Structural interventions in public health

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Objective: To review structural interventions in public health, identify distinct approaches to structural interventions, and assess their implications for HIV-prevention interventions.

Method: The MEDLINE, HealthStar, PsychInfo and Sociofile databases were searched on specific health issues, types of public health interventions, and conceptual topics (e.g. empowerment, social structure, and inequality) to compile a list of public health interventions in the United States. We excluded interventions focused on testing and surveillance unless they specifically facilitated prevention, and educational or media campaigns focused on increasing individuals' level of knowledge about a particular health problem.

Results: The term 'structural' is used to refer to interventions that work by altering the context within which health is produced or reproduced. Structural interventions locate the source of public-health problems in factors in the social, economic and political environments that shape and constrain individual, community, and societal health outcomes. We identified two dimensions along which structural interventions can vary. They may locate the source of health problems in factors relating to availability, acceptability, or accessibility; and they may be targeted at the individual, organizational, or environmental levels. All together, this framework suggests nine kinds of structural interventions, and it is possible to identify examples of each kind of intervention across a range of public health issues.

Conclusions: The relevance of this framework for developing HIV prevention interventions is considered.

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Introduction

In this paper, a range of structural interventions that have been adopted to address public health problems are reviewed. We use the term 'structural' to refer to interventions that work by altering the context within which health is produced or reproduced. Structural interventions locate the source of public-health problems in factors in the social, economic and political environments that shape and constrain individual, community, and societal health outcomes. In some instances, they may attribute these outcomes to the normal functioning of organizations, institutions, or whole social or economic systems; and recognize that health improvements can require changes in or challenges to this functioning.

In order to better understand the different approaches embodied within structural interventions and their potential impact on prevention, we reviewed structural interventions in a wide range of health areas. In this article, based on this review, we develop a

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framework for characterizing and classifying structural interventions and, very briefly, consider its relevance for HIV prevention.

Methods

To compile a list of structural interventions for promoting public health, we searched the MEDLINE, HealthStar, PsychInfo and Sociofile databases on specific health issues (e.g. tuberculosis, food-borne illnesses, lead poisoning, firearms, etc.) We also searched on specific types of public-health interventions (e.g. fluoride, bicycle helmets, product safety standards), and conceptual topics (e.g. empowerment, social structure, and inequality). We then selected three types of articles for review: evaluations of what appeared from the abstracts to be structural interventions; descriptions of such interventions, even if they did not include an evaluation; and any legislation or government initiative relating to public-health prevention, some of which were ultimately determined not to qualify as structural interventions. We excluded interventions focused on testing and surveillance unless they specifically facilitated prevention, and educational or media campaigns focused on increasing individuals' level of knowledge about a particular health problem. In addition, we focused primarily on interventions in the United States.

Our initial search yielded approximately 1000 abstracts or articles, about one-third of which were ultimately selected for full review [1]. It is worth noting at the outset that the range of approaches analyzed in this article is narrower than we would like because it has focused primarily on what 'is' (existing interventions), and not what 'might be'.

A framework for classifying structural interventions

Our analysis suggests that, while structural interventions have located the cause of public-health problems in the social, political and economic context, they have focused on three kinds of contextual factors that determine health: availability, acceptability and accessibility.

Approaches that focus on 'availability' emphasize the behaviors, tools, equipment, materials, or settings that are necessary to prevent individuals from being exposed to the particular health problem, or that are necessary to facilitate healthy outcomes. Availability interventions are based on the assumption that health problems result from the lack of or, conversely, the excessive availability of these tools, behaviors, or settings. In general, they can either increase the availability of the means to reduce risk, or reduce the availability of those that represent a risk.

Structural interventions that focus on 'acceptability' promote public health by altering social norms. Such interventions recognize that the health of a society and of its members is partially determined by its values, culture and beliefs, or those of subgroups within it. Public health is implicated when risky behavior is glamorized or promoted as 'normal', or safe behaviors are stigmatized or represented as 'deviant'.

Finally, structural interventions that emphasize 'accessibility' explicitly acknowledge that health is a function of social, economic and political power and resources, and, as such, manipulate power and resources to promote public health. In this way, they are distinct from availability interventions, which focus on providing more or less of the settings or tools themselves but do not recognize that the ability to avail oneself of them may be restricted by lack of resources and power. Accessibility interventions can increase access by consciously providing the tools, mechanisms, behaviors or environments for addressing health problems in ways that benefit all social groups: by increasing the social, economic or political power of those whose marginalization prevents their health and well-being; or by altering the structures and processes that promote social, economic or political inequality.

While all structural interventions seek to change the social context in order to promote public health, they can also be distinguished from one another according to whether they are targeted to individuals, organizations, or the social, legal or physical environment. Interventions targeted to 'individuals' affect public health by attempting to modify individual behaviors (for example, placing restrictions on risky behaviors). Those targeted to 'organizations' affect public health by affecting the functioning or structures of organizations or institutions such as industry, professional associations, or educational institutions. Interventions may also affect public health by targeting the social, legal or physical 'environment' more generally. Table 1 visually depicts this two-dimensional classification scheme and gives examples of interventions represented in each category. In the following, these different kinds of interventions are described in greater detail.

Availability interventions

Availability interventions comprise some of the most common and familiar structural interventions in public health (see Table 1). When targeting individuals, these interventions often take the form of explicit restrictions on, prohibitions against, and penalties for

Table 1. A framework for conceptualizing structural interventions in public health[a]

	Intervention targeted toward:		
Source of problem	Individual level	Organizational level	Environmental level
Availability	Seat belt laws Bicycle helmet laws Motorcycle helmet laws Speed limits Minimum driving ages License revocation Taxation of high-fat/ high-cholesterol foods Taxation of tobacco products Insurance discounts for use of seat belts Gun safe-storage laws Cigarette vending machine locks/bans Criminalization of drug use by pregnant women	Prohibitions against sale of alcohol/ tobacco to minors Public ordinances requiring smoke-free public buildings Mandatory reporting of child-abuse disclosures Designated-driver programs Litigation holding gun manufacturers responsible for shooting deaths, or tobacco industry for tobacco-related deaths Dram Shop Acts Autoindustry safety standards Regulations of food industry Removal of lead from gasoline Requirements for child safety locks on guns	Making state receipt of federal funds contingent on passage of laws such as minimum drinking age Incentive grants to states encouraging them to adopt specific blood-alcohol standards Regulations on public space (e.g. prostitute or drug-free zones) Enhancement of public-transportation systems Immigration policies restricting entrance of individuals with certain diseases
Acceptability	'Shaming initiatives', such as public display of pictures of male clients of prostitutes Anti-drug T-shirt giveaways	Industry boycotts Counter-ads Regulations on the advertising of alcohol and tobacco products Regulations on violence in the media Use of more average and large-sized models in fashion advertising Public-service messages promoting responsible drinking, denouncing violence against women	US Postal Service elimination of cigarettes from famous pictures depicted in stamps Social marketing
Accessibility	Free bicycle helmet distribution programs Car seat giveaway programs Free school-lunch programs	DOT through outreach to park benches, shelters, etc. Zoning regulations relating to sale of alcohol Prohibition of single-cigarette sales	Water fluoridation Medicaid coverage of mental health and drug treatment services Medicaid coverage of family planning Community-based initiatives to reduce child abuse

[a]This table is meant to be illustrative of the kinds of interventions that characterize each category; it is not inclusive. Inclusion in this table does not necessarily signify that the intervention has been successful. DOT, Directly observed therapy.

unsafe or risky behavior. Examples of such interventions include seat belt laws, bicycle and motorcycle helmet regulations, speed limits, taxation of tobacco products, and criminalization of drug use by pregnant women. Such interventions target individuals by manipulating the incentive structure within which health-related decisions are made, attempting to reduce the availability of risk-taking as a behavioral option. Conversely, interventions may consist of the provision of incentives to individuals who engage in safe behavior. For example, insurance companies often provide discounts to customers who regularly use safety devices such as smoke detectors and seat belts. In either case, these availability interventions involve minimal change to the social context, reflecting little concern for the structural factors that may explain why individuals make the health-related behavioral choices they do. Instead, they provide structural incentives that, to greater or lesser degrees (fines versus incarceration), seek to force individuals to stop taking risks.

Another group of availability interventions targeted to individuals operates by impacting on the distribution or availability of dangerous or healthy products, rather than behaviors. These take the form of regulations, policies or practices that are meant to increase the availability of products that promote

health or reduce the availability of harmful products. Examples include gun safe-storage laws, programs or regulations relating to cigarette vending machine locks, and requirements for background checks before purchasing firearms. Instead of coercing individuals into healthy behaviors, these interventions change the context within which individuals make health-related decisions by providing tools or mechanisms that make it more difficult to engage in risky behavior.

Availability interventions also may be targeted to organizations, by involving them in the prevention of risky behaviors. These interventions may prohibit organizations or establishments from providing unsafe products or services, require that they provide healthy environments, or mandate them to report unsafe behaviors. Such interventions include prohibitions against the sale of alcohol or tobacco products to persons below a certain minimum age, requirements for the provision of nonsmoking sections in restaurants or entire smoke-free facilities, and mandatory reporting of child-abuse disclosures. With any of these, organizations are seen to bear some responsibility for promoting public health. There is the recognition, either implicit or explicit, that even if individuals are required to stop taking risks, it may be difficult to do so in a context in which products or settings that constitute a health risk are widely available. While most such availability interventions have focused on targeting organizations in restricting or expanding the availability of health-related products, another form such interventions have taken is actions that hold manufacturers or establishments responsible for what is done with products they make or sell, or for their health consequences. Litigation against the tobacco industry, holding it responsible for the costs of smoking-related illnesses, and that against the gun industry, holding it responsible for urban violence, are exemplary in this regard; as well as Dram Shop Acts that hold any agent or establishment selling liquor to an intoxicated person liable for that person's actions. These interventions, even more so than those relating to the sale of health-related products, recognize that industry, in the normal pursuit of profit, may actively create product markets and, in other ways, encourage behaviors that they know to be a threat to public health.

Another type of availability intervention targeted to organizations focuses on manipulating the production or design of health-related settings or products rather than on regulating their sales. Many of these interventions take the form of product standards, or standards in the provision of services, such as auto industry regulations requiring cars to have seat belts and shoulder harnesses, food industry standards, and requirements that lead be removed from paint and gasoline.

Availability interventions have also targeted the environmental level, focusing on creating a physical, social or legal environment conducive to public health. One common form such interventions take is federal incentive programs to encourage states to pass laws deemed to promote public health. For example, in 1984, a federal law was passed requiring states either to enact a minimum drinking age of 21 years by 1986, or lose a portion of their federal highway funds [2]. Public space has also been the target of availability interventions, such as initiatives to improve the design of highways to make them safer for travel, elimination of smoking in public buildings, and 'free zones' that seek to prohibit 'undesirable' activities from a specific geographically defined area (e.g. see [3] for a description of the 'prostitution-free zones' of Portland, Oregon). Enhancements to public transportation systems may also promote public-health objectives, as increased spending on public transportation decreases the number of cars on the road and, hence, reduces traffic-related fatalities, and environmental pollution and its associated health consequences.

Acceptability interventions

Acceptability interventions expressly locate the source of public health problems in the normative structure, and focus on manipulating social norms in order to affect public health. A few of these, like some of the availability interventions already described, target individuals in their focus on altering the incentive structures within which individuals make behavioral decisions, although they focus on the social incentive structure. Such acceptability interventions are embodied in what could be termed 'shaming initiatives', whereby individuals who engage in unhealthy or risky behaviors are publicly embarrassed in order to deter the behavior. One example of this can be found in programs in a growing number of communities that seek to eliminate prostitution by publicly displaying the pictures, and even calling the families of men seen using the services of commercial sex workers [4]. Another group of acceptability initiatives targeted to individuals focuses on distributing health messages in order to change norms and thereby affect behaviors. T-Shirt giveaways in the public schools that are designed to spread anti-drug messages among teenagers are one such example.

Acceptability interventions also may target organizations. Shaming initiatives, for example, have their parallels at the organizational level in industry boycotts. One example is the boycott of Nestlé products in the 1970s, which was motivated by a concern that the company's sale of infant formula in developing countries was reducing the practice of breastfeeding and increasing the risk of infant mortality. In part, the boycott was meant to damage the company's public image and thereby force it to change its practices.

Advertising has also been used to promote public health by damaging industry image, as in California and other states where 'counter ads' taken out against tobacco industries direct viewers' attention to industry intent to market products with negative health consequences [5].

A substantial number of acceptability initiatives targeted to organizations involve manipulating the production of messages regarding health-related products. These interventions generally take the form of regulations on the advertising of products or behaviors, such as smoking, alcohol, and violence. In a variation on such interventions, networks, or producers and writers of prime-time television programs are encouraged, and sometimes provided incentives to include public health related messages in their programming in order to normalize healthy behaviors or stigmatize unhealthy ones. For example, the Harvard Alcohol Project [6] encouraged producers and writers to introduce designated drivers into their prime-time programs. The federal government also requires networks to devote a certain amount of time to public service announcements and these have been used to manipulate norms, such as when announcements regarding the unacceptability of wife-battering are aired during major sporting events.

A third group of acceptability interventions are targeted at the environmental level, and are meant to promote a general change in the social environment by manipulating images to which nearly everyone is exposed on a regular basis. For example, in a US Postal Service series of commemorative stamps, classic pictures of performance artists were altered to remove cigarettes [7]. Social marketing, which involves the mass marketing of healthy behaviors, represents another such intervention [8–10].

Accessibility interventions

Accessibility interventions locate public health in the unequal distribution of resources and power, which in turn limits the accessibility of health for marginalized populations. These interventions may seek to compensate for socioeconomic inequities, or they may focus on increasing the social, economic or political power of those who are marginalized. In general, we found fewer examples of accessibility interventions in the literature than other kinds of structural intervention.

Among accessibility interventions, one common form taken are programs that provide prevention materials or tools to individuals, free of charge, including free lunch programs and bicycle helmet or car seat distribution programs. By providing preventive equipment to individuals free of charge, these programs make it accessible to all. In this way, they often extend availability initiatives that disproportionately burden lower-income families, e.g. by requiring children to wear helmets, or parents to drive their infants in car seats, without providing them with the means of doing so.

Accessibility interventions also may be targeted to the organizational level. Some such interventions focus on reorganizing service provision in ways which recognize that, because of their limited resources, some potential clients may have difficulty conforming to, and may even be penalized by, program standards. In this regard, consider a New York City policy that permits the detainment of patients who fail to voluntarily comply with tuberculosis therapy. Because of concern that some individuals would be disproportionately more likely to be detained because of their lack of housing and access to healthcare and other resources, every effort was made to provide for voluntary, directly observed therapy in settings that were accessible, including clinics, homes, park benches, and abandoned buildings [11].

Accessibility interventions have also recognized that organizations or industry may attempt to make unhealthy products accessible to marginalized populations or communities with limited resources, and have intervened in order to counter this tendency. Interventions of this kind have taken the form of zoning regulations aimed at reducing the accessibility of products such as alcohol and tobacco in low-income communities of color [12]. Similarly, research suggests that the sale of single cigarettes is aimed at making cigarettes available to individuals who cannot afford to pay for a pack [13,14]. In such a context, bans on the sale of single cigarettes also comprise accessibility interventions.

One common form that accessibility interventions targeted to the environmental level take is provision relating to public funding, particularly Medicaid funding of health and prevention services. For example, if certain reproductive-health and family-planning services are not covered for people who receive income assistance, they will not be accessible to some groups of women. Similarly, limitations on Medicaid coverage of mental-health and drug-treatment services restrict the accessibility of these services. Child abuse-prevention programs that have sought to address child abuse by providing community support, job training, day care, and medical care to families at risk [15–18] represent another type of accessibility intervention. They have focused on how a lack of social and economic resources can generate abusive behavior, and have sought to alter the social context in which child abuse is produced by creating a local environment designed to increase residents' ability to demonstrate nurturing rather than abusive behavior.

We believe that the described framework provides a useful tool for distinguishing among types of structural intervention. It also demonstrates that changes in individual behavior are not the only path to improved public health. Certainly, some structural interventions are meant to promote individual behavior change, such as, for example, speed-limit laws and criminalization of drug use during pregnancy. But a large number of structural interventions operate to promote public health without necessarily altering individual behavior. For example, various product standards serve a public-health purpose without causing a change in individual behavior. Indeed, in many instances, they accept that individual behavior is not likely to change, and focus on changing the consequences of that behavior instead. Interventions requiring production of lead-free paint, or bacteria-free food, demonstrate this. People still buy paint and food, but the health consequences of their actions are less harmful in the presence of these interventions.

In spite of its utility, this framework, like any classification framework, makes static, for the purposes of classification, what are, in the real world, dynamic and complex processes, so it cannot be applied too rigidly. The categories in this classification scheme are not mutually exclusive, and interventions may be multidimensional, in that they may target or impact upon multiple areas and levels simultaneously. They do so in various ways.

Structural interventions may primarily target one level – individual, organizational, or environmental – but have an impact on one or both of the others. For example, smoke-free public buildings or restaurants are interventions primarily targeted to organizations but, from the perspective of smokers, they work through organizations to change individual behavior by defining when and where individuals may smoke, and perhaps, in the process, reduce the time they spend smoking.

Similarly, structural interventions may primarily target the area of availability, acceptability, or accessibility, but, in their operation, impact on one or both of the others. For example, seat belt or child safety seat laws are availability interventions whose existences have undoubtedly affected acceptability by changing social norms regarding the use of this safety equipment. Also, accessibility interventions expand availability as they confront inequities in power and resources.

Some structural interventions are designed to target more than one area simultaneously. The school-lunch program of Hartford, Connecticut, which provides lunches free of charge to all students, represents a shift from an earlier policy in which the students who received free lunches were easily identified by the color of their lunch tickets, and thereby stigmatized [19]. The current intervention provides all children with free school lunches, regardless of economic status, and thereby gives poor children access to lunches without stigmatizing them. Hartford's school-lunch program attends to all three problem sources: it makes lunches accessible to all in a way that also increases their acceptability and expands their availability.

Finally, some public-health problems have been addressed with packages of interventions that combine different types of structural intervention. Consider interventions to reduce traffic fatalities. Seat belt laws address this problem by targeting individuals. Regulations requiring auto manufacturers to build cars with seat belts address it at the organizational level, and interventions to improve highway safety address it at the environmental level. It is possible to imagine each of these interventions in the absence of the others, but the most comprehensive approach is clearly one that seeks to address traffic injuries and death at each level simultaneously. This quality of multidimensionality, therefore, signifies a potential strength of structural interventions in public health rather than a weakness of our classification scheme.

Implications for HIV prevention

Although we have only touched on some of the many examples of structural interventions in public health in this article, it is clear that they have a considerable history of use, and reviews of research in a number of areas indicate that they have had a sizeable impact on tobacco-related illness (for example [20–23]), on motor-vehicle-related injuries (for example [24,25]), on skin cancer (for example [26–29]), and on gun-related injuries (for example [25,30,31]). This history suggests that there is also an important place for structural interventions in HIV prevention. As we have indicated, however, structural interventions may take a variety of forms. What do we know of their success and what are the implications of this for HIV?

In this paper, we cannot provide an exhaustive discussion of either evaluations of existing interventions in non-HIV public health or existing and potential structural interventions in HIV. (A number of structural interventions in HIV are the subject of more detailed discussion in some of the other articles in this special issue.) Instead, we classify in this article some examples of existing or potential HIV interventions within our framework, and briefly describe some of the potential strengths and limitations of structural interventions in non-HIV public health areas, and their implications for HIV prevention.

Research has demonstrated the effectiveness of a number of availability interventions focused on prohibiting or regulating individual behavior. For example, license suspensions are an effective sanction for drunk-drivers (discussed in [32]). Similarly, according to a General Accounting Office [33] review of 49 studies, motorcycle helmet laws significantly reduce fatalities, increase helmet use, and reduce public costs for injuries (see also [34–36]). In a review of research, the Council on Scientific Affairs of the American Medical Association [37] concluded that wearing a helmet reduces the relative risk of head and brain injuries among bicyclists in a number of US cities. There is disagreement in the literature over whether restricting access to guns lowers rates of homicide and suicide by firearms (see for example [38,39]). However, research on efforts to regulate individual behaviors through criminalization of risky behaviors, such as drug use among pregnant women, suggests that such interventions deter women from seeking prenatal care [40–42].

It appears that the effect of restrictions on individual behavior depends partly on whether the regulated behavior is relatively public or private. For example, there is greater compliance with motorcycle helmet laws (over 99% compliance in California [35]) than with seat-belt laws (about 62% nationwide [43]). Similarly, directly observed therapy in tuberculosis treatment has a higher adherence rate and is associated with higher cure rates than self-administered therapy (in Tarrant County, Texas [44] and in Baltimore, Maryland [45]). It may also be that regulations relating to more public behaviors are easier to enforce because the perceived level of risk of being punished for offenses is greater. Indeed, some structural interventions focus on increasing the likelihood or perception of the likelihood of arrest for violations of these regulations [32,46]. Finally, it appears that the behaviors which are the easiest targets of direct regulation are those over which individuals have both the most direct control and no compelling interest in maintaining. For example, individuals do not typically have an economic, or other compelling interest, in driving fast, or riding bicycles or motorcycles without a helmet, so these behaviors may be relatively easy to regulate (although there is substantial resistance to motorcycle-helmet laws).

Taken together, this research suggests that direct regulation of risky behavior – one common form of structural intervention focused on availability and targeted to individuals – may be difficult to implement in HIV prevention. For one thing, the behaviors that put individuals at risk of HIV infection are private, already illegal, or both. Interventions such as setting minimum ages for engaging in sex, or requiring condom use when having sex or new syringes when injecting drugs (analogous to minimum driving ages or speed-limit laws, seat-belt or helmet requirements) have little chance of being implemented effectively. At least three kinds of laws have been used in HIV prevention to regulate individual behavior; these include the criminalization of possession of drug paraphernalia, knowing transmission or exposure of another to HIV, and prostitution. The criminalization of possession of drug paraphernalia contradicts prevention policy in the other areas we have considered because, instead of making equipment that is necessary to protect against infection more available, or making equipment that increases risk of infection less available, as is typically done, these laws make equipment that is necessary to protect against infection *less* available. If the experience with criminalizing drug use in pregnant women is any example [47], it may be that criminalizing transmission or exposure of others to HIV deters individuals at risk for HIV from being tested. Similarly, there is some evidence to suggest that tighter enforcement drives prostitution into more dangerous settings [4]. These latter behaviors may be difficult to regulate because they are rooted in complex social and economic factors that limit women's control over them, or give them an economic (e.g. prostitution), physical (e.g. drug use), or other interest in maintaining them.

If some kinds of structural intervention that have been used for nonHIV-related prevention might not be effective in HIV, many others may have analogs for HIV prevention. Table 2 presents some examples of structural interventions in HIV prevention that have been implemented or considered, or that might have the potential to prevent HIV transmission (see [48] for an alternative way of classifying structural barriers and facilitators to HIV prevention). This list is not inclusive of all interventions, nor is inclusion on the list meant to indicate the likely effectiveness of the intervention. Rather, it is intended to be suggestive of the range of structural interventions in HIV. For example, structural interventions that address availability through increasing the distribution and, hence, availability of materials and equipment that prevent infection or injury, have their parallels in HIV in the widespread placement of condom machines in bars, bathrooms, etc., and in laws permitting pharmacy sale of syringes and lifting caps on the number of syringes that may be distributed. Conversely, interventions like vending machine bans to reduce the availability of cigarettes have their parallels in such interventions as sharps containers in bathrooms, and programs to place needle-disposal containers in drug-use areas.

There is a range of availability interventions targeted to organizations that could promote HIV prevention by making establishments responsible for the behaviors of their clients or for providing settings or

Table 2. Examples of structural interventions in HIV prevention[a]

	Individual	Organizational	Environmental
Availability	Criminalization of transmission related to sex or drug use Prohibitions against possession of drug paraphernalia Criminalization of drug use Criminalization of prostitution Community campaigns to put condom machines in bathrooms, bars, etc. Sharps containers in bathrooms Needle-disposal sites Pharmacy sale of syringes Lifting cap on number of syringes NEP are allowed to distribute, and pharmacists are allowed to sell	Development of better/more reliable condoms Development of single-use syringes Extended school hours Decriminalization of syringe possession More structured, alcohol-free leisure time for school children Minimum drinking age 100% condom-use policies in brothels 100% condom-use policies in bathhouses Regulations on blood industry to improve quality of blood supply Treatment on demand Implementing drug-treatment programs in prison Distributing syringes or condoms in prisons Closing bathhouses	Restricting federal funds for NEP Overturning the ban on use of federal funds for NEP City-sponsored safe-injection rooms/buildings/parks Quarantine of HIV-infected individuals Prohibiting HIV-infected individuals from entering the country Prostitute-free zones
Acceptability	Anti-prostitution stigmatization campaigns (john of the week) Distribution of anti-drug T-shirts, etc., to teenagers	Anti-drug use television programming initiatives Requirements that networks devote time to PSA, including anti-drug programming Media campaigns to eroticize condoms	Social marketing of condoms
Accessibility	Comprehensive case management Needle-exchange programs Massive distribution of free condoms Women-only needle-exchange programs	Development and production of female-controlled prevention methods such as female condoms and microbicides Zoning ordinances for alcohol to reduce the concentration of liquor stores in low-income neighborhoods Expansion of publicly funded drug-treatment programs	Junkie groups/organizing Prostitute organizing Medicaid coverage of drug treatment Regulations restricting eligibility of drug users for income maintenance Rebuilding infrastructure in urban communities Legalization of marriage among gay men and lesbians Decriminalization of drug use and possession Decriminalization of sex work/prostitution Elimination of sodomy laws

[a]This table is meant to be illustrative of the kinds of interventions that characterize each category; it is not inclusive. Inclusion in this table does not necessarily signify that the intervention has been successful. PSA, Public service announcement; NEP, needle-exchange program.

materials that would reduce client risk. Examples include condom-use policies in brothels or bathhouses, or other settings where sex occurs. Another common form that structural interventions focusing on availability have taken is the regulation of products that promote risk, or funding for the development of new products to reduce risk. In HIV, we would include, in this category, improvements in the blood supply and in the design of condoms, and development of single-use syringes (although these may increase risk of HIV in injecting drug users [49]). In addition, there is growing attention toward the need to develop prevention methods, such as female condoms and microbicides, which acknowledge that women frequently lack the power to negotiate condom use in sexual relationships. We have included these in the category of accessibility interventions.

Research in injury prevention suggests that some of the most successful interventions require no active participation on the part of individuals [24]. It is difficult to know what the equivalent to an air bag or collapsible steering wheel in cars is in HIV prevention. There is also a raging debate in the field over whether interventions aimed at making risky behaviors safer with product or environmental changes can

increase the potential for harm by promoting risk compensation. Specifically, it is argued that individuals may compensate for the added safety of, for example, a seat belt or improved highway lighting by driving faster or more recklessly, thereby increasing their overall risk of injury in an accident. Although injury prevention researchers dispute the role of risk compensation (see for example [50–56]), at least one study has suggested that the benefits of condom promotion may similarly be undermined by changes in sexual-risk perception and subsequently in risk behavior [57].

One highly effective structural-level intervention seen in non-HIV public-health prevention involves the manipulation of federal government funding to encourage passage of prevention-related policies. Ryan White funds have been similarly manipulated to encourage passage of state laws relating to HIV testing, and to express government support for sanctions against purposeful exposure to HIV. In a variation on this approach, the federal government has refused to fund needle-exchange programs, thereby limiting the ability of states to promote such programs. As in other public-health areas, public space also may be regulated in an effort to prevent HIV. Another potential environmental-level structural intervention in HIV involves the quarantining of HIV-infected individuals. Although this has not been proposed in the United States as a general policy, in some states, HIV-infected prisoners are being separated from other inmates [58]. One of the relevant lessons from tuberculosis prevention, where quarantine once constituted a prevention intervention and where compulsory treatment currently constitutes prevention, is that, at minimum, it is crucial to ensure that such interventions do not disproportionately burden marginalized populations.

Research has also demonstrated the potential effectiveness of structural interventions focused on acceptability. Interventions that address the social acceptability of tobacco use have been both widely utilized and effective. For example, an anti-smoking media campaign implemented in California reduced cigarette sales by 232 million packs over a 2-year period [22]. Widespread news coverage, programming, and public service announcement campaigns also appear to have changed norms regarding drinking and driving, and, in particular, the social acceptability of the 'designated driver' concept [6], and social marketing seems to have impacted on norms regarding 'responsible drinking' [59]. More research is needed, however, to determine the relative impact of acceptability interventions focused on promoting negative images of risky behavior and those focused on promoting positive images of healthy behaviors. For, in HIV, most structural interventions focused on acceptability and relating to drug use convey anti-drug messages, and in the process further stigmatize drug users.

A third group of structural interventions, focused on accessibility, shows considerable potential in HIV prevention. Free distribution programs comprise one common form of such initiatives, and have been shown to increase the use of protective equipment, whether distributing bicycle helmets [60,61], smoke detectors [62], or infant car seats [63]. In HIV prevention, needle-exchange programs constitute an accessibility intervention in recognizing that even if syringes are made available through purchase from pharmacies, those with limited resources may be unable to buy them. The work of Cohen *et al.* [64] has demonstrated that when it comes to condoms, cost does matter: free condom-distribution programs can significantly increase their use. Similarly, those who cannot pay for needed prevention services, such as drug treatment, are impacted by interventions that increase the number of publicly funded treatment programs, or alter Medicaid coverage of such services. Furthermore, while the accessibility interventions discussed thus far seek to compensate for limited resources by making free the services or products that reduce risk, or by providing public funds to pay for them, other structural interventions in HIV address inequalities in power and resources by, for example, attempting to organize drug users, sex workers, or other marginalized groups at risk for HIV. These have the potential to alter their social and political power, and thereby their risk for HIV.

Conclusions

We have offered a brief review of structural interventions in a range of public-health areas, provided a framework for understanding and analyzing these interventions, and suggested some applications of this framework for structural interventions in HIV. In general, structural interventions appear to be a promising strategy for HIV prevention. However, direct regulation of HIV-risk behavior is less likely to be effective than are efforts to expand the availability of tools and settings necessary for prevention (e.g. condoms, syringes, drug treatment), and to reduce the availability of those associated with risk (such as used syringes). In part, this is because of the difficulty of regulating private behaviors. In addition, we have suggested that when individuals have an interest in maintaining risky behaviors (as do sex workers who are paid more for unprotected sex, or drug addicts who face physical withdrawal) or have limited control over those behaviors (as is women's control over condom use), it makes them difficult to regulate.

While individual behaviors associated with HIV risk may be difficult to regulate directly, we have suggested that organizational-level interventions have potential for HIV prevention, although more research is needed to address the question of risk compensation. Structural interventions targeted to the environment that promote exclusion or segregation often harm the most marginalized, and are therefore less desirable than those expanding opportunities and spaces for healthy behavior. Our examination of structural interventions indicates that modification of social norms can also be an effective prevention tool, but more research is needed to determine the relative impact of positively as compared with negatively framed images (e.g. eroticization of condoms versus stigmatization of drug use). We have also seen that availability approaches can be limited by a failure to take differences in power and resources among individuals and social groups into account. Structural interventions must take these differences into account if they are to be truly accessible to all, regardless of social location. Ultimately, we would suggest that the most effective structural initiatives in HIV prevention are likely to be those that attend to all three sources of HIV risk – factors affecting availability, acceptability, and accessibility – through interventions targeted to the individual, organizational and environmental levels.

Finally, although not discussed in this paper, structural interventions are distinct from other interventions in that their development and implementation requires consensus building, sometimes in the face of considerable resistance. Structural interventions can involve major policy or programmatic changes, and sometimes challenge firmly rooted political, social, and economic interests. They can also challenge deeply held beliefs in the principles of individualism and can be limited to the extent that they are seen as infringing on individual autonomy. This means that in developing structural interventions, it is important to consider whether they are politically viable and acceptable to the communities they most affect.

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