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Assessing girls' HIV vulnerability: evidence from Botswana, Malawi and Mozambique

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Abstract

Past research documents multiple factors associated with girls' susceptibility to human immunodeficiency virus transmission; yet a literature review found no systematic approach to measure vulnerability. This study characterized, developed and tested a set of indicators to measure girls' vulnerability, resulting in the vulnerable girls index (VGI). A quasi- experimental, separate-sample pre-/post-test design was used to test the index. Adolescent girls were randomly drawn for the pre-test (2277 respondents) and post-test (1418 respondents) from 16 purposively selected communities in Botswana, Malawi and Mozambique. The higher the VGI score—or the more vulnerable the girl—the more likely she was to report premarital sexual experience across the three countries and the more likely she was to report low agency to insist upon condom use in Botswana and Mozambique. The VGI can be used to assess girls' vulnerability levels across time and space for policy and programme planning purposes, and as part of programme evaluations.

Key words: Adolescent health, HIV prevention, gender, health behaviour, social determinants

Key Messages

- The aim of this study was to develop a comprehensive index to measure girls' vulnerability to human immunodeficiency virus: the vulnerable girls index (VGI), and to test the validity of the index in Botswana, Malawi and Mozambique.
- The higher the VGI score—or the more vulnerable the girl—the more likely she was to report premarital sexual experience in Botswana, Malawi and Mozambique.
- The higher the VGI score—or the more vulnerable the girl—the more likely she was to report low agency to insist upon condom use in Botswana and Mozambique.

Introduction

In sub-Saharan Africa, where women make up 60% of those living with the human immunodeficiency virus and acquired immunodeficiency syndrome (HIV and AIDS) and young people aged 15–24 represent more than half of all new infections (UNAIDS 2008), adolescent girls are particularly susceptible to HIV transmission. There is an extensive and growing literature on girls' vulnerability to HIV and multiple factors associated with HIV transmission have been identified. The literature points to a range of family, social- and structural-level factors over which adolescent girls have no control, but that are statistically associated with HIV infection. These factors include orphanhood and household (HH) composition (Eaton *et al.* 2003; Birdthistle *et al.* 2008), migration (Mabala 2006; Rassjo *et al.* 2006), school attendance (Obasi *et al.* 2001; Gavin *et al.* 2006), cultural norms (Bates *et al.* 2004), gender inequality (Bates *et al.* 2004; Poulin 2007), socio-economic status (Eaton *et al.* 2003; Hallman 2005; Ndebele *et al.* 2012), alcohol exposure (Morrison-Beedy *et al.* 2003) and poor communication with parents (Eaton *et al.* 2003).

Given this wide-ranging list of factors and the urgent need to address the specific needs of girls in the HIV epidemic, it is vital to have a ready tool to assess vulnerability levels. Yet, a review of the literature found no systematic approach to help assess what proportion of girls in a community, region or nation was vulnerable to HIV. We argue that an index to measure girls' vulnerability to HIV would be useful to the field. When multiple factors are associated with health-related behaviours or actions, research has demonstrated the utility of indices and scales. For example, in the area of gender norms, a gender equitable masculinity scale was found to be significantly and positively correlated with contraceptive use and less self-reported partner violence (Pulerwitz and Barker 2008). In a very different arena, that of community capacity strengthening, there is evidence that the use of a validated scale comprising a range of community capacity indicators can help predict health-related actions at both the individual and community levels (Underwood *et al* 2012). Finally, social vulnerability indices were developed and validated as predictors of susceptibility to natural disasters (Mustafa *et al*. 2011). A comprehensive index to measure vulnerability to HIV, particularly when the intent is to work with vulnerable girls defined more broadly than implied by the standard definition of orphans and vulnerable children, has not been validated and applied to date. Given that a tool to assess girls' susceptibility to HIV would benefit programmes and research alike, the goals of this study were to characterize, develop and test a set of indicators to measure girls' vulnerability and develop a vulnerable girls index (VGI).

The VGI described in this article arose from the understanding that girls' vulnerability to HIV is multi-faceted and that a myriad of extra-individual factors influence their opportunities and options. In an attempt to measure girls' vulnerability to HIV and provide a tool that could be used to evaluate programmes designed to reduce vulnerability levels, the authors adopted a panoramic view, expanding beyond a narrow focus on the individual-as-risk-taker to encompass the contextual and systemic factors that render girls vulnerable. The focus on girls' vulnerability in lieu of 'girls at risk' is purposeful as the former implicates the social context that influences the individual's health-related actions and outcomes while risk evokes individual choices and behaviour void of cultural and structural influences (UNAIDS 1998; Bronfman *et al*. 2002; Gupta 2008). A social ecological framework informed the research (Bronfenbrenner 1979; Rose 1985). This conceptual framework depicts the fact that resource availability, community support for girls, social support from parents and other community members, family circumstances and girls' normative constructs all shape the degree to which girls are vulnerable to HIV. In short, factors within and across the social ecological levels, each of which potentially influences, directly or indirectly, individuals' ability or propensity to act. Thus, individuals' choices, decisions and behaviours are theorized to depend not only on their own characteristics, but also on group- or community-level attributes, thereby implicating the larger social and environmental contexts within which they live.

Research question and study objectives

The central research question that guided this study was: Is there a discrete list of variables that, when combined in an index, constitute a robust measure of HIV vulnerability among adolescent girls across multiple settings? To that end, the objectives of this research were to create an index of vulnerability based on a review of the literature, measure the level of girls' vulnerability to HIV based on this index and test the newly developed index by assessing the association between the VGI and several outcomes that were hypothesized to be associated with HIV vulnerability, including low levels of agency to insist upon condom use and premarital exposure to sexual intercourse.

This study examines the following two hypotheses:

H1. VGI scores will be negatively associated with the self-efficacy to refuse sex without a condom. That is, the more vulnerable the girl, the less likely she will be able to insist on condom use.

H2. VGI scores will be positively related to pre-marital sexual intercourse. That is, as vulnerability increases, the likelihood of pre-marital sex increases.

Methodolgy

Materials and methods

The research team used a quasi- experimental, separate-sample pre-test and post-test design. The research was fielded in four communities in the Thyolo district of Malawi, four communities in the Francistown district of Botswana and eight communities in Mozambique (four in Zambezia and four in Nampula provinces). Half of the communities were in peri-urban and half in rural sites. While the national HIV prevalence differs greatly between Botswana, Malawi and Mozambique—the highest prevalence is found in Botswana and the lowest in Malawi—districts in each country were selected based upon the criteria of high levels of HIV prevalence, specifically, between 18% and 23% (National Statistical Office (NSO) [Malawi], and ORC Macro. 2005; Central Statistics Office, Botswana. 2008; UNAIDS 2008). These communities were identified for the implementation of a multi-level initiative designed to reduce girls' susceptibility to HIV. That intervention is not described herein as the focus here is the validation of the index. As such, an evaluation of programme effects is beyond the scope of this article.

Communities were purposively selected based on a set of predetermined criteria, including 15–25% HIV prevalence, population size of ~5000, geographic accessibility and availability of relevant non-governmental organizations. In each study community, complete household (HH) listings were conducted prior to sample selection. In the next stage, HHs were randomly selected from the HH lists (the interval between HHs was based on the number of HHs in the community) and, lastly, an adolescent was sampled from the HHs using the Kish grid for random selection. Thus, the adolescents were selected randomly within the communities for the pre-test and post-test interviews.

The pre-test cross-sectional sample survey was conducted in September and October 2009 in the programme intervention communities across the three countries and the post-test survey was conducted between September and December 2010 in the same communities. The pre-test cross-sectional sample survey was conducted to establish benchmark indicators to gain a better understanding of the communities. The post-test survey was conducted primarily as part of a comprehensive process evaluation that also included a limited outcome evaluation of the aforementioned initiative.

The pre-test/post-test sample sizes were 536/401 in Botswana, 823/414 in Malawi and 918/603 in Mozambique with a total sample of 2277 in the pre-test and 1418 in the post-test. Respondents were oversampled in the pre-test for programmatic purposes; thus, compared with the pre-test samples the post-test samples were smaller in all three countries.

Measures

The survey instrument included questions regarding background variables, HH characteristics, indicators for vulnerability and sex-related

behaviours. The post-test survey instrument included questions about programme participation; other than those questions, the pre-test and post-test questionnaires were identical. The items in the Vulnerable Girls Index are theoretically informed and evidence based. Based on the previously cited research, the working definition of 'vulnerable girls' in the context of HIV risk included those who are 'orphans': maternal, paternal or dual orphan, 'early' 'school leavers': never attended school; not currently in school, 'live in impoverished conditions': lives in a HH that falls in the two bottom of the wealth quintiles; lives in a child-headed HH; often goes to bed hungry; has often slept without an adult in the HH in the past 12 months, 'are recent migrants': lived in the community for <3 years, 'are socially marginalized': has no close female friends; identified no caring adult, 'who have poor relationships with their parents': poor relationship with mom; poor relationship with dad 'and/or who have been exposed to alcohol': visited an alcohol establishment often or every day, have ever drank alcohol, and who have slept in a HH where an adult was often drunk. The 16 indicators for these seven factors were included in the questionnaire for adolescents at both pre-test and post-test.

The VGI is an unweighted sum of the 16 component items. The index was created by assigning respondents one point for each of the indicators mentioned above. Thus, the higher the score, the more vulnerable the girl is.

It is worth mentioning that the research team abides by the theoretical distinction between scales and indices. While this distinction is not always observed in the literature, the two are not equivalent. A scale comprises what Bollen (1989) refers to as 'effect indicators' or items that reflect an underlying construct or latent variable; therefore, the items must be correlated to be included in a single scale (Montgomery and Asberg 1979). An index is 'made up of "cause indicators," or items that determine the level of a construct' (DeVellis 1991) and are not necessarily correlated (see Measure Evaluation 2009, for more details).

Wealth quintiles

To create the wealth variable, principal components analysis on ownership of 10 HH assets (electricity, radio, television, telephone, refrigerator, bicycle, motorcycle, car/truck, agricultural land, livestock), three types of housing material (floor, roof, and wall) and the types of toilet and drinking water were utilized to categorize wealth into quintiles: low, second, middle, fourth and high. Wealth was further delineated into poor, the two lowest wealth quintiles, and not poor, the upper three wealth quintiles.

Dependent variables

One of the dependent variables included in this analysis is the girls' indication of a willingness to have sex even if a partner refused to wear a condom, 'Would you still have sexual intercourse with your partner if he refuses to wear a condom?' The response options included: yes, no, do not know. Only survey respondents who knew about sexual intercourse and condoms were asked this question.

The other dependent variable included in this analysis is self-reported premarital sexual intercourse. Girls who knew about sex and were never married were included in the sample frame.

Independent variables

The main independent variable of interest was the VGI—as a measure of girls' vulnerability to HIV. Other background variables adjusted for in this analysis, included: age, religion and residence.

Data analysis

To determine statistical significance in bivariate analyses, chi-square tests of differences in proportions and Student's t-tests for the difference in means were utilized. Multilevel, multivariate logistic regression analyses were conducted to determine whether confounding accounted for significant differences in the bivariate analyses while allowing for variation at the community and individual levels because individuals in the same community may share similar characteristics. Stata/SE 12.1 was utilized for the analysis.

First, changes in the prevalence of each indicator in the VGI between pre-test and post-test samples were assessed. Next, the multilevel, bivariate association between the dependent and independent variables were assessed. Finally, the multilevel, multivariate association between the dependent and independent variables were assessed.

Ethical procedures

Ethical approval to conduct this research was obtained from the Institutional Review Board at the Johns Hopkins Bloomberg School of Public Health, the Health Research Unit in the Ministry of Health in Botswana, the National Health Science Research Committee in Malawi, and the National Bioethics Committee, Ministry of Health in Mozambique. The support of community leaders was also obtained at the local level. Informed parental consent and child assent were obtained prior to conducting interviews with minors (aged 10–17) at baseline and endline. Informed consent was obtained from respondents aged 18 at endline. Confidentiality was protected in many ways: training interviewers, employing female interviewers and supervisors, allowing respondents to choose an interview location of their choice, and instructing interviewers to stop the interview if they saw or suspected that anyone could overhear the conversation. Anonymity was protected by not recording personal identifiers on the questionnaires.

Results

Table 1 shows the distribution of the indicators that make up the VGI as well as the overall prevalence of vulnerability and the mean VGI scores by time. Overall, high proportions of girls in the samples report one or more vulnerability attributes, demonstrating remarkable similarity across the three countries. Between 74% and 84% of girls report vulnerability on at least one indicator across space and time. As seen in Table 1, the percent of Batswana girls reporting that they had no female friends or no caring adults in their lives dropped significantly between pre-test and post-test. Yet, more girls in the post-test survey were likely to be orphans, not in school, recent migrants and/or had in the past year slept in a HH where one or more adults were often drunk. The prevalence and mean VGI score in Botswana increased slightly, but not statistically significantly, between the two surveys. In Malawi, there were statistically significant increases in several vulnerability attributes, including girls who reported that there are no caring adults in their lives and who reported poor mother–child and father–child relationships. The overall VGI score increased statistically significantly over time in Malawi, indicating that more girls were vulnerable at post-test as compared with pre-test. In Mozambique, there were some significant improvements between pre-test and post-test, lower report of going to bed hungry often, fewer girls report a poor relationship with their father, and there is a lower percentage who report sleeping in a HH where at least one adult was often drunk. In contrast, there were some significant increases in the percent of girls sampled in Mozambique who reported various vulnerability attributes, such

Table 1. Vulnerable girls prevalence by item and overall at baseline and endline in study communities in Botswana, Malawi, and Mozambique, 2009 and 2010

	Botswana		Malawi		Mozambique	
Vulnerable Girls Items	Baseline ($n = 536$)	Endline ($n = 401$)	Baseline ($n = 823$)	Endline ($n = 414$)	Baseline ($n = 918$)	Endline ($n = 603$)
Orphan	**%**	%	**%**	%	**%**	%
Maternal	7.5***	9.2	4.0	4.1	5.0	4.8
Paternal	14.4	22.2	14.3	16.2	16.0	18.7
Double	8.8	10.0	6.8	7.5	4.4	4.0
Schooling						
Never attended school	1.1	0.3	0.9	0.7	3.1	2.2
Not currently in school	8.4*	12.0	7.9	9.4	8.3	10.8
Impoverished living conditions						
Poor	40.1	40.2	40.5	40.1	40.1	40.3
Child-headed HH	0.8*	0.0	1.1**	0.0	0.3***	1.8
Goes to bed hungry often	2.1	2.7	5.5	5.6	5.7**	3.3
Sleeps without an adult in house often	4.5	5.7	3.9	5.3	1.2***	3.8
Recent migrant (<3 years)	12.9*	16.7	12.8*	9.4	29.1****	14.8
Socially Marginalized						
No female friends	10.8****	2.7	2.6**	0.7	6.8	7.3
No caring adult	8.8****	0.3	19.0****	32.9	1.6	2.5
Weak relationships with adults						
Poor relationship with mother	3.5	2.7	2.4**	4.8	3.1	4.5
Poor relationship with father	6.5	7.2	8.5**	12.1	6.5*	4.3
Alcohol exposure						
Been to an alcohol establishment often	1.5	2.5	1.8	1.5	0.4	1.0
Ever had a drink of alcohol	17.5	16.5	2.4	2.7	3.8***	7.6
Sleeps in HH that often has a drunk adult	7.1****	16.5	9.6	9.9	3.4****	0.2
Vulnerable Girls Prevalence	79.5	83.5	76.1**	82.4	76.3	74.0
Vulnerable Girls Index (mean)	1.9	2.0	1.7*	1.9	1.6	1.6

*$P \leq 0.10$.
**$P \leq 0.05$.
***$P \leq 0.01$.
****$P \leq 0.001$.

Table 2. Bivariate associations between the VGI, sociodemographics, and a willingness to have sex even if a partner refused to wear a condom in study areas in Botswana, Malawi, and Mozambique 2010

	Botswana		Malawi		Mozambique	
	No ($n = 362$)	Yes ($n = 24$)	No ($n = 324$)	Yes ($n = 66$)	No ($n = 290$)	Yes ($n = 137$)
VGI, mean, range (0–7 points)	2.0*	2.5	1.9	1.9	1.5***	2.0
Age, mean, range (11–18 years)	14.6*	13.7	13.9*	13.4	14.9*	14.5
Religion,%						
Christian	93.4	6.6	82.6	17.4	68.7	31.3
Other	96.2	3.8	100.0	0.0	65.4	34.6
Residence, %						
Urban	94.4	5.6	84.5	15.5	71.8	28.2
Rural	93.2	6.8	81.5	18.5	63.2	36.8

*$P \leq 0.10$.
**$P \leq 0.05$.
***$P \leq 0.01$.
****$P \leq 0.001$.

as: living in a child-headed HH, often sleeping in a HH without an adult present and drinking alcohol. There was no change in the mean VGI score in Mozambique over time.

Next, we examine the association between a willingness to have sex even if the partner refused to use a condom and the VGI, controlling for other sociodemographics among post-test respondents, as shown in Table 2. The bivariate results show that girls who would acquiesce to sex in such circumstances compared with girls who would refuse registered a lower mean VGI score both in Botswana (2.0 and 2.5, $P \leq 0.10$) and in Mozambique (1.5 and 2.0, $P \leq 0.01$). Multilevel level analysis, both the unadjusted and adjusted results, shown in Table 3, reveal that younger age in all three countries and a higher VGI score was significantly associated with a willingness to have sex with a partner even if the partner

Table 3. Multilevel bivariate logistic regression and multivariate logistic regression assessing the association between the VGI, sociodemographics, and a willingness to have sex even if a partner refused to wear a condom in study areas in Botswana, Malawi, and Mozambique 2010

	Botswana ($n = 386$)		Malawi ($n = 390$)		Mozambique ($n = 427$)	
	OR	aOR	OR	aOR	OR	aOR
VGI	1.26*	1.42**	1.02	1.03	1.25***	1.29***
Age	0.83*	0.78**	0.87*	0.87*	0.90**	0.86***
Religion						
Christian	1.00	1.00	na	na	1.00	1.00
Other	0.56	0.66	na	na	1.16	1.16
Residence						
Urban	1.00	1.00	1.00	1.00	1.00	1.00
Rural	1.22	1.10	1.23	1.19	1.48*	1.13

*$P \leq 0.10$.
**$P \leq 0.05$.
***$P \leq 0.01$.
****$P \leq 0.001$.

Table 4. Bivariate associations between the VGI, sociodemographic characteristics, and ever had sex among never-married adolescents girls in study areas of Botswana, Malawi and Mozambique, 2009 and 2010

	Botswana		Malawi		Mozambique	
	No ($n = 709$)	Yes ($n = 68$)	No ($n = 960$)	Yes ($n = 169$)	No ($n = 491$)	Yes ($n = 258$)
VGI, mean, range (0–8)	1.8****	3.4	1.7****	2.2	1.3****	2.0
Age, mean, range (10–18)	14.0****	16.8	13.2****	15.1	13.7****	15.9
Religion, %						
Christian	92.3***	7.7	85.0	15.0	65.4	34.6
Other	83.7	16.3	85.7	14.3	66.0	34.0
Residence, %						
Urban	91.8	8.2	86.2	13.8	68.2*	31.8
Rural	90.5	9.5	83.7	16.3	62.0	38.0

*$P \leq 0.10$.
**$P \leq 0.05$.
***$P \leq 0.01$.
****$P \leq 0.001$.

refused to wear a condom in both Botswana adjusted odds ratio or (aOR 1.42; $P \leq 0.05$) and Mozambique (aOR 1.29, $P \leq 0.01$). In sum, for every unit increase in the VGI there is an increase in the odds of lower levels of agency to insist on a partner's use of condoms in Botswana and Mozambique.

To further test this index, the extent to which the VGI score predicted ever having had premarital sex (among girls who were never married, 99% in Botswana, 98% in Malawi and 90% in Mozambique, and had heard of sex, 97% in Botswana, 97% in Malawi and 73% in Mozambique) was analysed. As shown in Table 4, the VGI is positively and strongly associated with ever having had premarital sex across the three countries (Botswana: mean VGI among non-sexually experienced, 1.8, as compared with those sexually experienced: 3.4, $P \leq 0.001$; Malawi: 1.7 and 2.2, $P \leq 0.001$; Mozambique: 1.3 and 2.0, $p \leq 0.001$, respectively) in the bivariate analysis; that is, the higher the VGI score—or the more vulnerable the girl—the more likely she was to report that premarital sex experience. In addition, older girls were more likely to report they had premarital sex than younger girls in all three countries. There was also an association between religion and premarital sexual experience in Botswana, those who report being Christian were less likely to have had premarital sex, as well as an association with residence in Mozambique, girls living in rural areas were more likely to have experienced premarital sex.

Finally, as shown in Table 5, a higher VGI score and older age remain strong predictors of premarital sexual experience in both the multilevel bivariate and multilevel multivariate analyses. The higher the VGI score, the more likely to have had sex (Botswana: aOR 1.63, $P \leq 0.001$; Malawi aOR 1.22, $P \leq 0.01$; Mozambique: aOR 1.54, $P \leq 0.001$).[aOR]

Discussion

The VGI was measured at two time points in three countries, and was associated with a willingness to engage in unprotected sex (Botswana and Mozambique) and exposure to premarital sexual intercourse (all countries), thus validating its usefulness for measuring girls' vulnerability to HIV. Thus, the findings suggest that the VGI is a robust predictor of acquiescence to a partner's refusal to use a condom and is also a strong predictor of sexual debut among never married girls aware of sex; both unprotected and early sexual debut have been shown to be associated with HIV risk (Hindin and Fatusi 2009). It is important to note that the focus on unmarried girls is not intended to suggest that married girls are not vulnerable to HIV, nor is the implication that all girls who have premarital sex are vulnerable to HIV transmission.

Table 5. Multilevel bivariate and multivariate logistic regression assessing the relationship between the VGI, sociodemographic characteristics, and experience of sex among never-married adolescents girls in study areas of Botswana, Malawi and Mozambique, 2009 and 2010

	Botswana ($n = 777$)		Malawi ($n = 1129$)		Mozambique ($n = 749$)	
	OR	aOR	OR	aOR	OR	aOR
VGI	1.82****	1.63****	1.23****	1.22***	1.53****	1.54****
Age	2.66****	2.60****	1.73****	1.74****	2.13****	2.20****
Religion						
Christian	1.00	1.00	1.00	1.00	1.00	1.00
Other	2.32***	1.51	0.88	0.78	0.97	1.44*
Residence						
Urban	1.00	1.00	1.00	1.00	1.00	1.00
Rural	1.18	1.50	1.21	1.40	1.32*	1.19

*$P \leq 0.10$.
**$P \leq 0.05$.
***$P \leq 0.01$.
****$P \leq 0.001$.

The results show that the overall VGI score tends to remain fairly stable over a short timeframe (in this study, 1 year), in part due to the immutable nature of some of the attributes and, in part due to the fact that change in the vulnerability level is often incremental. For that reason, programme implementers who use the VGI as part of a mid-term evaluation should examine which aspects of the VGI have decreased, if any, and whether the aspects that were targeted—such as a reduction in social isolation—had changed so as to make mid-term corrections to their programmatic emphases, if indicated.

While some of the vulnerability attributes are immutable—such as orphan and migrant status—so could not be changed by programme participation, and other factors would require long-term investments to make changes—such as the wealth quintile of a given HH—some of the components included in the index, such as social marginalization and an adolescent's relationship with adults, could potentially be reduced through programme participation. An adolescent's level of vulnerability could also be expected to improve to some extent through her own participation in a programme to enhance life skills, but would likely also require changes in the ways that key adults in her life interacted with her, such as through participation in an adult-child communication programme.

These findings point to and reconfirm the fact that action must be taken not only at the individual level, but also to reduce social vulnerability (Piot *et al.* 2008) by addressing the factors that hamper individuals' ability to protect themselves and others from HIV infection. Application of the VGI can bring to light the central role of extra-individual factors in girls' susceptibility to HIV (Auerbach *et al.* 2011). Moreover, use of the VGI can help reorient policy makers and programmers alike to allocate resources for, or create interventions that address, policy, economic and cultural factors—such as school fees, poverty alleviation and gender inequality (Aggleton *et al.* 2011)—as integral to the mitigation of HIV.

Conclusion and Recommendations

These results point to the utility of the VGI in identifying overall vulnerability as well as specific vulnerabilities. While individual researchers have identified factors associated with HIV vulnerability, the Vulnerable Girls Index combines the major known risk factors into a single, parsimonious and applicable measure for the first time by including measures for orphanhood, schooling, poverty, migration, social marginalization, personal relationships and exposure to alcohol. As such, the VGI comprises a readily available battery of questions for use across time and space. This study provides important findings regarding the confluence of factors that render girls vulnerable and highlights the fact that most, though certainly not all, of the key factors are extra-individual. Specifically, orphanhood and migration are family level variables. Social marginalization, too, is likely to be family-level factor. Schooling, though often treated as an individual-level factor, is in fact a community- or society-level variable as it is primarily an outcome of access and social policies. And, finally, we treat poverty as a society-level variable as it has been argued elsewhere that poverty is largely due to economic policies and exigencies (Sumartojo 2000).

We recommend use of the VGI by governmental agencies to assess the prevalence of girls' vulnerability in communities, states and/or districts. The information provided by the VGI analysis results could assist governments in identifying areas in their respective countries to allocate resources and target new interventions, whether those interventions were to provide additional support to girls who are vulnerable due to immutable factors (such as orphanhood) or to fund interventions that could reduce the prevalence of vulnerability due to mutable factors (such as access to schooling). The VGI could also help programme planners identify areas in which to intervene and is particularly useful because it includes factors from across the social ecological framework: at the structural level, it points to the importance of policy and financial commitments to provide income or employment options for girls and their families and improving access to schooling; at the community level, it includes social marginalization; and at the HH level, it points to the importance of adult-child relationships, among others. In addition to the programmatic applications, programme planners could use the VGI during the formative evaluation phase, as part of a pretest survey, for example, to ascertain the levels and types of vulnerability in a neighbourhood, community or larger geographical area. This information could guide the selection of communities or areas in which to work.

We also encourage programme staff to use the VGI to assess which vulnerabilities are most prevalent and, therefore, which to address first, though we would argue that interventions are needed across the social ecological framework to reduce girls' vulnerability. The VGI can also be employed as part of a mid-term evaluation to assess what aspects of the programme need to be revised or strengthened based on changes since the baseline. Finally, the VGI can be incorporated into summative evaluations of programmes designed to reduce girls' vulnerability to ascertain what difference, if any, the

programme made in girls' vulnerability as a result of programme efforts.

This study is not without limitations. The communities represented in these findings were purposively selected for implementation purposes so, are not necessarily representative of the provinces or countries in which they are located. Nonetheless, we believe the findings hold for girls living across a wide range of communities, including those with low levels of HIV prevalence, as the vulnerabilities included in the VGI are equally relevant in low-HIV-prevalence and remote areas. The pre-test and post-test samples are cross-sectional; a longitudinal sample design would have provided more persuasive results.

The VGI is unique and has been tested in this study; we recommend, however, further validation and refinement in different contexts, such as by expanding it to include other aspects of girls' social, economic and health-related vulnerabilities. Yet, even at this stage, researchers and programmers should feel equipped to measure girls' vulnerability to HIV using the VGI. Further application of the index would provide additional validation and, potentially, assist governments, funders and programme implementers as they seek to identify geographical as well as health areas that need their support as part of the larger effort to create a safe and supportive environment for adolescent girls the world over.

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References

Aggleton P, Yankah E, Crewe M. 2011. Education and HIV/AIDS-30 years on. *AIDS Education and Prevention* **23**: 495–507.

Auerbach JD, Parkhurst JO, Ca´ceres CF. 2011. Addressing social drivers of HIV/AIDS for the long-term response: conceptual and methodological considerations. *Global Public Health* **6**: S293–S309.

Bates I, Fenton C, Gruber J *et al*. 2004. Vulnerability to malaria, tuberculosis, and HIV/AIDS infection and disease. Part 1: determinants operating at individual and household level. *The Lancet Infectious Diseases* **4**: 267–77.

Birdthistle IJ, Floyd S, Machingura A *et al*. 2008. From affected to infected? Orphanhood and HIV risk among female adolescents in urban Zimbabwe. *AIDS* **22**: 759–66.

Bollen KA. 1989. A new incremental fit index for general structural equation models. *Sociological Methods & Research* **17**: 303–16.

Central Statistics Office, Botswana. Botswana AIDS Impact Survey IV (BAIS IV). 2008. Gaborone, Botswana: NACA, CSO, UN, ACHAP, UNDP.

Bronfenbrenner U. 1979. *The Ecology of Human Development: Experiments by Nature and Design*. Cambridge, MA: Harvard University Press.

Bronfman MN, Leyva R, Negroni MJ *et al*. 2002. Mobile populations and HIV/AIDS in Central America and Mexico: research for action. *AIDS* **16**: S42–9.

DeVellis RF. 1991. *Scale Development: Theory and Applications*. Newbury Park, CA: Sage Publications.

Eaton L, Flisher AJ, Aarø LE. 2003. Unsafe sexual behavior in South African youth. *Social Science & Medicine* **56**: 149–65.

Gavin L, Galavotti C, Dube H *et al*. 2006. Factors associated with HIV infection in adolescent females in Zimbabwe. *Journal of Adolescent Health* **4**: 596.e11–596.e18.

Gupta RG, Parkhurst JO, Ogden JA, Aggleton P, Mahal A. 2008. Structural approaches to HIV prevention. *The Lancet* **372**: 764–75.

Hallman K. 2005. Gendered socioeconomic conditions and HIV risk behaviors among young people in South Africa. *African Journal of AIDS Research* **4**: 37–50.

Hindin MJ, Fatusi AO. 2009. Adolescent sexual and reproductive health in developing countries: an overview of trends and interventions. *International Perspectives on Sexual and Reproductive Health* **35**(2): 58–62.

Mabala R. 2006. From HIV prevention to HIV protection: addressing the vulnerability of girls and young women in urban areas. *Environment & Urbanization* **18**: 407–32.

MEASURE Evaluation. 2009. *Child Status Index: A tool for assessing the well-being of orphans and vulnerable children*. http://www.cpc.unc.edu/measure/publications/pdf/ms-08-31a.pdf, accessed 15 October 2009.

Montgomery SA, Asberg M. 1979. A new depression scale designed to be sensitive to change. *The British Journal of Psychiatry* **134**: 382–9.

Morrison-Beedy D, Carey MP, Aronowitz T. 2003. Psychosocial correlates of HIV risk behavior in adolescent girls. *Journal of Obstetric, Gynecologic, & Neonatal Nursing* **32**: 94–101.

Mustafa D, Ahmed S, Saroch E, Bell H. 2011. Pinning down vulnerability: from narratives to numbers. *Disasters* **35**: 62–86.

National Statistical Office (NSO) [Malawi], and ORC Macro. 2005. *Malawi Demographic and Health Survey 2004*. Calverton, MD: NSO and ORC Macro.

Ndebele M, Kasese-Hara M, Greyling M. 2012. Application of the information, motivation and behavioural skills model for targeting HIV risk behaviour amongst adolescent learners in South Africa. *SAHARA-J: Journal of Social Aspects of HIV/AIDS* **9**: S37–47.

Obasi AI, Balira R, Todd J *et al*. 2001. Prevalence of HIV and Chlamydia trachomatis infection in 15–19-year olds in rural Tanzania. *Tropical Medicine and International Health* **6**: 517–25.

Piot P, Bartos M, Larson H, Zewdie D, Mane P. 2008. Coming to terms with complexity: A call to action for HIV prevention. *The Lancet* **372**(9641): 845–59.

Poulin M. 2007. Sex, money, and premarital partnerships in southern Malawi. *Social Science & Medicine* **65**: 2383–93.

Pulerwitz J, Barker G. 2008. Measuring attitudes toward gender norms among young men in Brazil development and psychometric evaluation of the GEM scale. *Men and Masculinities* **10**: 322–38.

Rassjo EB, Mirembe FM, Darj E. 2006. Vulnerability and risk factors for sexually transmitted infections and HIV among adolescents in Kampala, Uganda. *AIDS Care* **18**: 710–6.

Rose G. 1985. Sick individuals and sick populations. *International Journal of Epidemiology* **14**: 32–8.

Sumartojo E. 2000. Structural factors in HIV prevention: concepts, examples, and implications for research. *AIDS* **14**: S3–10.

UNAIDS. 1998. *Expanding the Global Response to HIV/AIDS through Focused Action, in UNAIDS Best Practice Collection*. Geneva: Joint United Nations Programme on HIV/AIDS.

UNAIDS. 2008. *Report on the global AIDS epidemic 2008*. Geneva, Switzerland: Joint United Nations Programme on HIV/AIDS.

Underwood C, Boulay M, Snetro-Plewman G *et al*. 2012. Community capacity as means to improved health practices and an end in itself: evidence from a multi-stage study. *International Quarterly of Community Health Education* **33**: 105–27.