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Social-structural indices and between-nation differences in HIV prevalence

Judy Y Tan¹, Valerie A Earnshaw², Felicia Pratto³, Lisa Rosenthal², and Seth Kalichman³

¹Department of Medicine, Center for AIDS Prevention Studies, University of California San Francisco, San Francisco, CA, USA

²Center for Interdisciplinary Research on AIDS, Yale University, New Haven, CT, USA

³Department of Psychology, University of Connecticut, Storrs, Connecticut, USA

Abstract

Research emphasises the role that social structures play in shaping national HIV prevalence. This study examined how social, economic, and political contexts that may represent the confluence of individual capabilities and environmental affordances or constraints are associated with national HIV prevalence. Based on social-ecological perspectives, we examined social-structural dimensions in relation to national HIV prevalence. The study identified six publicly available nation-level social, political, and economic indices and examined their associations with national 2009 HIV prevalence across 225 nations. National indices, (a) education expenditures, (b) unemployment rate, (c) homicide rate, (d) freedom of religion, and (e) women's social rights, altogether explained 43% of the variability in national HIV prevalence. Education expenditures, homicide rate, and freedom of religion were significant predictors of national HIV prevalence in the multivariate analysis. The present study identified nation-level factors that capture social, economic, and political contexts to explain between-nation differences in HIV prevalence. Findings extend current literature on the social-structural foundation of HIV-risk and the relationship between human rights and health. National safeguards that afford individuals the power to promote general quality of life and protection from structural violence may be most important to lowering overall rates of HIV transmission.

Keywords

National HIV prevalence; national indices; social and structural factors; power; human rights

An estimated 34 million people in the world lived with HIV/AIDS in 2010. HIV/AIDS prevalence varies substantially with geography, concentrated in the poorest of nations, but also among the most deprived living in the richest nations.¹ As such, research has

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Corresponding author: Judy Y Tan, Department of Medicine, Center for AIDS Prevention Studies, University of California San Francisco, San Francisco, CA, USA. judy.tan@ucsf.edu.

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Conflict of interest

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increasingly focused on social structures to understand the geographical variability in HIV prevalence. For example, in the United States, factors representing hierarchical income structure and racial composition at a regional level accounted for the variability in regional HIV prevalence.² Among African nations, factors that accounted for variability in nation-level HIV prevalence were religion (predominantly Muslim or Christian) and the ratio of the female-to-male economic participation rate, a proxy for the relative empowerment of women.³ These studies demonstrate the potential utility in using social, economic, and political indices to characterise the social situations, structures, and places that contribute to differences in HIV transmission risks, thereby accounting for variability in HIV prevalence across geographies.⁴

Indeed, there is ongoing research interest in the social production of HIV/AIDS.¹ Such work assumes that structural-level factors create ecological contexts that affect individual-level risks for HIV-infection.^{4,5} Structural-level factors may affect individuals' vulnerability to HIV-infection via ecological constraints and affordances on their power to meet their needs.⁶ Evidence strongly suggests that power plays an important role in individual HIV risk.⁷⁻¹⁰

Ecological consideration of power and HIV risk

Extant work presumes that individual HIV risk is impacted, at least in part, by social and structural factors that create the environment in which individuals live.^{11,12} Thus, in order to understand how HIV risk is affected by social and structural factors, we must not only examine individuals' capabilities but also the social and structural features of their environments. Using ecological perspectives on individual capabilities, namely power basis theory, we frame our understanding in terms of how social and structural factors create environments important to individual power and risk for HIV.¹³

According to power basis theory, individuals' power is the ease with which they are able to meet various survival needs.¹⁴ Along with individual capabilities, individuals' environments afford or constrain their ability to meet such needs. Thus, factors that capture social, economic, and political contexts may represent the confluence of individual capabilities and environmental affordances or constraints. Examples of social and structural factors that pertain to individual capabilities and contexts are national indices such as homicide and unemployment rates, as well as social indicators of policies that protect the rights of women.

Current study

An analysis of nations worldwide has the potential to deepen our understanding of the social and structural dimensions related to national HIV prevalence that vary across nations. The present work assumes that if nations vary in the social, economic, and political structures that affect individuals' power relevant to their vulnerability to HIV-infection, then differences in these contextual factors should account for variability in national HIV prevalence. We selected social-structural factors as indicators of power domains and based our analysis on power basis theory to understand how social and structural dynamics affect the individual power and HIV risk.

Method

Procedures

Nations and HIV prevalence—There are over 250 nations and sovereign states worldwide, including 193 officially recognised by the United Nations.¹⁵ In order to be geographically representative and to capture the most possible nations worldwide, we identified nations and territories available by the Central Intelligence Agency (CIA) World Factbook.¹⁶ We retrieved available nation-level HIV prevalence estimation from the World Health Organization and CIA World Factbook as the criterion variable, calculated by dividing the estimated number of adults living with HIV/AIDS at yearend by the total adult population at yearend.¹⁶

Nation-level indices—Nation-level indices are composite statistics that include economic indicators such as the unemployment rate and human rights measures such as the Freedom of Religion, Women's Social Rights, and Disappearance indices applicable in nation-level analyses.¹⁷ Sources for the indicators included United Nations Development Programme's Human Development Reports, World Bank's World Development Indicators database, and Cingranelli- Richards Human Rights Dataset. Indices were selected based on the most recently available and comprehensive data by nations. Consistent with past work, we retrieved the national indices available in 2009 or earlier to estimate their relationship with the nation-level HIV prevalence estimates in 2009.³

These indices include composite statistics calculated based on data from leading international data centers covering the respective region, enabling cross-country comparison. For example, education expenditure, a measure of a nation's investment in educating its citizens, is the public expenditure on education as a per cent of the gross domestic product. The Cingranelli- Richards indices are score composites that were independently coded based on annual reports and data sources on human rights. For instance, *Women's Social Rights* was given a score ranging from 0 to 3, with a score of 0 indicating that the country instituted no social rights for women in law and may have built into law systematic discrimination based on sex. The maximum score of 3 indicates that the country's laws and government fully and rigorously enforced all or nearly all of the laws guaranteeing women's social rights.¹⁸ Another score composite, *Freedom of Religion*, indicates the extent to which the government restricts the freedom of citizens to exercise and practice their religious beliefs.¹⁸ Appendix 1 summarises the nation-level predictors, including their respective data sources, measurement derivations, units, and range.

Power basis theory hypothesises why social and structural features of people's environmental contexts can put them at risk for HIV infection. In general, if one's environment does not readily afford satisfying one's basic and ongoing needs, then behaviors that might otherwise seem unattractive but which could even temporarily satisfy needs, such as having sex in order to obtain food and shelter, may become more attractive because they are more necessary. Moreover, the theory postulates why several domains of social and structural features, not simply material ones, could influence HIV transmission. The theory argues that there are several kinds of survival needs, implying a set of categories of environmental domains. All these domains may be implicated in HIV prevalence because

social transactions can allow people to change access to necessities in one domain to access to necessities in another domain. Thus, power basis theory provides a useful framework around which social and structural factors important to individual power may be organised into domains: (a) *Knowledge*, (b) *Material Resources*, (c) *Wholeness*, (d) *Legitimacy*, and (e) *Sexuality*. (a) The domain of *Knowledge* includes social and structural factors that facilitate the attainment of learning and education, as well as the ability to navigate one's environment with skill and efficiency. (b) The *Material Resources* domain includes social and structural factors that facilitate the attainment and control of material resources. (c) The *Wholeness* domain includes social and structural factors that facilitate individuals' ability to live free of violence and injustices. (d) The *Legitimacy* domain includes social and structural factors that facilitate individuals' maintenance of social recognition and legal integrity. (e) The *Sexuality* domain includes social and structural factors that facilitate reproductive freedom, sexual independence, and instituted and enacted protection against gender-based inequality.

We selected indices of environmental affordance for each of these domains. We sought indices that were as close as possible conceptually, non-redundant, and as comparable across nations as they could be. For *Knowledge*, we selected the national expenditures on education as a proportion of the gross domestic product and adult literacy rates as indicators of the richness of the national context in terms of knowledge. To gauge each nation's level of *Material Resources*, we selected the unemployment rate because it is the economic indicator most important to most people, gross domestic product, or GDP—a measure of the entire nation's economic output, size of the labor force, which indicates the resource potential of human labor, and the Human Development Index, which is an UN composite of human infrastructure. Violence is one of the most extreme ways that people's survival can be threatened. We indexed the contextual level of violence by the homicide rate and military expenditures. *Legitimacy* here means that people are accepted equally and respected within their societies. Corruption is one indicator that only elites and their favorites have access to public goods in a nation, so we used the corruption perception index as one indicator of legitimacy. Citizens' influence over their government indicates that they have legitimate power within their community, so we also included a measure of self-determination in elections. Respect for persons can also be shown by civil freedoms, so we included freedom of religion to gauge how readily available being included equally in communities would be.¹⁸ For *Sexuality*, because heterosexual relationships can generally place women at greater risk than men, we used *Women's Social Rights*, an overall score of the extent to which women's rights are protected by the state on the basis of gender, such as the right to enter into marriage on a basis of equality with men, the right to confer citizenship to children or a husband, the right to initiate a divorce, freedom from forced sterilisation, and freedom from female genital mutilation without consent.

In short, these general indices about societies indicate how much potential power of all these kinds is available to the people in it. The more readily available these social-structural sources of power are, the less we would expect people to engage in HIV-risk behavior because in environments that meet people's needs more readily, the less likely they would be to engage in relevant behaviors in order to meet those needs.

Statistical analyses

To derive the proportion of variance explained, we conducted linear regression models in *Mplus* v. 6.12. Logarithmic transformations were conducted to address non-normality in the predictors and the outcome.^{19,20} The mean scores were calculated by converting log-transformed data back to their original units. Maximum likelihood with robust standard errors (MLR) was used to fit the models. To detect non-linearity, residual plots of the relationship between predictors and the outcome were examined.²¹ In order to derive robust estimations based on the available data, missingness in direct data observations was addressed using Cox regression analysis using direct maximum likelihood using *Mplus*.²⁰

Given that each of the predictors assesses a domain of power, and we employed multiple comparisons using nation-level indices, multicollinearity was expected.¹⁹ To guard against multicollinearity of predictors influencing our model, we pre-screened candidate predictors using bivariate correlations to ensure that predictors were correlated moderately at most (e.g. $r \leq .50$); Appendix 2). Correlation and multivariate regression results were compared carefully to ensure that no evidence of collinearity-induced suppression (e.g. dramatic changes in sign and significance of predictors in the regression models) was present. A final regression model determined the extent to which variation may be uniquely attributed to each nation-level index adjusting for the effect of the other indices.²⁰

Results

A total of 225 nations spanning all regions of the world were included in the final regression analyses. Territories (e.g. the Wake Islands) were excluded because no separate HIV prevalence data were available for them ($n=7$).

Table 1 presents descriptive statistics of the data in their original metric, including bivariate correlation coefficients among nation-level indices and national 2009 HIV prevalence. The bivariate correlation between each predictor and HIV prevalence was statistically significant. *Unemployment Rate* and *Homicide Rate* were positively associated with HIV prevalence, such that higher rates of national unemployment and homicide were independently associated with higher national prevalence of HIV. Examples of nations with the *lowest* national unemployment rate in 2008 were Qatar (0.5%), Papua New Guinea (1.8%), Guatemala (3.2%), and Austria (4.7%); nations with the *highest* national unemployment rate included Zimbabwe (95.0%), Liberia (85.0%), Senegal (48.0%), and Kenya (40.0%). Nations with the *lowest* homicide rates (i.e. low rates of unlawful and intentionally inflicted death of a person by another) in 2008 included Morocco (0.4%), Indonesia (0.7%), Poland (1.2%), and Ghana (1.7%); examples of nations with the highest homicide rates were Honduras (60.9%), Jamaica (59.5%), Colombia (38.8%), and South Africa (36.5%).

Women's Social Rights was negatively associated with HIV prevalence: Greater protection of women's rights in the country was independently associated with lower national HIV prevalence. Nations scoring the *lowest* on *Women's Social Rights* (a score of 0, i.e. little or no protection or enforcement under law) in 2008 included Zambia, Serbia, Bangladesh, and

Saudi Arabia; nations scoring the *highest* (a score of 3, i.e. rights guaranteed by law and in practice) on the variable included Cuba, Singapore, Trinidad and Tobago, and Sweden.

Counter-intuitively, *Education Expenditures* was positively correlated with national HIV prevalence. That is, the greater the proportion of the GDP that was spent on education in 2008, the higher the national prevalence of HIV observed in the subsequent year. Examples of nations with the *lowest* education expenditures as a percentage of their GDP in 2008 were Nigeria (0.2%), Ecuador (1.0%), Pakistan (2.6%), and Turkey (4.0%); nations with the *highest* education expenditures included Lesotho (13.0%), Cuba (9.1%), Botswana (8.7%), and Norway (7.2%). Similarly, *Freedom of Religion* was positively associated with prevalence, so that the most severely restrictive government saw the lowest national prevalence of HIV. Examples of nations that scored the *lowest* (a score of 0) on *Freedom of Religion* (i.e. severe and widespread restrictions on religious freedom) were Egypt, Malaysia, Kenya, and Libya; those scoring the *highest* (a score of 2) on the variable (i.e., no restrictions on freedom of religion) included Namibia, South Africa, Thailand, and Haiti.

The five predictors accounted for a total of 43% of the variance in national HIV prevalence: education expenditures (under the *Knowledge* domain), unemployment rate (under the *Material Resources* domain), homicide rate (under the *Wholeness* domain), freedom of religion (under the *Legitimacy* domain), and women's social rights (under the *Sexuality* domain). Table 2 presents the standardised and unstandardised estimates of national HIV prevalence in the context of other predictors. This final model demonstrated that, when controlling for the presence of each predictor, *Unemployment Rate* ($b = .28$), *Homicide Rate* ($b = .25$), *Freedom of Religion* ($b = .36$), and *Women's Social Rights* ($b = -.54$) significantly and uniquely predicted national HIV prevalence.

Discussion

Despite increasing recognition of the importance of understanding how social and structural factors influence the spread of HIV, few studies have endeavored to do so. The present findings provide important insights into the social and structural factors associated with between-nation variability in HIV/AIDS epidemics. The influence of social-structural contexts on individual capabilities was represented by national indices that altogether accounted for 43% of the between-nation variability in HIV prevalence. *Homicide Rate* and *Women's Social Rights* remained highly statistically significant when controlling for other national indices, suggesting that environments in which social structures ensured the rights of women, as well as those that protected citizens against physical harm, may be most important to national HIV prevalence. The national *Homicide Rate*, representing the national level of extrajudicial killing and crimes involving physical threat and harm to individuals, had a positive effect on national HIV prevalence, so that as the national level of murder-related crimes increases, the overall prevalence of HIV increases. According to the United Nations Office on Drugs and Crime, homicide is much more common in countries with low levels of human development, high levels of income inequality, and weaker rule of law than in more equitable societies, where socio-economic stability seems to counteract homicide.²² Of note, of all homicides worldwide, only 18% were women. The vast majority of these women were murdered by their past or present male partner.^{22,23}

Counter-intuitively, *Freedom of Religion* was positively associated with national prevalence and remained statistically significant in the regression model. Several explanations for these findings are possible. First, *Freedom of Religion* includes data on forced conversions to a dominant or state-sponsored religion that often enforces strict codes of conduct pertaining to sexual behavior.¹⁸ Thus, *Freedom of Religion* may also represent the degree of tolerance for sexual freedom, capturing the difference between Muslim societies that are less tolerant of sexual freedom than other religions, and predominantly Christian nations that tolerate a greater degree of sexual freedom. Indeed, predominantly Muslim nations in Africa have been shown to have lower national HIV prevalence, and other work has posited both social and biologic reasons for the lower HIV prevalence among Muslim societies.^{3,24,25}

In the context of other factors, the present findings suggest that environments with social structures that ensured the rights of women, as well as those that protected citizens against physical harm, were most important to national HIV prevalence. These findings underscore the importance of understanding HIV epidemics in the context of the social-structural ecology of the nation. Socio-structural factors that were significant in the final model—unemployment rate, homicide rate, the freedom of religion and women’s social rights indices— represent environments that confer power to individuals in terms of material resources, physical integrity, legitimacy, and gender-based equality that may be particularly important to avoiding individual HIV risk.

Limitations

As with analyses using cross-sectional, one-time measurements, we caution readers to make causal inferences based solely on the present findings. The present analysis fitted a linear relationship between social and structural factors and HIV prevalence. Although examination of the results showed no evidence of simple non-linear patterns and the linear predictors fit best, future work may explore alternative model fits and modeling techniques (e.g. structural equation modeling) with other social and structural factors (e.g. type of government).

The predictors were obtained from various data sources that had different methods by which the data were collected and indices were measured. Further, because indices were not designed to be completely independent, it is impossible to precisely assess how much their interrelationships may contribute to the variance explained. More research is needed to parse the individual, additive and multiplicative effects of each of the predictors on the outcome.

The study was a one-time, comparative study, and the social and structural indices were likely associated with or confounded by other factors not included in the present study. Thus, more research is necessary to consider potential confounders in order to identify precisely what needs to be targeted at the national level to reduce HIV prevalence, or how different national interventions may have similar spreading effects. Future work may also consider using weights to reflect the differential associations among HIV prevalence and social and structural factors that may be affected by relative population and geographical size.

Finally, future analyses of the relationship between national HIV prevalence and social and structural factors could examine trends over time. Incorporating power into transmission rates across years and decades may reveal insights into the progression or containment of HIV and provide insights into how power as afforded and constrained by social and structural factors may account for the nature of the observed epidemics. Similarly, a time-series analysis may be appropriate for examining whether the effects of social, political, and economic structures on national epidemics are lagged.

Implications and future directions

Without a viable cure, the current results have implications for national interventions to reduce the HIV/AIDS epidemic worldwide. Study findings suggest that the abatement of national HIV epidemics should go hand-in-hand with environments that confer power to individuals in terms of material resources to meet our basic survival needs and a system of legal protection against physical harm, crime, and gender-based inequality. In short, HIV prevalence is lower where societies are more equitable. Given our view that social ecology is influential, funneling resources toward local and community-based prevention and intervention efforts should remain a priority in order to address immediate wellness and quality-of-life needs of the communities with relatively high HIV prevalence. In conjunction with this short-term approach, current findings suggest that long-term national AIDS prevention strategies may be designed to comprehensively address unprosecuted violence, kidnapping, trafficking, or murder. National strategies that commit to enacting and protecting women's social, political, and economic rights may be integrated with commitments to curbing respective AIDS epidemics. This is consistent with work that highlights the need to understand how broad-level social and structural factors may influence HIV epidemics by undermining or enhancing intervention strategies.¹⁷

The present approach is consistent with past work emphasising a structural level analysis to understand HIV/AIDS.^{26,27,28} Further, our approach is consistent with ecological perspectives on health, which understand HIV-related behaviors as a function of the interaction between individual and environment. As such, the present work has implications for understanding the social and structural factors that facilitate or impede individual behavior at multiple levels, factors that drive the HIV epidemic among vulnerable populations such as injection drug users and men who have sex with men. It is important to identify different social and structural predictors of HIV epidemics for countries in which the primary transmission routes differ.²⁹ More work is needed to consider how the socio-structural underpinnings affect vulnerability by affording or constraining risk behaviors that meet existing or create more needs in order to better inform interventions with high-risk populations.

Taken together, national spending priorities in education may be less pertinent to HIV prevalence at the national level. Rather, the basic human rights of individuals to engage in the workforce and to promote their personal security and overall quality of life was significantly predictive of lower national HIV prevalence. Socio-cultural and biologic factors representing the potential impact of religion on sexual behavior were important to shaping national epidemics, as were economic, social, and political assurances for gender-

based equality. National safeguards that afford individuals the power to promote their health potential and quality of life in contexts void of extra-judicial violence and persecutions may be most important to lowering their HIV risk and overall rates of HIV transmission.

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Table 1

Means and bivariate correlation coefficients of nation-level indices.

	<i>M</i>	<i>SD</i>	1	2	3	4	5
1 National HIV Prevalence (2009)	1.94	4.39	1				
2 Education Expenditures	4.70	2.32	.26 ^a	1			
3 Unemployment Rate	13.97	15.60	.41 ^a	.07	1		
4 Homicide Rate	7.68	11.97	.27 ^a	.09	.004	1	
5 Freedom of Religion	1.17	.81	.19 ^b	.17 ^b	.02	.34 ^a	1
6 Women's Social Rights	1.25	1.02	-.28 ^a	.27 ^a	-.22 ^a	.04	.37 ^a

M: means; *SD*: standard deviations; values in original metric. 1: Estimated number of adults aged 15–49 years with HIV infection, whether or not they have developed symptoms of AIDS, expressed as per cent of total population in that age group; 2: Public expenditure on education as a per cent of gross domestic product (GDP) in 2007; 3: Per cent of the labor force that is without jobs; 4: annual rate of homicide per 100,000 population; 5: Extent to which the freedom of citizens to exercise their religious beliefs without being subject to government sanctions and restrictions; 6: Rights of women guaranteed by law and enforced by the government, include a number of internationally recognized rights such as the right to equal inheritance, right to enter into marriage on a basis of equality with men, right to obtain a passport, right to initiate a divorce, right to an education, freedom from genital mutilation without their consent, and freedom from forced sterilization.

^aTwo-tailed $p < .01$.

^bTwo-tailed $p < .05$.

Table 2

National HIV prevalence in 2009 by nation-level indices ($k = 225$).

	<i>b</i>	<i>SE</i>	95% <i>CI</i>	β	<i>p</i>
1 Education Expenditures	.18	.20	[-0.22 to 0.57]	.09	.38
2 Unemployment Rate	.28	.09	[0.10 to 0.46]	.30	.003
3 Homicide Rate	.25	.06	[0.14 to 0.36]	.33	<.001
4 Freedom of Religion	.36	.14	[0.09 to 0.64]	.21	.01
5 Women's Social Rights	-.54	.16	[-0.86 to -0.23]	-.35	.001

b: unstandardized regression coefficient; *SE*: standard error; *CI*: confidence interval; β : standardized estimate; *p*: two-tailed *p* value. Proportion of variance explained, $R^2 = .43$. 1: Public expenditure on education as a per cent of gross domestic product (GDP) in 2007; 2: Public expenditure on education as a percent of GDP in 2007; 3: annual rate of homicide per 100,000 population; 4: extent to which the freedom of citizens to exercise their religious beliefs without being subject to government sanctions and restrictions; 5: Internationally recognized rights that includes right to equal inheritance, right to enter into marriage on a basis of equality with men, right to obtain a passport, right to initiate a divorce, right to an education, freedom from genital mutilation without their consent, and freedom from forced sterilization.