent community members. The investigators even documented how the local police have played an important role in referring drug users to the SIFs, and have shown how continued public injections are due in part to the lack of access to the SIF among some drug users [74]. The strong scientific data researchers generated by studying the Vancouver SIFs created a feedback loop. After the pilot program was established, the results of the empirical studies provided political power to advocate at the meso and macro levels to maintain the SIFs because of their benefits at multiple social levels.

Voluntary Counseling and Testing

It is estimated that 21% of the people living with HIV (PLWH) in the United States are unaware of being infected with the virus [75]. Because most persons who are infected with HIV reduce risk behavior when diagnosed [76] and because many also become less infectious with treatment [77, 78], persons who are unaware that they are infected are more likely to transmit HIV than persons who have received an HIV-positive diagnosis [79]. The FDA approved the first HIV testing technology in 1985. From 1985 to 2001, rates of HIV testing among the general population rose to a plateau of 40% [79]. This plateau in HIV testing uptake occurred despite widespread efforts to promote HIV testing. Multiple structural factors influence HIV testing behavior and have contributed to this plateau [80]. Table 2 presents an analysis of these factors from a structural perspective.

A major influence on HIV testing behavior is the physical location or *setting* where HIV tests are provided. Test settings affect HIV testing behavior by influencing two factors, *access*, or whether individuals can obtain an HIV test, and *cognitive and affective processes* including motivation and perceived norms. Persons may have more or less *access* to HIV tests, depending on whether a facility allocates resources to the provision of the tests, has tests available, and prioritizes the provision of HIV tests among other services (e.g., primary care, emergency care) [79–81]. Persons may be more or less willing to test for HIV (*cognitive and affective processes*) depending on whether they are offered the test in a setting where testing for HIV is private, normative, and does not disrupt alternative activities (e.g., socializing, seeking urgent care) [81, 82].

Setting is not only limited to the micro-level space where HIV tests are provided. The community or neighborhood within which tests are provided can also influence individuals' HIV testing access and willingness to test. Whether HIV tests are available in one's neighborhood can influence whether one accesses HIV testing because the demand for preventive services is sensitive to the cost associated with preventative care (e.g., travel, child care) [83, 84]. The community or neighborhood setting can also influence whether an individual is motivated to test for HIV. Factors such as the HIV prevalence in a given neighborhood or the density of outreach activities and educational displays can increase perceived vulnerability to HIV, a motivational influence on HIV testing behavior [85, 86]. Importantly, the degree to which services are integrated and visible in a community setting may create positive social norms toward testing by reducing fears of stigma and discrimination, important deterrents of HIV testing [16, 87].

Finally, the macro setting, such as the state or nation, can influence HIV testing behavior. For example, political and demographic lines can demarcate resource allocation for HIV testing (e.g., greater allocation to urban vs. rural settings or differential allocation to zip codes with predominately minority populations) [86]. These lines can also demarcate formal rules about testing provision and

Table 2 Structural analyses of voluntary testing and counseling

	Macro	Meso	Micro
Material resources and allocations	Budget devoted to HIV testing and HIV testing promotion; resources allocated to the discovery of HIV treatment, new HIV testing technologies, and HIV surveillance	Cost of transportation to HIV testing services; outreach and community HIV testing programs	Hours of operations, alternative and complementary services; staffing and equipment for HIV tests
Science & technology	Research on HIV treatment and rapid HIV testing technologies; studies on the impact of undiagnosed cases in the course of the HIV epidemic	Impact of HIV testing community promotion programs	Studies on testing sites and client preferences in that site
Informal social influences	Informal leadership of city, province, country; positions of religious, political, and cultural leaders; prevalent stereotypes about HIV, risk behavior, and risk groups	Community norms; neighborhood monitoring; neighborhood opinion leaders	Social norms in the setting about HIV, risk behaviors, and risk groups (staff and clients)
Formal social control mechanisms	Legal requirements to conduct HIV tests (informed consent and pretest counseling, anonymous versus confidential) and provide and communicate results (e.g. counseling, referrals notification requirements) HIV testing laws applied to specific groups (pregnant women, immigrants)	Interpretation and enforcement of laws	Formal mechanisms for HIV testing in testing sites (e.g., decision rules to recommend HIV testing to certain individuals, provision of results, partner notification procedures)
Social interconnectedness	Interaction of organizations involved in the development, prescription, and promotion of HIV tests, and organizations of potential users (human rights)	Networks of potential clients in a community (circulation of information and referrals, social incentives and deterrents)	Relationships among providers in the HIV testing facility in terms of competing activities, priorities, and resources; relationships between clients and staff; relationships among clients and their networks
Settings	Political and demographic boundaries; number and variety of testing sites within those boundaries	Local availability of HIV testing sites; HIV prevalence and density of educational programs in a community	Privacy, predominant norms, and competing activities in the site of HIV testing provision (community, outreach, and clinical sites)

reporting of results (e.g., policies about anonymous vs. confidential HIV testing, partner notification programs, mandatory reporting). Both resource allocation and formal rules delimit physical spaces where individuals and groups may find it more or less difficult to access services or feel more or less motivated to receive an HIV test.

Reception to HIV testing also depends on how different individuals, groups, and organizations *interact* in immediate and broader settings (*social interconnectedness*). At the micro level, interactions that can affect HIV testing behavior involve relationships among staff in the testing facility. The competing priorities and responsibilities of staff at an HIV testing site, whether a clinic, emergency department or a bar, may deter interpersonal connections necessary to carry out HIV testing objectives [79]. Heavy workloads may make health care providers reluctant to recommend HIV testing. This hinders opportunities for testing among persons at risk, even when individuals have access to health care and other services [88].

Other interpersonal connections that can influence individuals' HIV testing behavior are their interactions within their networks and communities. Individuals' interactions with their immediate network and the larger community provide *resources* (e.g. referrals or information) and act as *informal sources of social influence* (e.g., role models) and *control* (e.g., social segregation or integration mechanisms) [89]. Program developers have taken advantage of these spontaneous connections to increase HIV testing uptake. For example, the CDC has funded CBOs to provide incentives for at-risk individuals to persuade members of their immediate networks to request an HIV test [90, 91]. Other examples of interventions making use of spontaneous social connections are social network and community-based programs [92].

Informal social influences also operate within immediate networks (e.g., friendship groups) or broader networks (e.g., neighborhoods) by providing social perceptions about HIV, the behaviors associated with HIV risk (e.g., sex, drug use), and the most affected groups (e.g., MSM, drug users, sex workers). Similarly, informal sources of support and control influence HIV-related settings (e.g., availability of spaces and times to engage in healthy or risky behaviors)

[93]. However, changes in settings can change social control effects (e.g., greater availability of services in the community creates more positive HIV testing norms) [16]. Broader and more distal informal social influences on HIV testing include the endorsement or disapproval from role models including religious, political, or cultural leaders.

Finally, HIV testing behavior can depend on interactions among organizations at the county, state, national, and even multinational levels. These include organizations involved in HIV testing development, provision, and promotion (e.g., technology, research, public health and medical groups), organizations that represent the interests of potential clients and affected individuals (e.g., human rights groups), and organizations that develop HIV testing policies (e.g., legislative entities).

Interactions among macro level organizations can ultimately influence *resource distribution and allocation*, *scientific and technological development*, *formal control*, and *settings*. Social interactions at the macro level affect such diverse factors as the types of HIV tests available, the way HIV tests are provided, the decision rules for testing a person for HIV, the allocation of HIV testing resources among different communities, and the medical and legal consequences of testing positive for HIV. Interconnections at this level, therefore, strongly determine other structural influences on HIV testing and ultimately affect both individuals' perceptions about HIV testing and their access to HIV tests.

Formal social control can significantly affect HIV testing uptake. Most relevant are laws and policies that influence individuals' decisions to be tested (e.g., anonymous testing, case reporting, partner notification) and laws and policies that address the consequences of an HIV-positive test result (e.g., anti-discrimination, access to treatment). HIV-related laws to protect individual privacy and prohibit discrimination against persons living with or affected by HIV addressed perceived barriers to testing such as fears about these repercussions. These rights-protective laws encouraged persons at risk to seek testing voluntarily, which, by increasing testing rates, in turn required that resources be allocated for more HIV testing.

New science and technologies, including the advent of effective treatment and rapid HIV testing technologies as well as research pointing to a disproportionate number of infections attributed to individuals unaware of their HIV positive status [75], led public health leaders to reformulate the national approach to HIV testing. Relying on individuals to seek HIV testing services proved insufficient to increase the number of identified cases to significantly reduce HIV incidence [78]. Consequently, the CDC began to recommend that most adults be routinely tested [94]. Because this approach does not require individuals to initiate the testing process, motivational interventions to increase HIV testing may play a lesser role in achieving national HIV testing objectives than increasing access to HIV tests (e.g., efforts to mitigate the effect of competing priorities on provider ability and willingness to offer patients HIV tests and to recruit and train additional testing personnel) [79, 94, 95]. From a structural systems perspective it is important to assess how national HIV testing guidelines may lead to unanticipated changes at the macro, meso, and micro levels. It is also important to examine how the reallocation of resources to support increased testing may impact other HIV prevention programs and organizations and to assess whether policy changes alter norms regarding pre- and post-test counseling. One potential unanticipated outcome may be the altering of social interconnectedness through greater serosorting behaviors.

Ethical Issues with Structural-Level HIV Interventions

Although structural interventions make fewer demands on individual resources, the ethical implications of attempting to manipulate structural-level factors to affect individual behavior can be quite serious. As described above, structural forces are broad, external to the individual, and beyond individual control. Structural interventions may leave some individuals pursuing goals that they did not choose with methods that they cannot avoid. Such programs can compromise individual autonomy by burdening or eliminating behavioral options, thereby reducing individual choice. For example, criminal laws that require persons living with HIV to disclose their serostatus to prospective sexual partners effectively preclude infected individuals from legally exercising other options, such as practicing safer sex or engaging in alternatives to penetrative sex [96]. The option to allow intimacy to develop incrementally and to disclose as trust builds is eliminated or at least burdened with the possibility of felony charges.

Structural interventions can also compromise autonomy by imposing the interventionists' priorities and values. In most cases, interventionists operate under the assumption that health takes precedence over any priorities that the intervention efforts replace (e.g., pleasure, relationship development, economic security). When these assumptions serve as a basis for structural interventions, the effect of which may be virtually unavoidable for those in the intervention area, the intervention effectively imposes this priority on others. Micro finance interventions are based on the assumption that individuals should welcome the opportunity to become entrepreneurs. However, many of these endeavors produced mixed results, in part because entrepreneurship is not universally desirable [97, 98].

Efforts to routinely test all U.S. adults can serve as another example. While concentrating on the important goal of testing individuals for HIV infection, practitioners

may persuade individuals to be tested at a time when an HIV-positive diagnosis could topple an already unstable housing or employment situation or end a primary relationship. Structural interventions can also incur risk for persons who do not consent to test. Routine HIV testing increases the likelihood that some persons will be diagnosed with HIV or another condition when they do not have health insurance. The intervention then creates a documented preexisting condition and may preclude an individual from receiving health benefits in the context of current insurance coverage standards. Increasing risk for individuals who have not consented to this new risk is especially of concern if the individual who is put at risk by the intervention does not receive benefit from the intervention. This occurs, for example, with criminal HIV disclosure laws, which increase the risk of unwanted secondary disclosure of HIV-positive persons' serostatus by requiring disclosure if they want to engage in sex.

Because structural interventions make system wide changes, there is the risk that intervening factors may produce unanticipated and potentially deleterious outcomes. These outcomes may not only be difficult to anticipate, they may be difficult to neutralize or to control. Public trust, once called into question, especially by persons who occupy marginal positions in society, may be exceedingly difficult to regain. The collective memory of a community is a significant structure in itself.

Methods to Study Structural Factors

The broad scope and complex nature of structural factors and structural interventions create myriad challenges for research. Studies of structural factors affecting HIV-related behavior have fallen into three general categories. The first approach is to assess the impact of structural interventions at the macro, meso, and micro levels that were not initially designed to change HIV-related behaviors directly. The second is to assess structural factors that shape the context and processes of the epidemic and its eradication. A third approach includes experimental tests of the effects of structural interventions specifically designed to reduce the transmission and impact of HIV.

One example of the first approach is to assess the impact of district-wide interventions to reduce bullying in schools in the U.S. on levels of homophobia and risk behaviors among adolescent MSM. Another example is to study reproductive health clinics in high schools, both upstream on the macro level by examining the political systems and actors that lead to the establishment of the clinics, and downstream, at the meso and micro levels, by focusing on teachers' and students' attitudes about the clinics and condom use norms and practices.

The second approach includes examining the existing distribution of macro- and meso-level factors that may influence HIV prevention behaviors. For example, the number of gay bars varies by urban area and may influence sexual mixing patterns and risk behaviors. The assessment of differences in syringe access laws by jurisdiction and HIV rates is an example of the impact of structural level factors on HIV risk behaviors [99]. In the U.S., some states had less restrictive syringe access laws before the HIV epidemic. Others changed their laws in response to HIV, and some were highly resistant to increase syringe access even in the face of the HIV epidemic. There are many opportunities to study the dynamic influences of structural factors on HIV risk behaviors using this approach. Natural disturbances in systems such as new laws and law enforcement practices may lead to alterations in settings, resource allocations, and social configurations. The establishment of drug courts, legalization of gay marriages, and changes in legislation for syringe access may alter systems that lead to changes in HIV prevention behaviors. Moreover, even the same laws are often not simultaneously implemented in all jurisdictions, and there is often latitude in how they are implemented. Common measures across jurisdictions may allow for comparisons of the impact of laws and policies and their implementation.

Basic research on structural factors and dynamics represented by these first two approaches comes with significant theoretical challenges. One is the complexity and "immensity" of structural factors (i.e., their social distance from the individual and his/her ability to affect them), and the difficulty of distilling and/or unpacking key components on multiple levels that are hypothesized as most relevant to the particular question. The matrix of multilevel structural factors in our model represents the possible arenas to consider in building theory related to a specific problem; but not all arenas are relevant in each case. This complexity also makes it challenging to identify achievable actions to change these structural forces and constraints. Yet another problem is the difficulty both of conceptualizing the relationships between levels of structural factors, including their relationships with the individual level, and effecting change on these levels or on their hypothesized relationships. Applying dynamic systems theory to test relationships among components of structural factors on multiple levels and testing multiple pathways in their relationships to individuals provides a means to organize and reduce this complexity and examine avenues of intervention.

The third approach to structural research on the HIV epidemic is to involve researchers in both the implementation and evaluation of structural interventions that have the explicit goal of reducing HIV risk behaviors or increasing awareness of and access to resources needed to

prevent infection or provide testing or care for the infected. In general, such efforts require a significant and long-term commitment of resources to achieve measurable outcomes. In some cases, because of the complex inputs in multilevel or structural interventions and the potential for numerous unanticipated or unmeasured confounders, the reasons for a lack of measurable affects of these interventions, or even for their stunning successes, might not easily be identified.

Structural Intervention Design and Evaluation

Challenges in the measurement and evaluation of structural intervention outcomes are increasingly the topic of scholarly debate. There is a lack of consensus about the appropriate research designs to provide valid outcome data. Particularly in question is the appropriateness of the RCT as an effective evaluation design for structural interventions [100, 101]. Although RCT remains the gold standard for testing medical instruments, new drugs, and individual-level behavioral interventions, the value of RCT when testing multilevel and community-level interventions is less clear and its limitations are increasingly evident [102, 103]. RCTs may not answer the questions of greatest importance, such as what systems are most malleable, what leadership factors lead organizations to success, and what factors lead to sustainability. Furthermore, issues of feasibility (e.g., randomization of sufficient "units" of study, such as cities, communities, macro networks, etc., while preventing contamination of control and intervention arms) and ethical considerations (e.g., the potential for greater benefits than just health, and for unanticipated negative consequences in randomized units) raise questions about the ultimate scientific and social benefits of using RCT designs to test structural interventions [100, 104, 105].

Alternative evaluation designs are needed that allow intensive study of the complex iterative and interactive change processes in the local context [101, 102, 104]. These include such alternatives as qualitative and observational studies [105–108], multiple baseline or crossover studies [109], comprehensive dynamic trials [110], and comparative case studies [111–114]. These alternative research designs address weaknesses of RCT through the use of multilevel modeling and various time series approaches that structure comparisons within a small number of "case studies" (or communities) over time. They address interactions across levels through careful designation in advance and measurement of intervention components at each level, and through measurement of inter-level exposures using ethnographic observation. Thus, they are better suited to testing multi-level community intervention change processes and outcomes and are designed to increase external validity [115]. These alternatives allow for measures of the dynamic interplay between community forces and key intervention factors. Process evaluation and analysis are essential components of non-RCT research designs because of the need to understand the relationships and interactive processes among levels of outcomes and to test hypothesized causal factors expected to affect outcomes in order to understand *why* the program worked, or did not, and the mechanisms involved [100, 116]. In observational studies, intensive ethnographic qualitative documentation of process and outcomes is critical in order to minimize both Type 1 and Type 2 errors [44].

The evaluation of SIFs provides a good example of design issues confronting the evaluation of structural interventions. If the investigators had decided to attempt an RCT by randomizing individual drug users, contamination between controls and experimentals would be likely. Moreover, one city is likely to have resources and support for one or only a few SIFs. Even if the sample size of SIFs that could be randomized were sufficiently large, an RCT study design with only pre and post-test assessments would limit the knowledge gained. An RCT could tell us that there was a difference between conditions in levels of risk behavior but not necessarily the cause of those differences. Historic events such as number of drug overdoses in the areas of the city, the availability of drugs, arrests and violence, all differ by geographic area and hence may have a strong impact on both the use of injection facilities and the risk behaviors. Moreover, even in the absence of these historic events and threats to validity, an RCT would not provide information on how to replicate the establishment of a SIF.

Many researchers presume that, due to their complexity, structural interventions have limited generalizability and are more similar to case studies than replicable experiments. Although it may not be possible to replicate a specific structural intervention exactly, it is feasible to replicate the process of intervention implementation and the methods of process evaluation.

Before embarking on structural interventions, it may be useful to conduct an analysis of relevant systems, such as a community readiness assessment. Not all settings are equally appropriate for structural interventions and not all structural factors and dynamics are equally salient to a particular problem. Some communities have high levels of social disorganization and specific programs may quickly decay. A community with few resources and vehemently against harm reduction programs may not be the ideal environment to establish a SIF. A more appropriate goal may be to increase community organization and foster a better understanding of substance abuse before embarking on the establishment of a SIF. Key factors to consider in analyses of structural factors include the stability of these structures, ability of change agents to organize and modify structural factors, the sustainability of these changes, and

potential power of these structural factors to lead to behavior change.

Despite this complexity, there are many opportunities to build structural interventions to reduce HIV/AIDS. For example, it is possible to use extant structural conditions, social action groups, social movements, and dynamic conditions to build action to change the environment and context of risk, policies, and laws. Scientists can take advantage of opportunities to view ongoing events and their impacts (e.g., mass media reports, sex education policy, increased involvement of national leadership, economic crisis) in order to better understand the structural factors affecting HIV/AIDS. Further, structural interventions can be built on resources in the environment and structural conditions that support social action for change.

Yet another approach is to engage affected communities in research and action to facilitate their own ability to bring about broader structural change on multiple levels. An example is the mobilization of interested and highly impacted subgroups and issue-specific coalitions and the grassroots HIV advocacy organizations. Early in the HIV epidemic, the organization ACT UP had a major influence on promoting HIV prevention and treatment. ACT UP was highly successful in pushing for legislative changes and access to governmental resources for HIV research and medical treatment. A structural analysis of ACT UP could examine the structure and leadership of the organization, and how a relatively small group was able to amplify its activities and social influence through media savvy and intense lobbying.

Significant benefits to science and society derive from increasing our focus on structural factors and our efforts to develop and test structural interventions to reduce the spread and impact of HIV/AIDS. We may achieve a more effective understanding of the individual and the couple, family, or peer group within the social context of multilevel contextual factors and dynamics that affect their behaviors. This wider perspective offers the potential to build broader theories that allow specification of non-linear change dynamics expected in complex systems. From a practical standpoint, the study of structural factors and implementation of structural interventions may allow achievement of long-term sustainability and comprehensiveness of intervention outcomes, greater cost effectiveness because of broad reach, and greater impact on the epidemic and its far-ranging consequences. These benefits justify the challenges in cost and scientific complexity of seeking to understand and use structural factors and dynamics to change the course of the epidemic.

Intervention researchers who are working toward the right end of the conceptual model are encouraged to determine the feasibility of incorporating factors toward the left end of the model as well. For example, it may be possible to alter micro-structural factors, such as intervening in risk settings to promote HIV prevention by organizing and training individuals or natural peer groups who use these setting. Syringe exchange interventionists may want to address neighborhood factors and larger community factors, such as transportation and locations that may impede access to syringes and formal and informal polices on syringe possession. Even if researchers believe that it is not feasible to intervene on more distal structural levels, it is often possible to measure these factors and model them as mediators and moderators. Such efforts are overdue and stand to contribute greatly to further understanding of social influences on behavior and more successful and sustainable impact on reducing the HIV epidemic and its consequences.

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