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Examining the influence of contextual factors on risky sexual behavior among young women in Zomba district, Malawi: A multilevel analysis

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EXAMINING THE INFLUENCE OF CONTEXTUAL FACTORS ON RISKY SEXUAL BEHAVIOR AMONG YOUNG WOMEN IN ZOMBA DISTRICT, MALAWI: A MULTILEVEL ANALYSIS

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Melissa Kari Ward-Peterson

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To: Dean Tomás R. Guilarte
Robert Stempel College of Public Health and Social Work

This dissertation, written by Melissa Kari Ward-Peterson, and entitled Examining the Influence of Contextual Factors on Risky Sexual Behavior among Young Women in Zomba District, Malawi: A Multilevel Analysis, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

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Date of Defense: September 5, 2017

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Florida International University, 2017

DEDICATION

This dissertation is dedicated to my grandmothers, Winnie Ward and Barbara Bryan Rojas. Thank you for your tenacity and sacrifice.

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ABSTRACT OF THE DISSERTATION

EXAMINING THE INFLUENCE OF CONTEXTUAL FACTORS ON RISKY SEXUAL BEHAVIOR AMONG YOUNG WOMEN IN ZOMBA DISTRICT, MALAWI: A MULTILEVEL ANALYSIS

by

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Miami, Florida

Professor Kristopher Fennie, Major Professor

The objective of this study was to examine the association between risky sexual behavior and contextual factors related to economic resources, woman's empowerment, and health facility characteristics among young women in Zomba district, Malawi. Secondary analyses of the Schooling, Income, and Health Risk (SIHR) study were undertaken. Four outcomes related to risky sexual behavior were examined: if participants had ever had sex, consistent condom use, and two scores measuring risk related to partner history and age during sexual activity. Regression models with cluster-robust standard errors and multilevel regression models were used to estimate associations; analyses were stratified by school enrolment status at baseline of the SIHR study and utilized weights to account for SIHR sampling design.

For participants in school at baseline, the percent of girls enrolled in school at the community level was associated with ever having sex and consistent condom use. Belief in the right to refuse sex was protective against ever having sex, lower household education was associated with higher odds of ever having sex, and near rural and far rural

residence was associated with decreased odds of condom. For participants not in school at baseline, lower individual education was associated with riskier scores related to age and partner history and lower household education was associated with lower age during sexual activity. Private or non-governmental health facilities were associated with decreased odds of condom use and higher age during sexual activity. In both strata, increasing age and near rural residence (within 16 kilometers of urban center) increased odds of ever having sex; lower educational achievement was associated with lower age during sexual activity. A history of pregnancy was associated with lower odds of condom use and riskier partner history.

Risky sexual behavior is multifaceted and complex. While various factors related to women's empowerment played a role, the most consistent variables associated with risky sexual behavior were those related to education. Interventions and programs seeking to reduce risky sexual behavior among young women, thereby reducing their risk of HIV infection, should continue to focus on improving access to education at multiple levels.

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ABBREVIATIONS AND ACRONYMS

AIDS	acquired immunodeficiency syndrome
ASSIA	Applied Social Sciences Index and Abstracts
CINAHL	Cumulative Index to Nursing and Allied Health Literature
DHS	Demographic and Health Surveys
HIV	human immunodeficiency virus
HSV-2	herpes simplex virus 2
ICC	intraclass correlation coefficient
IPV	intimate partner violence
MeSH	medical subject heading
MLM	multilevel model
OVC	orphans and vulnerable children
PEPFAR	President's Emergency Plan for AIDS Relief
PMTCT	prevention of mother-to-child transmission
PRISMA-P	Preferred Reporting Items for Systematic review and Meta-Analysis Protocols
PROSPERO	International Prospective Register of Systematic Reviews
QATQS	Quality Assessment Tool for Quantitative Studies
RCT	randomized controlled trial
RSB	risky sexual behavior
SIHR	Schooling, Income and Health Risk Study
SSA	sub-Saharan Africa
SES	socioeconomic status

STI	sexually transmitted infection
USAID	United States Agency for International Development

INTRODUCTION

Risky sexual behavior, including early sexual debut and sexual activity without condoms, is a critical factor in the causal pathway for human immunodeficiency virus (HIV) (1). HIV attacks the immune system, causing acquired immunodeficiency syndrome (AIDS) which eventually leads to death (2). Despite recent progress marked by an 11% reduction in new infections since 2010, HIV remains a global challenge (3). Sub-Saharan Africa (SSA) carries approximately 70% of the world's HIV burden, a disproportionate amount considering it is home to only 16% of the world's population (4-6). While there are a number of ways HIV can be transmitted, heterosexual sexual activity is the most common mode of transmission in SSA (4). Reducing risky sexual behavior can reduce the incidence of HIV (7).

There has been progress in SSA, with a 29% decrease in the number of new HIV infections in eastern and southern Africa between 2000 and 2016 (3). However, more progress is needed, particularly for women, who carry approximately 58% of the burden in SSA (3). Young women are particularly vulnerable: HIV acquisition affects a young woman's educational outlook and economic productivity, puts the health of her future children at risk, and can further destabilize a household which may already be living in extreme poverty (8, 9).

This is the case in Malawi, a small, landlocked country located in southeastern Africa and bordered by Zambia, Tanzania, and Mozambique. It has a very young population: of its approximate 18.57 million residents, 46.5% are below the age of 15 (10). Although it is politically stable, Malawi is one of the poorest country in the world

with a gross domestic product per capita of $301 (11). Approximately 71% of the population lives below the international poverty line of $1.90 per day (12). Malawi has one of the worst life expectancies (61.2 years) and one of the highest fertility rates (5.54 children per woman) in the world. Health infrastructure is weak, with 0.02 physicians and 1.3 hospital beds per 1,000 population (10).

Figure 1. Map of Malawi

Source: NSO Malawi & ICF, 2017.

The first case of AIDS in Malawi was diagnosed in 1985 (13). Currently, Malawi has a generalized HIV epidemic with a 2015 estimated adult prevalence of 9.1%, the ninth highest HIV prevalence in the world, as well as in the region (14, 15). Overall, the adult prevalence of HIV has decreased, declining from an estimated 15.2% in 2003 (16). The annual HIV incidence rate has decreased to an estimated 0.38% from 1.33% in 2003 (16). The infrastructure available to combat HIV has improved dramatically as well: between January 2004 and December 2005, the number of public facilities offering antiretroviral therapy increased from nine, serving approximately 4,000 patients, to sixty, serving close to 37,480 patients (17).

While women are biologically more vulnerable to sexual transmission of HIV, contextual factors that may lead to risky sexual behavior exacerbate this vulnerability (8, 18). The influence of contextual factors—social, political, economic, or environmental—on health and health behavior is well-documented in the literature (19-23). The social determinants of adolescent health and HIV infection have been examined by numerous researchers (24, 25). Relevant conceptual frameworks can be drawn from the social

capital literature, as well as work that combines behavioral and biological mechanisms of disease transmission (26, 27).

In Malawi, the contextual factors related to risky sexual behavior are complex. A known driver of risky sexual behavior among young women is transactional sex. Due to economic hardships, young girls may decide to date and have sex with older men in exchange for gifts or economic support (18, 28). Women living in communities with increased economic development may not face the same pressures to engage in risky sexual behavior compared to women who do not. Education is another factor that has implications for HIV prevention. Additionally, sociocultural norms driven by factors such as a community's tribe or religion may affect risky sexual behavior (29-32). Women living in communities where women have higher social status may be more empowered to negotiate condom use in sexual encounters, and may have more autonomy in choosing their partners (29-32). Furthermore, some evidence suggests access to voluntary counseling and testing (VCT) services may be important for behavior change and HIV prevention (33, 34).

These contextual factors have partially led to the gender disparities evident in Malawi's HIV distribution. Among men aged 15-49, HIV prevalence decreased from 10.2% to 8.3% between 2004 and 2015-2016. The same gains were not observed among women aged 15-49, who had HIV prevalence of 13.3% in 2004 and 12.2% in 2015-2016 (35, 36). In urban settings, HIV prevalence among women aged 15-49 is 17.8% compared to 11.0% among men of the same age (36). The disproportionately higher prevalence among women compared to men holds among the young population: 3.3% for

women aged 15-19 as compared to 1.0% among men of the same age, and 6.4% compared to 1.1% for women and men aged 20-24, respectively (36). The difference between women and men aged 15-24 is even more pronounced in the Southern region of Malawi (6.3% versus 1.6%, respectively), among those with no education (7.2% versus 1.7%, respectively), and in urban settings (9.1% versus 1.0%, respectively) (36).

The complexity of contextual factors suggest structural interventions may be effective prevention strategies. The Schooling, Income, and Health Risk (SIHR) study, conducted by Baird and colleagues, was a cluster randomized trial examining the effect of an intervention addressing poverty and education on sexual behavior and the prevalence of HIV and herpes simplex virus 2 (HSV-2) among young women in Zomba District, located in the Southern Region of Malawi (37). Zomba District includes both a large rural population and an urban center in Zomba City, one of Malawi's four large cities (38). Agriculture represents 87% of economic activity; farming and fishing, supported by Lake Chilwa in eastern Zomba district, are the main agricultural activities. A 2009 profile of Zomba District reported that 97% of adults 15 years and older were employed in some way. However, most residents of Zomba District did not receive a formal income (38). In 2008, only 6% of the population received a regular income. A vast majority of the population was unpaid or received casual payments. The average household lived on 183 Malawian kwacha, or approximately $0.39 per day, well under the international poverty line of $1.90 per day (12, 38). As of 2009, Zomba District was the third poorest district in Malawi (38). In 2015-2016, HIV prevalence among women aged 15-49 in Zomba District was 16.8%, compared to 9.3% among men (36).

The SIHR intervention consisted of a cash transfer program. The study included two cohorts: girls who were enrolled in school at baseline and girls who were not. Among baseline schoolgirls, the experimental arm of the study was subdivided into a conditional cash transfer group, in which receiving the cash transfer was contingent upon attending school regularly, and an unconditional cash transfer group. Among baseline dropouts, the experimental arm consisted only of conditional cash transfers. The control group in both cohorts received no cash transfers (37). Among the baseline schoolgirls, results showed a decrease in risky sexual behaviors and lower prevalence of HIV and HSV-2 in the intervention group (those receiving cash transfers) compared to those in the control group (37). These findings strengthen the argument that improving education and reducing poverty has a positive influence on HIV-related behaviors and outcomes.

Aims of the Dissertation

While the SIHR study is the only cash transfer intervention to date to show better HIV outcomes among the intervention group, other conditional cash transfer programs have had positive effects on the upstream drivers of HIV risk, including risky sexual behavior, health service utilization, poverty, and gender inequities, highlighting the potential of structural interventions to prevent HIV (8, 39, 40). However, the influence of higher-level contextual factors—such as community-level economic activity, women's empowerment, and health services offered in the community—on risky sexual behavior has not been fully explored in Malawi and warrants further investigation.

The primary aim of this dissertation is to determine whether contextual factors are related to risky sexual behavior among a representative, weighted sample of young women in Zomba District, Malawi, by examining the following specific aims:

Specific Aim 1: To examine the ways in which economic contextual factors affect risky sexual behavior.

Specific Aim 2: To examine the ways in which sociocultural contextual factors, specifically those related to women's empowerment, affect risky sexual behavior.

Specific Aim 3: To examine the ways in which contextual factors related to health services proximal to HIV risk affect risky sexual behavior.

These aims were examined through several studies and secondary analyses of data available from the control group of the SIHR study. The results of the dissertation are presented here in three manuscripts. The first manuscript is a systematic review which sought to describe the use of multilevel models in evaluating the influence of contextual factors on HIV/AIDS, sexually transmitted infections, and risky sexual behavior in sub-Saharan Africa. The second manuscript sought to examine the ways in which economic contextual factors and women's empowerment in the community are associated with risky sexual behavior (Specific Aims 1 and 2). The final manuscript examined the ways in which health services and facility characteristics, as well as other factors related to HIV awareness, are associated with risky sexual behavior (Specific Aim 3).

References

1. How is HIV Transmitted? [Internet].: U.S. Department of Health and Human Services; 2017 [cited July 1, 2017]. Available from: https://www.hiv.gov/hiv-basics/overview/about-hiv-and-aids/how-is-hiv-transmitted.

2. What Are HIV and AIDS? [Internet].: U.S. Department of Health and Human Services; 2017 [cited July 1, 2017]. Available from: https://www.hiv.gov/hiv-basics/overview/about-hiv-and-aids/what-are-hiv-and-aids.

3. Fact Sheet July 2017 [Internet].: Joint United Nations Programme on HIV/AIDS (UNAIDS); 2017 [cited July 1, 2017]. Available from: http://www.unaids.org/sites/default/files/media_asset/UNAIDS_FactSheet_en.pdf.

4. Joint United Nations Programme on HIV/AIDS (UNAIDS). The Gap Report. Geneva: Joint United Nations Programme on HIV/AIDS (UNAIDS); 2014.

5. HIV/AIDS [Internet].: World Health Organization Regional Office For Africa [cited July 1, 2017]. Available from: http://www.afro.who.int/health-topics/hivaids.

6. United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects: The 2015 Revision, Key Findings and Advance Tables. Working Paper No. ESA/P/WP.241. New York: United Nations; 2015.

7. Chen L, Jha P, Stirling B, Sgaier SK, Daid T, Kaul R, et al. Sexual risk factors for HIV infection in early and advanced HIV epidemics in sub-Saharan Africa: systematic overview of 68 epidemiological studies. PLoS One. 2007;2(10):e1001.

8. United Nations Development Programme (UNDP). Discussion Paper: Cash Transfers and HIV Prevention. New York: United Nations Development Programme (UNDP); 2014.

9. Buve A, Bishikwabo-Nsarhaza K, Mutangadura G. The spread and effect of HIV-1 infection in sub-Saharan Africa. Lancet. 2002;359(9322):2011-7.

10. The World Factbook: Malawi [Internet].: Central Intelligence Agency (CIA); 2017 [cited August 1, 2017]. Available from: https://www.cia.gov/library/publications/the-world-factbook/geos/mi.html.

11. GDP per capita (current US$) [Internet].: World Bank [cited July 1, 2017]. Available from: http://data.worldbank.org/indicator/NY.GDP.PCAP.CD.

12. Poverty [Internet].: World Bank [cited July 1, 2017]. Available from: http://data.worldbank.org/topic/poverty.

13. Mwale B. HIV/AIDS in Malawi. Malawi Med J. 2002;14(2):2-3.

14. Malawi HIV and AIDS Estimates (2015) [Internet].: Joint United Nations Programme on HIV/AIDS (UNAIDS) [cited July 1, 2017]. Available from: http://www.unaids.org/en/regionscountries/countries/malawi.

15. The World Factbook: Country Comparison, HIV/AIDS Adult Prevalence Rate [Internet].: Central Intelligence Agency (CIA) [cited July 1, 2017]. Available from: https://www.cia.gov/library/publications/the-world-factbook/rankorder/2155rank.html.

16. PEPFAR Fact Sheet [Internet].: U.S. President's Emergency Plan for AIDS Relief [cited August 1, 2017]. Available from: https://www.pepfar.gov/documents/organization/264882.pdf.

17. Libamba E, Makombe SD, Harries AD, Schouten EJ, Yu JK, Pasulani O, et al. Malawi's contribution to "3 by 5": achievements and challenges. Bull World Health Organ. 2007;85(2):156-60.

18. Chersich MF, Rees HV. Vulnerability of women in southern Africa to infection with HIV: biological determinants and priority health sector interventions. AIDS. 2008;22(Suppl 4):S27-40.

19. Berkman LF, Kawachi I, Glymour M, editors. Social Epidemiology. 2nd ed. Oxford: Oxford University Press; 2014.

20. Marmot M, Wilkinson RG, editors. Social Determinants of Health. 2nd ed. Oxford: Oxford University Press; 2006.

21. Oakes JM, Kaufman JS, editors. Methods in Social Epidemiology. 2nd ed. San Francisco: Jossey-Bass; 2017.

22. Kawachi I, Subramanian SV. Neighbourhood influences on health. J Epidemiol Community Health. 2007;61(1):3-4.

23. Subramanian SV, Belli P, Kawachi I. The macroeconomic determinants of health. Annu Rev Public Health. 2002;23:287-302.

24. Viner RM, Ozer EM, Denny S, Marmot M, Resnick M, Fatusi A, et al. Adolescence and the social determinants of health. Lancet. 2012;379(9826):1641-52.

25. Poundstone KE, Strathdee SA, Celentano DD. The social epidemiology of human immunodeficiency virus/acquired immunodeficiency syndrome. Epidemiol Rev. 2004;26:22-35.

26. Carpiano RM. Toward a neighborhood resource-based theory of social capital for health: can Bourdieu and sociology help? Soc Sci Med. 2006;62(1):165-75.

27. Boerma JT, Weir SS. Integrating demographic and epidemiological approaches to research on HIV/AIDS: the proximate-determinants framework. J Infect Dis. 2005;191 (Suppl 1):S61-7.

28. Nagoli J, Holvoet K, Remme M. HIV and AIDS vulnerability in fishing communities in Mangochi district, Malawi. Afr J AIDS Res. 2010;9(1):71-80.

29. Gilbert L, Walker L. Treading the path of least resistance: HIV/AIDS and social inequalities a South African case study. Soc Sci Med. 2002;54(7):1093-110.

30. Gupta GR. How men's power over women fuels the HIV epidemic. BMJ. 2002;324(7331):183-4.

31. Zierler S, Krieger N. Reframing women's risk: social inequalities and HIV infection. Annu Rev Public Health. 1997;18:401-36.

32. Amaro H. Love, sex, and power. Considering women's realities in HIV prevention. Am Psychol. 1995;50(6):437-47.

33. Bunnell R, Ekwaru JP, Solberg P, Wamai N, Bikaako-Kajura W, Were W, et al. Changes in sexual behavior and risk of HIV transmission after antiretroviral therapy and prevention interventions in rural Uganda. AIDS. 2006;20(1):85-92.

34. Painter TM. Voluntary counseling and testing for couples: a high-leverage intervention for HIV/AIDS prevention in sub-Saharan Africa. Soc Sci Med. 2001;53(11):1397-411.

35. National Statistical Office (NSO) and ORC Macro. Malawi Demographic and Health Survey 2004. Calverton, Maryland: NSO and ORC Macro; 2005.

36. National Statistical Office (NSO) [Malawi] and ICF, editor. Malawi Demographic and Health Survey 2015-16. Zomba, Malawi, and Rockville, Maryland, USA: NSO and ICF; 2017.

37. Baird SJ, Garfein RS, McIntosh CT, Ozler B. Effect of a cash transfer programme for schooling on prevalence of HIV and herpes simplex type 2 in Malawi: a cluster randomised trial. Lancet. 2012;379(9823):1320-9.

38. Zomba District Assembly Department of Planning and Development. Zomba District Socio-Economic Profile 2009-2012. Zomba: Zomba District Assembly; 2009.

39. Pettifor A, MacPhail C, Nguyen N, Rosenberg M. Can money prevent the spread of HIV? A review of cash payments for HIV prevention. AIDS Behav. 2012;16(7):1729-38.

40. Heise L, Lutz B, Ranganathan M, Watts C. Cash transfers for HIV prevention: considering their potential. J Int AIDS Soc. 2013;16:18615.

MANUSCRIPT 1

Using multilevel models to evaluate the influence of contextual factors on HIV/AIDS, STIs, and risky sexual behavior in sub-Saharan Africa: a systematic review

Abstract

Purpose. To describe the use of multilevel models (MLMs) in evaluating the influence of contextual factors on HIV/AIDS, sexually transmitted infections (STIs), and risky sexual behavior (RSB) in sub-Saharan Africa. **Methods.** Ten databases were searched through May 29, 2016. Two reviewers completed screening and full-text review. Studies examining the influence of contextual factors on HIV/AIDS, STIs, and RSB and utilizing MLMs for analysis were included. The Quality Assessment Tool for Quantitative Studies was used to evaluate study quality. **Results.** A total of 118 studies met inclusion criteria. Seventy-four studies focused on HIV/AIDS-related topics; forty-six focused on RSB. No studies related to STIs other than HIV/AIDS met the eligibility criteria. Of five studies examining HIV serostatus and community socioeconomic factors, three found an association between poverty and measures of inequality and increased HIV prevalence. Among studies examining RSB, associations were found with numerous contextual factors, including poverty, education, and gender norms. **Conclusions.** Studies utilizing MLMs indicate that several contextual factors, including community measures of socioeconomic status and educational attainment, are associated with a number of outcomes related to HIV/AIDS and RSB. Future studies utilizing MLMs should focus on contextual-level interventions in order to strengthen the evidence base for causality.

Keywords: multilevel analysis; HIV; sexually transmitted diseases; sexual behavior; sub-Saharan Africa; social determinants of health

Introduction

Multilevel models (MLMs), also referred to as hierarchical linear models or mixed-effects models, allow researchers to account for both ecological, or contextual, and individual-level, or compositional, variables. While other statistical methods (including population-averaged methods, such as cluster-robust standard errors and generalized estimating equations) may be used to account for potential clustering of data collected within hierarchical structures, MLMs are unique because they provide estimates of variance for contextual-level units (1). For example, a researcher interested in exploring how community-level factors influence the prevalence of HIV/AIDS among individuals might collect data at both the community (or contextual) and individual (or compositional) levels. Analysis with population-averaged methods adjusts variance estimates to account for the clustered-nature of the data. However, analysis with MLMs will provide the researcher with the additional information of variance estimates at the community level (1). Such information may be useful when determining if a community intervention is appropriate, and if such an intervention has potential to influence individual-level health outcomes.

Relatively recent advances in the computational abilities of statistical programs have made MLMs more accessible to researchers. While MLMs were developed and have been utilized extensively in other fields, they have recently gained popularity within epidemiology to examine the contextual factors, such as community or household

variables, that may be part of the causal pathway for various health outcomes. MLMs are particularly useful in interpreting clustered data, causal processes that occur at multiple levels, and variation and heterogeneity--inferences that might be incorrectly made through the use of single-level modelling (2).

Montgomery and Hewett examined Demographic and Health Survey data and found that poor communities in developing countries are not homogenous, noting a need for future research related to contextual factors in these settings (3). Given the complexity of the processes leading to HIV/AIDS, sexually transmitted infections (STIs), and risky sexual behavior (RSB), MLMs may be particularly useful for exploring how contextual factors might influence these outcomes at the individual level. For example, how might community-level poverty influence RSB among adolescent girls and young women? A scoping search conducted by the authors showed that, to date, no systematic review has been undertaken to describe the use of MLMs for such outcomes in sub-Saharan Africa (SSA).

The objective of this systematic review was to describe the use of MLMs in evaluating the influence of contextual factors on HIV/AIDS, STIs, and RSB in SSA. We addressed the following questions: 1) to what extent are MLMs being used to evaluate the impact of interventions related to contextual factors on HIV/AIDS, STIs, and RSB in SSA; 2) what do the results of MLMs indicate about the role of contextual factors in HIV/AIDS, STIs, or RSB in SSA; 3) in what settings are MLMs being used for analysis of the influence of contextual factors on HIV/AIDS, STIs, and RSB in SSA; 4) among what populations are MLMs being used to analyze the influence of contextual factors on

HIV/AIDS, STIs, and RSB in SSA; 5) for non-interventional studies, which study designs utilize MLMs to analyze the influence of contextual factors on HIV/AIDS, STIs, and RSB in SSA; 6) what are the quality of studies that utilize MLMs to analyze the influence of contextual factors on HIV/AIDS, STIs, and RSB in SSA; and 7) what are the funding sources for these studies.

Materials and Methods

The protocol for this systematic review was drafted in accordance with the Preferred Reporting Items for Systematic review and Meta-Analysis Protocols (PRISMA-P) guideline (4) and registered with the International Prospective Register of Systematic Reviews (PROSPERO: CRD42016038580) (5).

We searched ten databases, including PubMed; Embase; Cumulative Index to Nursing and Allied Health Literature (CINAHL) Plus; Scopus; Global Index Medicus; Web of Science Core Collection; EconLit; ABI/INFORM Complete; Business Source Complete; and Applied Social Sciences Index and Abstracts (ASSIA).

The search terms used are shown in Table 1-1. The list of STIs included in the search was defined by the Centers for Disease Control and Prevention (6), and the list of countries was defined by the World Bank's definition of SSA (7). Recognizing studies utilizing MLMs in their analysis may not have specified this in their abstracts, we sought to be as inclusive as possible in the MLM-related keywords utilized in the search strategy (Table 1-1). Database-specific subject headings were also included for each keyword when available.

Studies eligible for inclusion examined the influence of contextual factors on HIV/AIDS, STIs, and RSB and utilized MLMs for analysis. Studies examining public health topics related to HIV/AIDS, STIs, and RSB, such as counseling, testing, prevention of mother-to-child transmission (PMTCT), treatment, and stigma, were also eligible for inclusion. MLMs were defined as regression techniques that produce estimates of variation at more than one level (2). Studies examining contextual factors but utilizing multivariate regression modeling methods which do not provide estimates of higher-level variation (such as cluster-robust standard errors or generalized estimating equations) were considered ineligible for inclusion (1). Studies examining repeated measures and dyad studies (i.e. relationship dynamics of couples) were excluded, since these topics were not considered to be related to contextual factors. Inclusion was limited to peer-reviewed articles, published in English, Spanish, or French. Gray literature, including conference abstracts and non-peer-reviewed publications, was excluded from the search. Databases were searched through May 29, 2016; no time limits were applied.

Screening was carried out in two stages. First, two reviewers on the screening team (MWP, DM, MS, CC, & PB) independently screened titles and abstracts for eligibility based on the inclusion criteria. A second screen of full text articles by two reviewers on the screening team was conducted to determine final eligibility for inclusion. Because it was possible authors may have stated in their titles or abstracts that they utilized a multilevel approach, while in reality they utilized a standard regression modeling procedure, only papers which, upon full-text review, explicitly stated they utilized multilevel regression modeling techniques were deemed eligible for inclusion. At both screening stages, any conflicts were resolved through discussion and consensus. The

bibliographies of studies selected for inclusion were hand-searched for additional studies that might meet eligibility criteria.

After study selection was complete, information was extracted into an electronic database. Quality was assessed for studies implementing non-secondary analyses. Studies utilizing a randomized controlled trial (RCT), quasi-experimental, cohort, or case-control study design were evaluated using the Quality Assessment Tool for Quantitative Studies (QATQS) (8), recommended by the Cochrane Collaboration (9). The quality of cross-sectional studies was assessed using an adapted version of QATQS, examining risk for selection bias, data collection methods, and confounders included. Information was extracted independently by two reviewers; conflicts were resolved through discussion and consensus.

Covidence systematic review software (Veritas Health Innovation, Melbourne, Australia) was used to manage article screening and selection by the team of reviewers and to eliminate duplicates. NVivo 11 (QSR International, Melbourne, Australia) was used to manage full text articles and a standardized table in Excel (Microsoft, Seattle, United States) was used for information extraction. RefWorks (ProQuest, Ann Arbor, United States) was used to manage citations.

Results

The flowchart in Figure 1-1 shows the number of studies at each stage of the screening process. A total of 118 studies were included in the review (Tables 1-2 and 1-3). Seventy-four studies focused on the broad topic of HIV/AIDS; ten of these focused on PMTCT, and eight focused on orphans and vulnerable children (OVCs). Forty-six studies

focused on the broad topic of RSB; 13 focused on condom use or contraception, and 11 examined intimate partner violence (IPV). No studies related to STIs other than HIV/AIDS met eligibility criteria. Only two studies were published prior to 2000, and two studies between 2000 and 2006; all remaining studies were published in 2007 or later. All included studies were published in English.

Aim 1: Interventions

Of the 118 studies that met final inclusion criteria, five represented primary evaluation of interventions targeting contextual factors (Table 1-2). Two were interventions conducted in health facilities, one in a church congregation, one in a school, and one was a community-wide intervention. All studies reported improvement on HIV/AIDS-related outcomes in the intervention group compared to the control group (see Table 1-2 for details).

Aim 2: Role of Contextual Factors in HIV/AIDS and Risky Sexual Behavior

The included studies found associations between HIV infection and a number of contextual factors. Of nineteen studies that examined HIV serostatus as the outcome of interest, three found associations between contextual-level poverty and the likelihood of HIV positivity. One of the three found that women living in communities with lower socioeconomic status (SES) had higher risk of HIV infection (10). In contrast, two of the three found a lower odds of HIV positivity in poorer communities (11, 12). Findings from studies examining contextual-level measures of inequality were more consistent. Durevall et al. found that increased consumption inequality increased HIV risk (13). Brodish found increases in Gini coefficients and wealth ratios similarly increased HIV risk (14). Of the

remaining fourteen studies, researchers found positive associations between HIV serostatus, community ethnic diversity (15), and levels of sexual concurrency (16). One study found higher community-level educational attainment was protective (17), while another found mixed associations depending on levels of globalization (18). Magadi et al. found mixed associations between regional and country-level media exposure and HIV prevalence (19). One study found no association between country-level HIV prevalence and HIV status (20). Two others examined variance at the country level (21, 22), while six utilized MLMs but did not report results related to contextual-level factors (23-28).

The forty-six studies reporting results related to RSB examined a variety of outcomes, including abstinence, age of sexual initiation, number of partners, extramarital sex, and condom use; many studies examined more than one (Table 1-3). Associations were found with numerous contextual factors, including community aggregate women's employment and control of earnings (29), educational attainment (18, 30-32), SES and community development (33-38), concentrated disadvantage (39), HIV knowledge (40), gender norms and inequality (41-49), women's average age of marriage (41, 50-52), and community sexual norms (53). A total of 6 studies examining RSB did not report contextual findings (54-59). The studies included in this review were too heterogeneous for meta-analysis.

Aim 3: Settings

Two aspects of study setting were considered: country and the unit for which the random effect (or the contextual level studied) was used. The most frequently studied country was Nigeria (26 studies). Of the 47 countries classified as SSA by the World

Bank, 11 were not represented by studies included in this review: Burundi, Cape Verde, Equatorial Guinea, Eritrea, Gambia, Guinea-Bissau, São Tomé and Principe, Seychelles, Somalia, Sudan, and South Sudan. Community was the most frequently reported unit for random effects (75 studies). Nineteen studies used health facility or health system as the unit for random effects. Less frequently used units for random effects included country, region, school, church congregation, and household (Table 1-3).

Aim 4: Populations Studied

Forty-five studies focused solely on women or girls. Most of these studies focused generally on women of reproductive age, while others focused on subgroups such as those who were pregnant or participating in PMTCT programs, those who were post-partum or recently had a live birth, those who were sexually active, those who were married, or those who reported experiencing IPV. Thirty-eight studies focused on infants, children, adolescents, and young adults. These studies focused on topics ranging from OVCs and youth-friendly services to sexual initiation, coercive sex, and condom use (Table 1-3).

Aim 5: Study Designs

A total of 108 studies were cross-sectional. Four studies were RCTs, and four were retrospective cohorts. One study utilized a prospective cohort design, and one reported using a pre-post randomized group design (Table 1-3). A majority of studies, 89, conducted secondary data analysis. The most frequently used data source was The Demographic and Health Surveys (DHS) Program (51 studies), which is funded by the

United States Agency for International Development (USAID) and is implemented in 90 countries globally, including 43 within SSA (60).

Aim 6: Study Quality

The full QATQS was used for a total of nine studies representing primary data analysis of RCTs or cohort studies. Four studies were rated moderate and five as weak (Table 1-4). Weak ratings were largely due to lack of reporting on the validity and reliability of data collection methods employed.

An adapted QATQS was used for a total of 20 studies representing primary analysis of cross-sectional data (Table 1-5). A total of three studies were rated as strong in regards to minimizing selection bias; 13 were rated as moderate. Eighteen studies were rated as strong with regard to confounders, while two were rated as weak. Four studies were rated moderate with regards to the validity and reliability of data collection methods; the remaining were rated as weak.

Aim 7: Funding Sources

The most frequently reported funder was the Eunice Kennedy Shriver Institute of Child Health and Human Development (14 studies), followed by USAID (11 studies), the National Institute of Mental Health (9 studies), the United Kingdom Medical Research Council (8 studies), and the President's Emergency Plan for AIDS Relief (6 studies). Other funding from bilateral agencies came from France, the United Kingdom, Canada, Norway, and Japan.

Reporting Multilevel Modelling

A secondary finding was related to variation in the statistics reported for MLMs. Sixty-nine of 118 studies reported random effects, while only 49 reported the intraclass correlation coefficient (ICC). Twenty-one studies reported statistics comparing different models to one another (such as deviance or log likelihood), and nine studies reported measures of model fit (such as deviance, Akaike, or Bayesian information criterions). The most frequently reported software used for analysis was Stata (45 studies).

Discussion

Nearly all studies consisted of a cross-sectional design, and most represented secondary data analysis, with DHS being the most frequently utilized data source. Only five studies evaluated the impact of a contextual-level intervention. While cross-sectional studies provide insight into associations between contextual-level factors and individual-level outcomes, they cannot be used to establish temporality or determine causality. This presents one of the greatest challenges to the expanded focus on multilevel modelling among social epidemiologists (61, 62). While it is clear that contextual disparities are associated with HIV/AIDS and RSB, the mechanisms underlying these associations and their causal pathways require more exploration.

The use of the QATQS is best suited for RCTs, and therefore may have resulted in overly conservative quality assessments for cohort studies. Additionally, we noted gaps in the instructions provided by the QATQS, leaving criteria open to interpretation by the rater (8). In spite of this, use of the QATQS draws attention to the importance of reporting on the validity and reliability of data collection methods, which was lacking in

most studies conducting primary data analysis. While failure to report this aspect of the methodology may indicate the validity and reliability of measures were not taken into consideration, it may also be due to the fact that the instruments were validated elsewhere, or the researchers only examined some aspect of validity. If one of the latter reasons was true, it is still important to report any element of known validity.

To our knowledge, there are no standardized reporting guidelines for MLMs. The heterogeneity in the measures reported among the studies included in this review highlight the potential benefit of such guidelines. In our opinion, estimates of random effects (or contextual-level variation) and ICCs represent the most insightful information for readers and should be included in all studies reporting the results of MLMs. It should be noted that, since ICC is a measure of how similar individuals within a contextual unit are to one another, even small ICCs may represent important opportunities for intervention (63). For example, if individuals living within the same community tend to have a similarly high likelihood of being HIV-positive, it may be worthwhile to invest in community-level interventions to impact individual-level practices, even if the ICC is low.

Since women and young girls are among the highest risk groups for HIV infection in SSA, it is encouraging that approximately 38% of the studies included focused on this vulnerable population (64). However, it should be noted that none of the studies included examined samples of men who have sex with men or injection drug users. These groups historically have been underrepresented in HIV/AIDS research in SSA due to marginalization and criminalization, as well as social stigma and donor funding priorities.

However, both groups are at high risk and may play an important role in generalized epidemics (65, 66). Future research related to contextual factors should intentionally seek to include these groups.

One strength of our study is the use of ten databases to search the existing literature, including databases from the fields of medicine, public health, nursing/health sciences, and economics. Another strength is our broad inclusion of topics related to HIV/AIDS and RSB, particularly given the complex and multifaceted nature of these public health issues in SSA. The compendium of studies presented in this review provide members of the global health community a valuable starting point before undertaking additional research related to the role of contextual factors.

One limitation of this review is reflected in the need to include language related to MLMs in keyword criteria for screening titles and abstracts in order to manage the number of studies in the screening process. It is possible some studies utilizing MLMs in their analysis did not specify this in their abstracts and therefore did not meet eligibility criteria for this review. However, we did our best to mitigate this limitation by being as inclusive as possible in the MLM-related keywords we used in the search strategy. Another limitation includes our lack of meta-analyses of results, namely contextual factors; future studies should explore meta-analyses further as more data become available. Finally, it is possible that studies with non-significant findings may not have been published, leading to publication bias.

Conclusions

MLMs have gained increasing popularity among social epidemiologists. To our knowledge, this is the first systematic review to describe the use of MLMs in evaluating the influence of contextual factors on HIV/AIDS, STIs, and RSB in SSA. The results of the studies included indicate numerous contextual factors, such as community-level poverty and education, are associated with a number of outcomes related to HIV/AIDS and RSB. Future studies utilizing MLMs should focus on contextual-level interventions and include measures of potential mediators in order to elucidate the mechanisms underlying these associations and to strengthen the evidence base for causality.

References

1. McNeish D, Stapleton LM, Silverman RD. On the Unnecessary Ubiquity of Hierarchical Linear Modeling. Psychol Methods. 2017;22(1):114-140.

2. Kaufman JS, Oakes JM, editors. Methods in Social Epidemiology. 1st ed. San Francisco: Jossey-Bass; 2006.

3. Montgomery MR, Hewett PC. Urban poverty and health in developing countries: household and neighborhood effects. Demography. 2005;42(3):397-425.

4. Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2015 statement [Internet].: The EQUATOR Network [cited March 1, 2016]. Available from: http://www.equator-network.org/reporting-guidelines/prisma-protocols/.

5. PROSPERO: International Prospective Register of Systematic Reviews [Internet].: University of York [cited March 1, 2016]. Available from: https://www.crd.york.ac.uk/PROSPERO/.

6. Sexually Transmitted Diseases [Internet].: Centers for Disease Control and Prevention; 2014 [updated February 25; cited May 1, 2016]. Available from: https://www.cdc.gov/std/general/default.htm.

7. World Bank Country and Lending Groups [Internet].: World Bank [cited April 3, 2016]. Available from:

https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups.

8. Quality Assessment Tool for Quantitative Studies [Internet].: Effective Public Health Practice Project [cited April 3, 2016]. Available from: http://www.ephpp.ca/tools.html.

9. Armstrong R, Waters E, Doyle J. 21.4 Assessment of study quality and risk of bias. In: Higgins JPT, Green S, editors. Cochrane Handbook for Systematic Reviews of Interventions. Version 5.1.0 ed. The Cochrane Collaboration.

10. Gabrysch S, Edwards T, Glynn JR, Study Group on Heterogeneity of HIV Epidemics in African Cities. The role of context: neighbourhood characteristics strongly influence HIV risk in young women in Ndola, Zambia. Trop Med Int Health. 2008;13(2):162-70.

11. Msisha WM, Kapiga SH, Earls FJ, Subramanian SV. Place matters: multilevel investigation of HIV distribution in Tanzania. AIDS. 2008;22(6):741-8.

12. Ishida K, Arnold M, Stupp P, Kizito P, Ichwara J. Exploring the connections between HIV serostatus and individual, household, and community socioeconomic resources: evidence from two population-based surveys in Kenya. Soc Sci Med. 2012;74(2):185-95.

13. Durevall D, Lindskog A. Economic Inequality and HIV in Malawi. World Dev. 2012;40(7):1435-51.

14. Brodish PH. An association between neighbourhood wealth inequality and HIV prevalence in sub-Saharan Africa. J Biosoc Sci. 2015;47(3):311-28.

15. Brodish PH. An association between ethnic diversity and HIV prevalence in sub-Saharan Africa. J Biosoc Sci. 2013;45(6):853-62.

16. Fox AM. Marital concurrency and HIV risk in 16 African countries. AIDS Behav. 2014;18(4):791-800.

17. Kayeyi N, Sandøy IF, Fylkesnes K. Effects of neighbourhood-level educational attainment on HIV prevalence among young women in Zambia. BMC Public Health. 2009;9:310.

18. Van Stam M, Michielsen K, Stroeken K, Zijlstra B. The impact of education and globalization on sexual and reproductive health: retrospective evidence from eastern and southern Africa. AIDS Care. 2014;26(3):379-86.

19. Magadi M, Desta M. A multilevel analysis of the determinants and cross-national variations of HIV seropositivity in sub-Saharan Africa: evidence from the DHS. Health Place. 2011;17(5):1067-83.

20. Robertson L, Gregson S, Garnett GP. Sexual risk among orphaned adolescents: is country-level HIV prevalence an important factor? AIDS Care. 2010;22(8):927-38.

21. Magadi MA. Understanding the gender disparity in HIV infection across countries in sub-Saharan Africa: evidence from the Demographic and Health Surveys. Sociol Health Illn. 2011;33(4):522-39.

22. Magadi MA. Migration as a Risk Factor for HIV Infection among Youths in Sub-Saharan Africa: Evidence from the DHS. Ann Am Acad Polit Soc Sci. 2013;648(1):136-58.

23. Maslovskaya O, Brown JJ, Padmadas SS. Disentangling the complex association between female genital cutting and HIV among Kenyan women. J Biosoc Sci. 2009;41(6):815-30.

24. Shi CF, Kouyoumdjian FG, Dushoff J. Intimate partner violence is associated with HIV infection in women in Kenya: a cross-sectional analysis. BMC Public Health. 2013;13:512.

25. Cuadros DF, Branscum AJ, García-Ramos G. No evidence of association between HIV-1 and malaria in populations with low HIV-1 prevalence. PloS One. 2011;6(8):e23458.

26. Kidman R, Anglewicz P. Are adolescent orphans more likely to be HIV-positive? A pooled data analyses across 19 countries in sub-Saharan Africa. J Epidemiol Community Health. 2016;70(8):191-7.

27. Magadi MA. The disproportionate high risk of HIV infection among the urban poor in sub-Saharan Africa. AIDS Behav. 2013;17(5):1645-54.

28. Smolak A. The association of female circumcision with HIV status and sexual behavior in Mali: a multilevel analysis. J Acquir Immune Defic Syndr. 2014;65(5):597-602.

29. Benefo KD. The Determinants of the Duration of Postpartum Sexual Abstinence in West Africa: A Multilevel Analysis. Demography. 1995;32(2):139-57.

30. Benefo KD. The community-level effects of women's education on reproductive behavior in rural Ghana. Dem Res. 2006;14:485-507.

31. Chiao C. Community context and the prevalence of premarital sex among young women in Kenya and the Philippines: trends and differences from 1993 to 2003. Health Place. 2010;16(3):512-22.

32. Antai D. Traumatic physical health consequences of intimate partner violence against women: what is the role of community-level factors? BMC Womens Health. 2011;11:56.

33. Uthman OA, Moradi T, Lawoko S. The independent contribution of individual-, neighbourhood-, and country-level socioeconomic position on attitudes towards intimate partner violence against women in sub-Saharan Africa: A multilevel model of direct and moderating effects. Soc Sci Med. 2009;68(10):1801-9.

34. Ukwuani FA, Tsui AO, Suchindran CM. Condom use for preventing HIV infection/AIDS in sub-Saharan Africa: a comparative multilevel analysis of Uganda and Tanzania. J Acquir Immune Defic Syndr. 2003;34(2):203-13.

35. Maticka-Tyndale E, Tenkorang EY. A multi-level model of condom use among male and female upper primary school students in Nyanza, Kenya. Soc Sci Med. 2010;71(3):616-25.

36. Benefo KD. Determinants of condom use in Zambia: a multilevel analysis. Stud Fam Plann. 2010;41(1):19-30.

37. Kaufman CE. Contraceptive use in South Africa under apartheid. Demography. 1998;35(4):421-34.

38. Ngome E, Odimegwu C. The social context of adolescent women's use of modern contraceptives in Zimbabwe: a multilevel analysis. Reprod Health. 2014;11:64.

39. Burgard SA, Lee-Rife SM. Community characteristics, sexual initiation, and condom use among young Black South Africans. J Health Soc Behav. 2009;50(3):293-309.

40. Kayeyi N, Fylkesnes K, Wiium N, Sandøy IF. Decline in sexual risk behaviours among young people in Zambia (2000-2009): do neighbourhood contextual effects play a role? PloS One. 2013;8(5):e64881.

41. Uthman OA, Lawoko S, Moradi T. The role of individual, community and societal gender inequality in forming women's attitudes toward intimate-partner violence against women: a multilevel analysis. World Health Popul. 2010;12(2):5-17.

42. Stephenson R, Baschieri A, Clements S, Hennink M, Madise N. Contextual influences on modern contraceptive use in sub-Saharan Africa. Am J Public Health. 2007;97(7):1233-40.

43. Stephenson R. Community-level gender equity and extramarital sexual risk-taking among married men in eight African countries Int Perspect Sex Reprod Health. 2010;36(4):178-88.

44. Paek H, Lee B, Salmon CT, Witte K. The contextual effects of gender norms, communication, and social capital on famiy planning behaviors in Uganda: a multilevel approach. Health Educ Behav. 2008;35(4):461-77.

45. Linos N, Slopen N, Subramanian SV, Berkman L, Kawachi I. Influence of Community Social Norms on Spousal Violence: A Population-Based Multilevel Study of Nigerian Women. Am J Public Health. 2013;103(1):148-55.

46. Linos N, Slopen N, Berkman L, Subramanian SV, Kawachi I. Predictors of help-seeking behaviour among women exposed to violence in Nigeria: a multilevel analysis to evaluate the impact of contextual and individual factors. J Epidemiol Community Health. 2014;68(3):211-7.

47. Gage AJ. Child marriage prevention in Amhara Region, Ethiopia: association of communication exposure and social influence with parents/guardians' knowledge and attitudes. Soc Sci Med. 2013;97:124-33.

48. Antai D, Adaji S. Community-level influences on women's experience of intimate partner violence and terminated pregnancy in Nigeria: a multilevel analysis. BMC Pregnancy Childbirth. 2012;12:128.

49. Kaggwa EB, Diop N, Storey JD. The role of individual and community normative factors: a multilevel analysis of contraceptive use among women in union in Mali. Int Fam Plan Perspect. 2008;34(2):79-88.

50. Uthman OA. Geographical variations and contextual effects on age of initiation of sexual intercourse among women in Nigeria: a multilevel and spatial analysis. Int J Health Geogr. 2008;7:27.

51. Stephenson R. Community influences on young people's sexual behavior in 3 African countries. Am J Public Health. 2009;99(1):102-9.

52. Elfstrom KM, Stephenson R. The role of place in shaping contraceptive use among women in Africa. PLoS One. 2012;7(7).

53. Uchudi J, Magadi M, Mostazir M. A multilevel analysis of the determinants of high-risk sexual behaviour in sub-Saharan Africa. J Biosoc Sci. 2012;44(3):289-311.

54. Gari S, Malungo JR, Martin-Hilber A, Musheke M, Schindler C, Merten S. HIV testing and tolerance to gender based violence: a cross-sectional study in Zambia. PloS One. 2013;8(8):e71922.

55. Alio AP, Salihu HM, Nana PN, Clayton HB, Mbah AK, Marty PJ. Association between intimate partner violence and induced abortion in Cameroon. Int J Gynaecol Obstet. 2011;112(2):83-7.

56. Andersson N, Paredes-Solís S, Milne D, Omer K, Marokoane N, Laetsang D, et al. Prevalence and risk factors for forced or coerced sex among school-going youth: national cross-sectional studies in 10 southern African countries in 2003 and 2007. BMJ Open. 2012;2(2):e000754.

57. Goodman ML, Selwyn BJ, Morgan RO, Lloyd LE, Mwongera M, Gitari S, et al. Sexual Behavior among Young Carers in the Context of a Kenyan Empowerment Program Combining Cash-Transfer, Psychosocial Support, and Entrepreneurship. J Sex Res. 2016;53(3):331-45.

58. Kamndaya M, Kazembe LN, Vearey J, Kabiru CW, Thomas L. Material deprivation and unemployment affect coercive sex among young people in the urban slums of Blantyre, Malawi: A multi-level approach. Health Place. 2015;33:90-100.

59. Robinson AL, Seiber EE. Does community clustering mitigate the negative effect of poverty on adolescent condom use in South Africa? Int Fam Plan Perspect. 2008;34(3):121-6.

60. Countries List [Internet].: The Demographic and Health Surveys Program [cited February 2, 2017]. Available from: https://dhsprogram.com/Where-We-Work/Country-List.cfm.

61. Gelman A. Multilevel (Hierarchical) Modeling: What It Can and Cannot Do. Technometrics. 2006 08/01;48(3):432-5.

62. Kaplan GA. What's wrong with social epidemiology, and how can we make it better? Epidemiol Rev. 2004;26:124-35.

63. Merlo J, Chaix B, Yang M, Lynch J, Rastam L. A brief conceptual tutorial of multilevel analysis in social epidemiology: linking the statistical concept of clustering to the idea of contextual phenomenon. J Epidemiol Community Health. 2005;59(6):443-9.

64. Dellar RC, Dlamini S, Karim QA. Adolescent girls and young women: key populations for HIV epidemic control. J Int AIDS Soc. 2015;18(2 Suppl 1):19408.

65. Smith AD, Tapsoba P, Peshu N, Sanders EJ, Jaffe HW. Men who have sex with men and HIV/AIDS in sub-Saharan Africa. Lancet. 2009 Aug 1;374(9687):416-22.

66. Mathers BM, Degenhardt L, Phillips B, Wiessing L, Hickman M, Strathdee SA, et al. Global epidemiology of injecting drug use and HIV among people who inject drugs: a systematic review. Lancet. 2008 Nov 15;372(9651):1733-45.

67. Aliyu MH, Blevins M, Audet CM, Kalish M, Gebi UI, Onwujekwe O, et al. Integrated prevention of mother-to-child HIV transmission services, antiretroviral therapy

initiation, and maternal and infant retention in care in rural north-central Nigeria: a cluster-randomised controlled trial. Lancet HIV. 2016;3(5):e202-11.

68. Carlson M, Brennan RT, Earls F. Enhancing adolescent self-efficacy and collective efficacy through public engagement around HIV/AIDS competence: a multilevel, cluster randomized-controlled trial. Soc Sci Med. 2012;75(6):1078-87.

69. Ezeanolue EE, Obiefune MC, Ezeanolue CO, Ehiri JE, Osuji A, Ogidi AG, et al. Effect of a congregation-based intervention on uptake of HIV testing and linkage to care in pregnant women in Nigeria (Baby Shower): a cluster randomised trial. Lancet Glob Health. 2015;3(11):e692-700.

70. Jennings L, Yebadokpo A, Affo J, Agbogbe M. Use of job aids to improve facility-based postnatal counseling and care in rural Benin. Matern Child Health J. 2015;19(3):557-65.

71. Kaljee L, Zhang L, Langhaug L, Munjile K, Tembo S, Menon A, et al. A randomized-control trial for the teachers' diploma programme on psychosocial care, support and protection in Zambian government primary schools. Psychol Health Med. 2016:1-12.

72. Ahonkhai AA, Noubary F, Munro A, Stark R, Wilke M, Freedberg KA, et al. Not all are lost: interrupted laboratory monitoring, early death, and loss to follow-up (LTFU) in a large South African treatment program. PloS One. 2012;7(3):e32993.

73. Charalambous S, Grant AD, Churchyard GJ, Mukora R, Schneider H, Fielding KL. Clinic-level factors influencing patient outcomes on antiretroviral therapy in primary health clinics in South Africa. AIDS. 2016;30(7):1099-109.

74. Lahuerta M, Lima J, Nuwagaba-Biribonwoha H, Okamura M, Alvim MF, Fernandes R, et al. Factors associated with late antiretroviral therapy initiation among adults in Mozambique. PloS One. 2012;7(5):e37125.

75. Lessells RJ, Mutevedzi PC, Cooke GS, Newell M. Retention in HIV Care for Individuals Not Yet Eligible for Antiretroviral Therapy: Rural KwaZulu-Natal, South Africa. J Acquir Immune Defic Syndr. 2011;56(3):E79-86.

76. Yao J, Agadjanian V, Murray AT. Spatial and social inequities in HIV testing utilization in the context of rapid scale-up of HIV/AIDS services in rural Mozambique. Health Place. 2014;28:133-41.

77. Allen S, Karita E, Chomba E, Roth DL, Telfair J, Zulu I, et al. Promotion of couples' voluntary counselling and testing for HIV through influential networks in two African capital cities. BMC Public Health. 2007;7:349.

78. Audureau E, Kahn JG, Besson MH, Saba J, Ladner J. Scaling up prevention of mother-to-child HIV transmission programs in sub-Saharan African countries: a multilevel assessment of site-, program- and country-level determinants of performance. BMC Public Health. 2013;13:286.

79. Avila D, Althoff KN, Mugglin C, Wools-Kaloustian K, Koller M, Dabis F, et al. Immunodeficiency at the Start of Combination Antiretroviral Therapy in Low-, Middle-, and High-Income Countries. J Acquir Immune Defic Syndr. 2014;65(1):E8-E16.

80. Babalola S, Fatusi A, Anyanti J. Media saturation, communication exposure and HIV stigma in Nigeria. Soc Sci Med. 2009;68(8):1513-20.

81. Beaudoin CE. HIV prevention in sub-Saharan Africa: a multilevel analysis of message frames and their social determinants. Health Promot Internation. 2007;22(3):198-206.

82. Benefo KD. Determinants of Zambian men's extra-marital sex: a multi-level analysis. Arch Sex Behav. 2008;37(4):517-29.

83. Birungi H, Obare F, van der KA, Namwebya JH. Maternal health care utilization among HIV-positive female adolescents in Kenya. Int Perspect Sex Reprod Health. 2011;37(3):143-9.

84. Bonnenfant YT, Hindin MJ, Gillespie D. Couple VCT clients in Ethiopia: a heterogeneous HIV risk group. AIDS Care. 2012;24(7):856-65.

85. Boyer S, Clerc I, Bonono CR, Marcellin F, Bilé PC, Ventelou B. Non-adherence to antiretroviral treatment and unplanned treatment interruption among people living with HIV/AIDS in Cameroon: Individual and healthcare supply-related factors. Soc Sci Med. 2011;72(8):1383-92.

86. Boyer S, Abu-Zaineh M, Blanche J, LoubiÃ¨re S, Bonono RC, Moatti JP, et al. Does HIV services decentralization protect against the risk of catastrophic health expenditures?: some lessons from Cameroon. Health Serv Res. 2011;46(6):2029-56.

87. Chiao C, Mishra V, Sambisa W. Individual- and community-level determinants of social acceptance of people living with HIV in Kenya: results from a national population-based survey. Health Place. 2009;15(3):712-20.

88. Crea TM, Reynolds AD, Sinha A, Eaton JW, Robertson LA, Mushati P, et al. Effects of cash transfers on Children's health and social protection in Sub-Saharan Africa: differences in outcomes based on orphan status and household assets. BMC Public Health. 2015;15:511.

89. Denison JA, Koole O, Tsui S, Menten J, Torpey K, van Praag E, et al. Incomplete adherence among treatment-experienced adults on antiretroviral therapy in Tanzania, Uganda and Zambia. AIDS. 2015;29(3):361-71.

90. Denoeud-Ndam L, Clément MC, Briand V, Akakpo J, Agossou VK, Atadokpédé F, et al. Tolerability of mefloquine intermittent preventive treatment for malaria in HIV-infected pregnant women in Benin. J Acquir Immune Defic Syndr. 2012;61(1):64-72.

91. Gathara D, English M, van HM, Todd J, Allen E. Exploring sources of variability in adherence to guidelines across hospitals in low-income settings: a multi-level analysis of a cross-sectional survey of 22 hospitals. Implement Sci. 2015;10:60.

92. Geary RS, Webb EL, Clarke L, Norris SA. Evaluating youth-friendly health services: young people's perspectives from a simulated client study in urban South Africa. Glob Health Action. 2015;8:26080.

93. Hung KJ, Scott J, Ricciotti HA, Johnson TR, Tsai AC. Community-Level and Individual-Level Influences of Intimate Partner Violence on Birth Spacing in Sub-Saharan Africa. Obstet Gynecol. 2012;119(5):975-82.

94. Hutchinson PL, Mahlalela X, Yukich J. Mass media, stigma, and disclosure of HIV test results: multilevel analysis in the Eastern Cape, South Africa. AIDS Educ Prev. 2007;19(6):489-510.

95. Johnson FA, Madise NJ. Targeting women at risk of unintended pregnancy in Ghana: Should geography matter? Sex Reprod Healthc. 2011;2(1):29-35.

96. Kankeu HT, Boyer S, Fodjo TR, Abu-Zaineh M. How do supply-side factors influence informal payments for healthcare? The case of HIV patients in Cameroon. Int J Health Plann Manage. 2016;31(1):E41-57.

97. Karimli L, Ssewamala FM, Ismayilova L. Extended families and perceived caregiver support to AIDS orphans in Rakai district of Uganda. Child Youth Serv Rev. 2012;34(7):1351-8.

98. Kidman R, Hanley JA, Subramanian SV, Foster G, Heymann J. AIDS in the family and community: the impact on child health in Malawi. Soc Sci Med. 2010;71(5):966-74.

99. Kidman R, Hanley JA, Foster G, Subramanian SV, Heymann SJ. Educational Disparities in AIDS-affected Communities: Does Orphanhood Confer Unique Vulnerability? J Dev Stud. 2012;48(4):531-48.

100. Kidman R, Palermo T. The relationship between parental presence and child sexual violence: Evidence from thirteen countries in sub-Saharan Africa. Child Abuse Negl. 2016;51:172-80.

101. Lamidi EO. State variations in women's socioeconomic status and use of modern contraceptives in Nigeria. PloS One. 2015;10(8):e0135172.

102. Larose A, Moore S, Harper S, Lynch J. Global income-related inequalities in HIV testing. J Public Health (Oxf). 2011;33(3):345-52.

103. Lerebo W, Callens S, Jackson D, Zarowsky C, Temmerman M. Identifying factors associated with the uptake of prevention of mother to child HIV transmission programme in Tigray region, Ethiopia: a multilevel modeling approach. BMC Health Serv Res. 2014;14:181.

104. Loevinsohn M. The 2001-03 Famine and the Dynamics of HIV in Malawi: A Natural Experiment. PloS One. 2015;10(9):e0135108.

105. Lumbiganon P, Laopaiboon M, Intarut N, Vogel JP, Souza JP, Gülmezoglu AM, et al. Indirect causes of severe adverse maternal outcomes: a secondary analysis of the WHO Multicountry Survey on Maternal and Newborn Health. BJOG. 2014;121(Suppl 1):32-9.

106. Luseno WK, Singh K, Handa S, Suchindran C. A multilevel analysis of the effect of Malawi's Social Cash Transfer Pilot Scheme on school-age children's health. Health Policy Plan. 2014;29(4):421-32.

107. Magadi MA. Household and community HIV/AIDS status and child malnutrition in sub-Saharan Africa: evidence from the demographic and health surveys. Soc Sci Med. 2011;73(3):436-46.

108. Magadi MA. Cross-national analysis of the risk factors of child malnutrition among children made vulnerable by HIV/AIDS in sub-Saharan Africa: evidence from the DHS. Trop Med Int Health. 2011;16(5):570-8.

109. Magadi MA, Agwanda AO. Investigating the association between HIV/AIDS and recent fertility patterns in Kenya. Soc Sci Med. 2010;71(2):335-44.

110. Magadi MA, Uchudi J. Onset of sexual activity among adolescents in HIV/AIDS-affected households in sub-Saharan Africa. J Biosoc Sci. 2015;47(2):238-57.

111. Medema-Wijnveen J, Onono M, Bukusi EA, Miller S, Cohen CR, Turan JM. How Perceptions of HIV-Related Stigma Affect Decision-Making Regarding Childbirth in Rural Kenya. PLoS One. 2012;7(12).

112. Miller CM, Gruskin S, Subramanian SV, Heymann J. Emerging health disparities in Botswana: examining the situation of orphans during the AIDS epidemic. Soc Sci Med. 2007;64(12):2476-86.

113. Mohan D, Gupta S, LeFevre A, Bazant E, Killewo J, Baqui AH. Determinants of postnatal care use at health facilities in rural Tanzania: multilevel analysis of a household survey. BMC Pregnancy Childbirth. 2015;15:282.

114. Mulawa M, Yamanis TJ, Hill LM, Balvanz P, Kajula LJ, Maman S. Evidence of social network influence on multiple HIV risk behaviors and normative beliefs among young Tanzanian men. Soc Sci Med. 2016;153:35-43.

115. Nash D, Wu Y, Elul B, Hoos D, El Sadr W, Int Ctr AIDS Care,& Treatment Prog. Program-level and contextual-level determinants of low-median CD4(+) cell count in cohorts of persons initiating ART in eight sub-Saharan African countries. AIDS. 2011;25(12):1523-33.

116. Ota E, Ganchimeg T, Morisaki N, Vogel JP, Pileggi C, Ortiz-Panozo E, et al. Risk factors and adverse perinatal outcomes among term and preterm infants born small-for-gestational-age: Secondary analyses of the WHO multi-country survey on maternal and newborn health. PLoS ONE. 2014;9(8).

117. Sagna ML, Schopflocher D. HIV counseling and testing for the prevention of mother-to-child transmission of HIV in Swaziland: a multilevel analysis. Matern Child Health J. 2015;19(1):170-9.

118. Schwandt HM, Underwood C. Engaging school personnel in making schools safe for girls in Botswana, Malawi, and Mozambique. Int J Educ Dev. 2016;46:53-8.

119. Snelling D, Rasugu OD, Hong S, Georgiades K, Racine Y, Boyle MH. HIV/AIDS knowledge, women's education, epidemic severity and protective sexual behaviour in low- and middle-income countries. J Biosoc Sci. 2007;39(3):421-42.

120. Stephenson R, Beke A, Tshibangu D. Community and health facility influences on contraceptive method choice in the Eastern Cape, South Africa. Int Fam Plan Perspect. 2008;34(2):62-70.

121. Stephenson R, Miriam EK, Winter A. Community influences on married men's uptake of HIV testing in eight African countries. AIDS Behav. 2013;17(7):2352-66.

122. Stringer JS, Stinson K, Tih PM, Giganti MJ, Ekouevi DK, Creek TL, et al. Measuring coverage in MNCH: population HIV-free survival among children under two years of age in four African countries. PLoS Med. 2013;10(5):e1001424.

123. Suzan-Monti M, Blanche J, Bilé P, Koulla-Shiro S, Abu-Zaineh M, Marcellin F, et al. Individual and structural factors associated with HIV status disclosure to main partner in Cameroon: ANRS 12-116 EVAL survey, 2006-2007. J Acquir Immune Defic Syndr. 2011;57(Suppl 1):S22-6.

124. Tabana H, Doherty T, Swanevelder S, Lombard C, Jackson D, Zembe W, et al. Knowledge of HIV status prior to a community HIV counseling and testing intervention in a rural district of South Africa: results of a community based survey. BMC Infect Dis. 2012;12:73.

125. Taha TE, Dadabhai SS, Rahman MH, Sun J, Kumwenda J, Kumwenda NI. Trends in birth weight and gestational age for infants born to HIV-infected, antiretroviral treatment-naive women in Malawi. Pediatr Infect Dis J. 2012;31(5):481-6.

126. Tenkorang EY, Maticka-Tyndale E, Rajulton F. A multi-level analysis of risk perception, poverty and sexual risk-taking among young people in Cape Town, South Africa. Health Place. 2011;17(2):525-35.

127. Tenkorang EY, Maticka-Tyndale E. Individual- and school-level correlates of HIV testing among secondary school students in Kenya. Stud Fam Plann. 2013;44(2):169-87.

128. Tenkorang EY, Maticka-Tyndale E. Assessing young people's perceptions of HIV risks in Nyanza, Kenya: are school and community level factors relevant? Soc Sci Med. 2014;116:93-101.

129. Trinitapoli J. Religious teachings and influences on the ABCs of HIV prevention in Malawi. Soc Sci Med. 2009;69(2):199-209.

130. Underwood C, Schwandt HM. Community Support and Adolescent Girls' Vulnerability to HIV/AIDS: Evidence From Botswana, Malawi, and Mozambique. Int Q Community Health Educ. 2015;35(4):317-34.

131. Uthman OA, Kongnyuy EJ. A multilevel analysis of effect of neighbourhood and individual wealth status on sexual behaviour among women: evidence from Nigeria 2003 Demographic and Health Survey. BMC Int Health Hum Rights. 2008;8:9.

132. Uthman OA, Kayode GA, Adekanmbi VT. Individual and contextual socioeconomic determinants of knowledge of the ABC approach of preventing the sexual transmission of HIV in Nigeria: a multilevel analysis. Sex Health. 2013;10(6):522-9.

133. Whetten K, Ostermann J, Whetten RA, Pence BW, O'Donnell K, Messer LC, et al. A Comparison of the Wellbeing of Orphans and Abandoned Children Ages 6-12 in Institutional and Community-Based Care Settings in 5 Less Wealthy Nations. Plos One. 2009;4(12):e8169.

134. Yahaya I, Uthman OA, Soares J, Macassa G. Social disorganization and history of child sexual abuse against girls in sub-Saharan Africa: A multilevel analysis. BMC Int Health Hum Rights. 2013;13(1):33.

Tables and Figures

Table 1-1. Search strategy for identifying studies using multilevel models to evaluate the influence of contextual factors on HIV/AIDS, STIs, and risky sexual behavior in sub-Saharan Africa by keyword[a]

Includes at least one of:
contextual* OR communit* OR neighborhood* OR neighbourhood* OR network* OR "social support" OR "social capital" OR "social determinants" OR "structural determinants" OR "proximal determinants" OR "intermediate determinants" OR "distal determinants" OR "social inequality" OR "social inequalities" OR "social inequity" OR "social inequities" OR "social class" OR "social classes" OR socioeconomic OR SES OR SEP OR disparit* OR catchment* OR "health service area" OR "health service areas" OR "health services area" OR "health services areas" OR "administrative boundary" OR "administrative boundaries" OR "administrative area" OR "administrative areas" OR "administrative unit" OR "administrative units" OR income OR "income inequality" OR "income inequalities" OR poverty OR education OR "social gradient" OR "social gradients" OR "social status" OR deprivation
And one of (A), (B), or (C):
(A) HIV OR AIDS OR "human immunodeficiency virus" OR "acquired immune deficiency syndrome"
(B) STI OR STIs OR STD OR STDs OR "sexually transmitted infection" OR "sexually transmitted infections" OR "sexually transmitted disease" OR "sexually transmitted diseases" OR "bacterial vaginosis" OR chlamydia OR gonorrhea OR hepatitis OR herpes OR HSV OR "human papillomavirus" OR HPV OR "pelvic inflammatory disease" OR PID OR syphilis OR trichomoniasis OR chancroid OR "lymphogranuloma venereum" OR LGV OR "mycoplasma genitalium" OR "pubic lice" OR crabs OR scabies
(C) (sex OR sexual* OR intercourse) AND ((unsafe OR safe OR unprotect* OR protect* OR risk* OR condom*) OR (behavior* OR behaviour*))
And includes at least one of:
multilevel OR multi-level OR MLM OR MLMs OR hierarch* OR HLM OR HLMs OR ICC OR ICCs OR "intraclass correlation coefficient" OR "intra-class correlation coefficient" OR "intraclass correlation coefficients" OR "intra-class correlation coefficients" OR "intracluster correlation coefficient" OR "intra-cluster correlation coefficient" OR "intracluster correlation coefficients" OR "intra-cluster correlation coefficients" OR "median odds ratio" OR "median odds ratios" OR MOR OR MORs OR "mixed model" OR "mixed models" OR "mixed effect" OR "mixed effects" OR cluster* OR nested
And includes at least one of:
Africa* OR Angola OR Benin OR Botswana OR "Burkina Faso" OR Burundi OR "Cabo Verde" OR Cameroon OR “Cape Verde” OR "Central African Republic" OR Chad OR Comoros OR Congo OR “Côte d'Ivoire” OR “Cote d’Ivoire” OR “Equatorial Guinea” OR Eritrea OR Ethiopia OR Gabon OR Gambia OR Ghana OR Guinea OR Guinea-Bissau OR “Ivory Coast” OR Kenya OR Lesotho OR Liberia OR Madagascar OR Malawi OR Mali OR Mauritania OR Mauritius OR Mozambique OR Namibia OR Niger OR Nigeria OR Rwanda OR "São Tomé and Principe" OR “Sao Tome and Principe” OR Senegal OR Seychelles OR "Sierra Leone" OR Somalia OR “South Africa” OR “South Sudan” OR Sudan OR Swaziland OR Tanzania OR Togo OR Uganda OR Zambia OR Zimbabwe

[a]Database-specific subject headings (such as Emtree and MeSH terms for Embase and PubMed, respectively) were also included for each keyword when available.

Table 1-2. Studies utilizing multilevel models to evaluate the impact of a contextual-level intervention on individual-level HIV/AIDS-related outcomes in sub-Saharan Africa

Author (Year)	Topic	Study Design	Description of Intervention	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Unit of Random Effect	Summary of Individual-Level Findings
Aliyu et al. (2016) (67)	HIV/AIDS-PMTCT	Clustered RCT	"The intervention sites received an integrated package of PMTCT services in maternal and child health settings that included point-of-care CD4 cell count or percentage testing, transition of decentralised PMTCT tasks to trained midwives (task shifting), integrated mother and infant care services, active influential family	"12 sites located in the rural Niger state of north-central Nigeria"	April 1, 2013-March 31, 2014	"HIV-infected women (age was not included in the eligibility criteria, but the youngest participant was 16 years old) and their infants, presenting for antenatal care or delivery who met one of the following inclusion criteria: unknown HIV status at time of presentation; history of antiretroviral prophylaxis or treatment, but not receiving prophylaxis or treatment at the time of presentation; or known HIV status but had never	369	Health Facility	"After adjustment for maternal age, education, travel time to facility, employment, maternal ethnicity, and time of HIV diagnosis, mothers in the intervention group were more likely to initiate ART than mothers in the control group (adjusted relative risk [RR] 3·3, 95% CI 1·4–7·8; table 3). After adjustment for maternal age, education, travel time, employment, ethnicity, and time of HIV diagnosis, mother and infant pairs in the intervention group were roughly ten times more likely to be retained in care at 6 weeks (adjusted RR 9·1, 95% CI

Author (Year)	Topic	Study Design	Description of Intervention	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Unit of Random Effect	Summary of Individual-Level Findings
			member (male partner) participation, and community involvement."			received treatment."			5·2–15·9) and 12 weeks (10·3, 5·4–19·7) postpartum than were pairs in the control group."
Carlson et al. (2012) (68)	HIV/AIDS-Health Promotion	Clustered RCT	The Youth Citizens program, an individual- and neighborhood-level health promotion training	Moshi Urban District, Kilimanjaro Region, northern Tanzania	2004-2006	Children between the ages of 9-14	724	Community	"...post-treatment scores on deliberative self-efficacy, communicative self-efficacy and emotional control were significantly higher in the treatment group than in the control group."
Ezeanolue et al. (2015) (69)	HIV/AIDS-Testing	Clustered RCT	"Healthy Beginning Initiative (HBI), a culturally adapted, family-centred approach that relies on the widely distributed religious infrastructure	Enugu state, southeast Nigeria	Jan 20, 2013- Aug 31, 2014	Pregnant women 18 years or older who attended any of the study sites	3,002	Congregation	"The odds of pregnant women not being HIV tested were 11 times higher in the control group than in the intervention group after controlling for age, educational level, employment, area of residence, age at first pregnancy, number of previous

Author (Year)	Topic	Study Design	Description of Intervention	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Unit of Random Effect	Summary of Individual-Level Findings
			and church-based community networks to promote individual testing, tracking, and retention of participants... provides free, integrated on-site laboratory tests during a church organised baby shower..."						pregnancies, and a history of previous HIV testing... Women in the intervention group were more likely to be linked to care before delivery than were those in the control group and were more likely to access care and receive ART during pregnancy."
Jennings et al. (2015) (70)	HIV/AIDS-Health Facilities	Pre–post randomized group design	Pictorial job aids	"14 public health facilities in the Zou/Collines region of Benin"	August-October 2008	Women who had recently given birth	411	Health facility, Provider	"Women in the intervention arm received significantly higher reinforcement messages regarding immediate neonatal care as compared to the control arm for skin-to-skin contact, newborn wrapping for warmth, exclusive breastfeeding,

Author (Year)	Topic	Study Design	Description of Intervention	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Unit of Random Effect	Summary of Individual-Level Findings
									continued delayed bathing, and umbilical cord care... Improvements in knowledge were observed in all topic areas, except postnatal care-seeking, which significantly increased in the intervention arm from 4 to 22 %, but remained low and was not statistically significant after adjusting for changes in the control arm."
Kaljee et al. (2016) (71)	HIV/AIDS-Social Support	RCT	Teachers' Diploma Programme	Primary schools in Lusaka and Eastern Province, Zambia	2013-2014	3rd and 4th grade teachers and students	325 teachers ; 1,378 students	School	For teachers, "gender equity for boys and girls were significant." For students, "perceived social support within schools was marginally significantly greater at post intervention for intervention students."

Table 1-3. Studies utilizing multilevel models to evaluate the associations between contextual-level factors and HIV/AIDS or risky sexual behavior-related outcomes in sub-Saharan Africa, sorted by study design

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
Ahonk-hai et al. (2012) (72)	HIV/AIDS	Continuity of Care	Retrospective cohort study	71 treatment sites in 8 South African provinces	January 2004-December 2008	"Adults 15 years or older enrolled in the treatment programs... were eligible for ART at clinic enrollment (baseline CD4 count ,200/uL or WHO stage III or IV disease), subsequently initiated ART, and had at least 400 days of potential follow-up time on ART before the end of the study."	11,397 patients	Health Facility	Interrupted Laboratory Monitoring, Early Death, Loss to Follow Up
Chara-lambous et al. (2016) (73)	HIV/AIDS	ART Outcomes	Retrospective cohort study	"Clinics owned by private practitioners or nongovernmental	2006-2010	"Adults (>18 years old) who started on ART from 1 January 2006 to 31 December 2009"	10,055	Health Facility	Unsuppressed viral load at 24 months, time to loss to follow-up, composite poor outcome at 24 months

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
				organizations which were part of the Aurum Institute's HIV treatment programme funded through the President's Emergency Plan for AIDS Relief (PEPFAR)" in South Africa					
Lahuerta et al. (2012) (74)	HIV/AIDS	ART Initiation	Retrospective cohort study	Health facilities in Maputo, Gaza, Inhambane, Nampula and Zambezia provinces, Mozambique	January 1, 2005-June 30, 2009	ART patients 15 years old or older	36,411	Health Facility	Late ART initiation
Lessells et al. (2011) (75)	HIV/AIDS	Retention in Care	Retrospective cohort study	Hlabisa health sub-district, northern KwaZulu-Natal, South Africa	2007-2009	Patients with "a first recorded CD4 cell count from a sample between Jan 1st 2007 – Dec 31st 2007; ART	4,223	Health Facility	Pre-ART retention

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
						naive; ≥16 years old at the time of zCD4 test; and CD4 count result was >200 cells/μl"			
Yao et al. (2014) (76)	HIV/AIDS	Testing	Prospective cohort	Gaza province, Mozambique	2006, 2009, 2011	Women responding to the survey	1,025	Community	HIV testing
Alio et al. (2011) (55)	Risky Sexual Behavior	IPV	Cross-sectional	Cameroon-nationally representative survey	2004	"Women of childbearing age, 15-49 years old."	2,570 women	Sampling Units	Induced Abortion
Allen et al. (2007) (77)	HIV/AIDS	VCT	Cross-sectional	Couples' Voluntary Counseling and Testing Centers & surrounding communities in Kigali, Rwanda & Lusaka, Zambia	January-July 2003	"The average ages of invited men and women in each country were similar (Rwanda: Men = 35.6 years, Women = 29.6 years; Zambia: Men = 34.5 years, Women = 28.1 years). Couples had been married or cohabiting for a mean of 8.0 years (Rwanda = 7.8 years, Zambia = 8.0	"9,900 couples (2,680 in Rwanda, 7,220 in Zambia) … Of 9,900 couples who received invitations, 1,411 (14.3%) requested CVCT."	Influence Network Agents	Couple VCT

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
						years), and had an average of 2.5 children (Rwanda = 2.5, Zambia = 2.4)."			
Anders-son et al. (2012) (56)	Risky Sexual Behavior	IPV	Cross-sectional	Secondary schools, rural & urban, in Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe	2002-2003, 2007	Students ages 11-16 years old	48,586	Country	Experience of forced or coerced sex, perpetration of forced sex
Antai (2011) (32)	Risky Sexual Behavior	IPV	Cross-sectional	Nigeria-nationally representative sample	2008	Women aged 15-49 years	23,752	Community	Traumatic physical consequences- i) bruises; ii) injuries, sprains, dislocations or burns; iii) wounds, broken bones, broken teeth or other serious; and iv) severe burns
Antai et al. (2012) (48)	Risky Sexual Behavior	IPV	Cross-sectional	Nigeria-nationally representative sample	2008	Women aged 15-49 years	19,226	Community	Terminated pregnancy

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
Audu-reau (2013) (78)	HIV/AIDS	PMTCT	Cross-sectional	269 Viramune Donation Program sites were included, participating in 20 PMTCT programs in 15 sub-Saharan countries (Benin, DR Congo, Côte d'Ivoire, Gabon, Ghana, Kenya, Lesotho, Malawi, Nigeria, Rwanda, South Africa, Tanzania, Togo, Uganda and Zambia)	January 2002-December 2005	Participants in PMTCT programs	283,410	Program, Country	Nevirapine coverage indicator (by site)
Avila et al. The IeDEA and ART cohort collabora	HIV/AIDS	ART Initiation	Cross-sectional	Data from "the International epidemiologi cal Databases to Evaluate	2000-2009	Patients aged ≥16 years at cART initiation	379,865, including "86,390 patients from nine LIC	Country	Median CD4 count at start of ART

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
tions (2014) (79)				AIDS (IeDEA), a global consortium structured through regional centres to pool clinical and epidemiological data on HIV-positive individuals, particularly patients on cART. The seven regions included in IeDEA are North America, Caribbean/Central and South America, Asia/Pacific, East Africa, West Africa, Central Africa and Southern			(23%), 176,858 from four LMIC (47%), 82,152 from four UMIC (22%) and 34,465 from six HIC (9%)."		

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
				Africa." 23 countries					
Babalola et al. (2009) (80)	HIV/AIDS	Health Promotion /Communication	Cross-sectional	Nigeria-nationally representative sample	2005	Women aged 15-49 years, men aged 15-64 years	10,081	Community	Accepting attitudes of PLHIV
Beaudoin (2007) (81)	HIV/AIDS	Health Promotion /Communication	Cross-sectional	Botswana, Cameroon, Cote d'Ivoire, Ethiopia, Ghana, Kenya, Malawi, Nigeria, Rwanda, Sierra Leone, South Africa, Tanzania, Uganda, Zambia and Zimbabwe	1990s-Present	Media content from unique HIV/AIDS posters	236	Country	HIV prevention message content
Benefo (1995) (29)	Risky Sexual Behavior	Abstinence	Cross-sectional	Cameroon, Cote d'Ivoire, Ghana (nationally representative surveys)	1978, 1979	Currently married women ages 15-49 with at least one birth in the five years preceding the survey	15,432	Community	Duration of postpartum sexual abstinence
Benefo (2006) (30)	Risky Sexual Behavior	Contraception	Cross-sectional	Ghana-nationally representative sample	1988	Women ages 15-49 years old	1,812	Community	Interest in fertility regulation, contraceptive use

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
Benefo (2008) (82)	Risky Sexual Behavior	Concurrent sexual partners	Cross-sectional	Zambia-nationally representative sample	2003	Married men aged 15–59 years	1,118	Community	Men's extramarital sex
Benefo (2010) (36)	Risky Sexual Behavior	Condom use	Cross-sectional	Zambia-nationally representative sample	2003	Sexually active females ages 15-49 years and males ages 15-59 year	3,215	Community	Condom use
Birungi et al. (2011) (83)	HIV/AIDS	PMTCT	Cross-sectional	Regions with the highest HIV prevalence in Kenya—Nyanza, Nairobi, Rift Valley and Coast provinces.	2009	HIV positive male and female adolescents aged 15–19	393	Health Facility	Receiving prenatal care; making four or more prenatal care visits (0–3, ≥4); receiving PMTCT services; receiving skilled assistance (being assisted by a doctor, nurse or facility midwife during delivery or induced or spontaneous abortion); and receiving postnatal/ post abortion care services
Bonnenfant et al. (2012) (84)	HIV/AIDS	VCT	Cross-sectional	Ethiopia	2008	Voluntary counseling and testing clients at least 15 years of age or older	1,858	Health Facility	Coupling counseling, individual counseling

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
Boyer et al. (2011) (85)	HIV/AIDS	ART Adherence	Cross-sectional	Cameroon- 6 of 10 provinces	September 2006-March 2007	Random sample of HIV-infected outpatients	3,151	Health Facility	Non-adherence to ART and unplanned treatment interruptions
Boyer et al. (2011) (86)	HIV/AIDS	Health Expenditures	Cross-sectional	Cameroon- 6 of 10 provinces	September 2006-March 2007	Random sample of HIV-infected outpatients	3,151	Health System	Catastrophic health expenditures
Brodish (2013) (15)	HIV/AIDS	HIV Prevalence	Cross-sectional	Kenya, Malawi, and Zambia (nationally representative samples)	Years unspecified	Women ages 15–49 years, Men ages 15-59 years	23,290 (Kenya-4,881; Malawi-10,346; Zambia-8,063)	Community	HIV serostatus
Brodish (2015) (14)	HIV/AIDS	HIV Prevalence	Cross-sectional	Kenya, Lesotho, Malawi, Swaziland, Zambia, Zimbabwe	Years unspecified	Women ages 15–49 years, Men ages 15-59 years	43,091	Community, Country	HIV serostatus, extramarital partners in the past year
Burgard et al. (2009) (39)	Risky Sexual Behavior	Sexual Initiation, Condom Use	Cross-sectional	Durban metropolitan area of KwaZulu-Natal, South Africa; South Africa-nationally representative sample	1999-2001, 1996	Black respondents age 14 to 24	2,736; 1,697	Community	Age of sexual initiation, condom use

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
Chiao (2009) (87)	HIV/AIDS	Stigma	Cross-sectional	Kenya-nationally representative sample	2003	Women aged 15-49 years, men aged 15-54 years	10,486	Community	"Willingness to care for an infected household member, willingness to buy vegetables from an infected vendor, and willingness to allow an infected female teacher to continue teaching."
Chiao (2010) (31)	Risky Sexual Behavior	Abstin-ence	Cross-sectional	Kenya-nationally representative sample	1993, 1998, 2003	Women aged 15–24 years	10,317	Household, Community	Premarital sex behavior
Crea et al. (2015) (88)	HIV/AIDS	OVCs	Cross-sectional	Manicaland, Zimbabwe	2009-2010	School-aged children	5,331	Household	Health vulnerability (chronic illness and disability) and social protection (birth registration status and school attendance)
Cuadros et al. (2011) (25)	HIV/AIDS	Malaria	Cross-sectional	Burkina Faso, Cameroon, Ghana, Guinea, Liberia, Mali-nationally representative samples	2003, 2004, 2005, 2006, 2007	Adult men aged 15–59 years and women aged 15–49 years	41,064	Community	HIV serostatus
Denison et al.	HIV/AIDS	ART Adher-ence	Cross-sectional	Health facilities in Tanzania,	2006	ART patients 18 years or older	4,489	Health facility	ART adherence

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
(2015) (89)				Uganda, and Zambia					
Denoeud-Ndam et al. (2012) (90)	HIV/AIDS	Malaria	Cross-sectional	Maternity clinics, Benin	2005-2008; 2009-2011	Pregnant women between 16 and 28 weeks of gestation, who had no history of a neuropsychiatric disorder or severe kidney or liver disease, and had no history of severe adverse reactions with mefloquine or sulfa drugs	524	Health facility	Tolerance of mefloquine
Durevall (2012) (13)	HIV/AIDS	Economic Inequality	Cross-sectional	Malawi-nationally representative sample	2004	Women aged 15-24	1,161	District, Neighbor-hood	HIV serostatus
Elfstrom et al. (2012) (52)	Risky Sexual Behavior	Contra-ception	Cross-sectional	Benin, Congo, Democratic Republic of Congo, Egypt, Ethiopia, Ghana, Guinea, Kenya,	2005, 2006, 2007, 2008, 2009	Currently married or co-habitating women ages 15-49 years	Ranges by country, from 4,916 to 33,385	Community	Modern contraceptive use

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
				Liberia, Madagascar, Mali, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Swaziland, Uganda, Zambia, Zimbabwe- nationally representative samples					
Fox (2014) (16)	HIV/AIDS	Con- current sexual partners	Cross- sectional	Burkina Faso, Cameroon, Ethiopia, Ghana, Guinea, Ivory Coast, Kenya, Lesotho, Malawi, Mali, Niger, Rwanda, Senegal, Swaziland, Tanzania, Zimbabwe- nationally representative samples	Unspec- ified	Survey participants married for at least 1 year	83,366	Region, Country	HIV serostatus

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
Gabrysch et al. (2008) (10)	HIV/AIDS	Adol-escents	Cross-sectional	Ndola, Zambia	1997-1998	Women ages 15-24 years old	447	Community	HIV serostatus
Gage (2013) (47)	Risky Sexual Behavior	Child Marriage	Cross-sectional	Amhara region, Ethiopia	2007	One co-resident parent/guardian of adolescents (female aged 10-19 and male aged 15-24) per household	4,445	Community	Knowledge of legal minimum age of marriage, knowledge of legal consequences, belief that marriage before age 18 occurs too early, belief in daughter's right to choose marriage age, belief in daughter's right to choose marriage partner
Gari et al. (2013) (54)	HIV/AIDS, Risky Sexual Behavior	HIV Testing, IPV	Cross-sectional	South and central provinces of Zambia	September 2010-February 2011	Members of selected households, 18 years or older	1,716	Community	Non-uptake of HIV testing
Gathara et al. (2015) (91)	HIV/AIDS	Health Facilities	Cross-sectional	Hospitals in Kenya	2012	Pediatric patients	1,298	Health Facility, Clinician	HIV testing for all admitted patients
Geary et al. (2015) (92)	HIV/AIDS	Youth Friendly Services	Cross-sectional	Clinics offering Youth Friendly Services in Soweto, South Africa	November 2011-March 2012	Soweto youth	58	Health Facility, Client	Clinic score, would recommend clinic

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
Goodman et al. (2016) (57)	Risky Sexual Behavior	Socioeconomic Resources	Cross-sectional	Meru County, Kenya	March 2014	Vulnerable households of OVC siblings identified by community leaders	1,060	Region, Working group	"sexual initiation, unprotected last sex among those sexually active in the previous six months (versus no sex in same time period), and multiple sex partners in the previous year"
Hung et al. (2012) (93)	Risky Sexual Behavior	IPV	Cross-sectional	Cameroon, Democratic Republic of the Congo, Ghana, Kenya, Liberia, Malawi, Nigeria, Rwanda, Uganda, Zambia, and Zimbabwe-nationally representative samples	2004, 2005, 2006, 2007, 2008	Multiparous women ages 15-49 years old	46,697	Community	Personal history of IPV
Hutchinson et al. (2007) (94)	HIV/AIDS	Stigma, Testing, Disclosure	Cross-sectional	Eastern Cape, South Africa	2002-2003	Men and women 15 years or older	1,065	Community	Heard HIV/AIDS information from media in last 4 weeks, Discussed HIV/AIDS with anyone in last 2

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
									weeks, HIV/AIDS stigma, HIV/AIDS knowledge, hypothetical disclosure of HIV test results, condom use at last sex
Ishida et al. (2012) (12)	HIV/AIDS	Socio-economic Resources	Cross-sectional	Kenya- nationally representative sample	2003, 2007	Women aged 15-49 years and men aged 15-54 years	5,706 (2003); 11,850 (2007)	Community	HIV serostatus
Johnson et al. (2011) (95)	Risky Sexual Behavior	Contra-ception	Cross-sectional	Ghana- nationally representative sample	1998, 2003	Fecund, non-pregnant, and sexually active women who were married or living with a partner	6,575	Community	Risk of unintended pregnancies- they were not using any method of contraception (either modern or traditional methods) but stated that they either did not want a child within two years or did not want any more children
Kaggwa et al. (2008) (49)	Risky Sexual Behavior	Contra-ception	Cross-sectional	Mali- nationally representative sample	2001	Women ages 15-49 years old in a union (married or co-habitating) residing in clusters with at least 25 women	7,671	Community	Use of a modern contraceptive method

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
Kamndaya et al. (2015) (58)	Risky Sexual Behavior	Coercive Sex	Cross-sectional	Blantyre, Malawi	June-July 2013	18-23 year olds	1,071	Community	Coercive sex
Kankeu et al. (2016) (96)	HIV/AIDS	Heath System	Cross-sectional	Hospitals in Cameroon	2006-2007	HIV patients who consulted with a doctor	1,637	Health Facility	Informal payments
Karimli et al. (2012) (97)	HIV/AIDS	Care-giving	Cross-sectional	Primary schools, Rakai district, Uganda	2005-2008	Orphaned children and adolescents ages 11-17 years old	283	School	Child's/adolescent's perception of caregiver support
Kaufman (1998) (37)	Risky Sexual Behavior	Contraception	Cross-sectional	South Africa-nationally representative sample	1987-1988	Black women aged 15-49 years	16,363; 11,153	Community, District	Current use of modem contraceptives
Kayeyi et al. (2009) (17)	HIV/AIDS	Education	Cross-sectional	Urban and rural neighborhoods in Lusaka, Zambia	2003	Young women aged between 15–24 years with known HIV status	1,295	Community	HIV serostatus
Kayeyi et al. (2013) (40)	Risky Sexual Behavior	Adolescents	Cross-sectional	Zambia-nationally representative sample	2000, 2009	Men and women aged 15–24 years	2000-1,376; 2009-1,594	Community	Premarital sex, multiple partnership, condom use at last premarital sex
Kidman et al. (2010) (98)	HIV/AIDS	OVCs	Cross-sectional	Malawi-nationally representative sample	2004-2005	Children & adolescents 6-17 years old	15,035	Community, Household	Health status of children

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
Kidman et al. (2012) (99)	HIV/AIDS	OVCs	Cross-sectional	Malawi-nationally representative sample	2004-2005	"children between 6 and 14 years (the official primary school ages) with information on whether their parents are alive"	13,090	Community, Household	Currently out of school and highest grade level attained
Kidman et al. (2016) (26)	HIV/AIDS	OVCs	Cross-sectional	Burkina Faso, Cameroon, Congo, Cote d'Ivoire, Democratic Republic of the Congo, Ethiopia, Gabon, Lesotho, Liberia, Malawi, Mozambique, Rwanda, Senegal, Sierra Leone, Swaziland, Tanzania, Uganda, Zambia, Zimbabwe-nationally	2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011	Adolescents aged 15-17 years old	38,010	Community, Strata, Survey	HIV serostatus

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
				representative samples					
Kidman et al. (2016) (100)	HIV/AIDS	OVCs	Cross-sectional	Cameroon, Cote d'Ivoire, Gabon, Ghana, Liberia, Malawi, Mozambique, Nigeria, Rwanda, Tanzania, Uganda, Zambia, Zimbabwe-nationally representative samples	2005, 2006, 2007, 2008, 2010, 2011	Female adolescents aged 15-17 years old	10,464	Community, Strata, Survey	Sexual violence
Lamidi (2015) (101)	HIV/AIDS	Contraception	Cross-sectional	Nigeria-nationally representative sample	2013	"sexually active, married and cohabiting women who were at risk of conceiving"	18,910	State	Modern contraceptive use
Larose et al. (2011) (102)	HIV/AIDS	HIV Testing	Cross-sectional	49 countries (18 countries in sub-Saharan Africa: Burkina Faso, Chad, Comoros, Congo, Cote	2002-2003	"all men and women of reproductive age (18–49 years old)"	106,705	Country	Voluntary counseling and testing

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
				d'Ivoire, Ethiopia, Ghana, Kenya, Malawi, Mali, Mauritania, Mauritius, Namibia, Senegal, South Africa, Swaziland, Zambia, Zimbabwe)- nationally representative samples					
Lerebo et al. (2014) (103)	HIV/AIDS	PMTCT	Cross-sectional	Tigray region, Ethiopia	2011	Post-partum women	210	Community	PMTCT- mother and child
Linos et al. (2013) (45)	Risky Sexual Behavior	IPV	Cross-sectional	Nigeria- nationally representative sample	2008	Ever-married women, 15-49 years old	18,798	State, Community	Spousal violence
Linos et al. (2014) (46)	Risky Sexual Behavior	IPV	Cross-sectional	Nigeria- nationally representative sample	2008	Women that reported physical or sexual violence victimization, 15-49 years old	5,553	State, Community	Help-seeking behaviour

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
Loevinsohn (2015) (104)	HIV/AIDS	Socioeconomic Resources	Cross-sectional	Malawi	2003	Women included in antenatal sentinel surveillance	6,078	Community	HIV prevalence
Lumbiganon et al. (2014) (105)	HIV/AIDS	PMTCT	Cross-sectional	29 countries (6 countries in sub-Saharan Africa: Angola, Democratic Republic of the Congo, Kenya, Niger, Nigeria, Uganda)	2010-2012	Women giving birth	314,574	Country, Health Facility	Maternal outcomes: "maternal near miss (MNM), maternal death (MD), and severe maternal outcome (SMO)"; Perinatal outcomes: "preterm birth, fetal mortality, early neonatal mortality, perinatal mortality, neonatal intensive care unit (NICU) admission, and an Apgar score <7 at 5 minutes"
Luseno et al. (2014) (106)	HIV/AIDS	OVCs	Cross-sectional	Mchinji District, Central Malawi	2007	Children ages 6-17 years old	1,197	Household	Illness in the past month, illness that stopped normal activities in the past month, missing school due to illness or injury in the past month and health care use

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
									for worst illness in the past year
Magadi (2011) (21)	HIV/AIDS	Gender	Cross-sectional	Burkina Faso, Cameroon, Cote d'Ivoire, Democratic Republic of the Congo, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Liberia, Malawi, Mali, Niger, Rwanda, Senegal, Sierra Leone, Swaziland, Tanzania, Zambia, Zimbabwe-nationally representative samples	2003, 2004, 2005, 2006, 2007, 2008	Survey respondents, details unspecified	174,592	Country, Community	HIV serostatus
Magadi (2011) (107)	HIV/AIDS	Malnutrition	Cross-sectional	Burkina Faso, Cameroon, Democratic Republic of the Congo, Ethiopia, Ghana,	2003, 2004, 2005, 2006, 2007, 2008	Survey respondents giving information on children in household less than 5 years old	55,749	Country, Community	Child nutritional status

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
				Guinea, Kenya, Lesotho, Liberia, Malawi, Mali, Niger, Rwanda, Senegal, Sierra Leone, Swaziland, Zambia, Zimbabwe- nationally representative samples					
Magadi (2011) (108)	HIV/AIDS	Malnutrition	Cross-sectional	Burkina Faso, Cameroon, Democratic Republic of the Congo, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Liberia, Malawi, Mali, Niger, Rwanda, Senegal, Sierra Leone, Swaziland, Zambia,	2003, 2004, 2005, 2006, 2007, 2008	Survey respondents giving information on "children aged under five whose mothers are infected with HIV in households selected for HIV testing"	3,157	Country, Community	Child nutritional status

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
				Zimbabwe-nationally representative samples					
Magadi (2013) (22)	HIV/AIDS	Adol-escents	Cross-sectional	Burkina Faso, Cameroon, Cote d'Ivoire, Democratic Republic of the Congo, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Liberia, Malawi, Mali, Niger, Rwanda, Senegal, Sierra Leone, Swaziland, Zambia, Zimbabwe-nationally representative samples	2000, 2003, 2004, 2005, 2006, 2007, 2008	Youths aged 15 to 24	66,789	Country, Community	HIV serostatus
Magadi (2013) (27)	HIV/AIDS	Socio-economic Resources	Cross-sectional	Burkina Faso, Cameroon, Cote d'Ivoire, Democratic Republic of the Congo,	2003, 2004, 2005, 2006, 2007, 2008	Survey respondents, details unspecified	175,699	Country, Community	HIV serostatus

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
				Ethiopia, Ghana, Guinea, Kenya, Lesotho, Liberia, Malawi, Mali, Niger, Rwanda, Senegal, Sierra Leone, Swaziland, Tanzania, Zambia, Zimbabwe-nationally representative samples					
Magadi et al. (2010) (109)	HIV/AIDS	Fertility	Cross-sectional	Kenya-nationally representative sample	2003	Women aged 15-49 years old	8,195	Community	Fertility preferences, recent fertility
Magadi et al. (2011) (19)	HIV/AIDS	Health Promotion Commun-ication	Cross-sectional	Burkina Faso, Cameroon, Cote d'Ivoire, Democratic Republic of the Congo, Ethiopia, Ghana, Guinea, Kenya, Lesotho,	2003, 2004, 2005, 2006, 2007, 2008	Women aged 15–49 and males aged 15–54 or 59 years old	174,592	Country, Community	HIV serostatus

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
				Liberia, Malawi, Mali, Niger, Rwanda, Senegal, Sierra Leone, Swaziland, Tanzania, Zambia, Zimbabwe- nationally representative samples					
Magadi et al. (2015) (110)	Risky Sexual Behavior	Adol- escents	Cross- sectional	Burkina Faso, Cameroon, Cote d'Ivoire, Democratic Republic of the Congo, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Liberia, Malawi, Mali, Niger, Rwanda, Senegal, Sierra Leone, Swaziland, Zambia, Zimbabwe-	2003, 2004, 2005, 2006, 2007, 2008	Adolescents aged 15–17 years old	22,260	Country, Community	Initiation of sexual activity

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
				nationally representative samples					
Maslovskaya et al. (2009) (23)	HIV/AIDS	Female Genital Mutilation	Cross-sectional	Kenya-nationally representative sample, excluding the North Eastern province	2003	Women aged 15–49 years old with documented HIV and female genital cutting status	3,114	Community	HIV serostatus
Maticka-Tyndale et al. (2010) (35)	Risky Sexual Behavior	Condom use	Cross-sectional	160 public schools in Nyanza Province, Kenya	2002-2003	Standard 6 and 7 students	8,183	Community/ School	Condom use
Medema-Wijnveen et al. (2012) (111)	HIV/AIDS	Stigma	Cross-sectional	ANC clinics, Nyanza Province, Kenya	November 2007-April 2009	"Women at least 18 years old in their first seven months of pregnancy, who were visiting the antenatal care clinic (ANC) for the first time in their pregnancy and did not know their current HIV status"	1,777	Health facility	Intention to deliver with a skilled healthcare provider
Miller et al.	HIV/AIDS	OVCs	Cross-sectional	Botswana-nationally	2000	Under five year olds (data collected from	2,723	Community	Growth failure (underweight)

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
(2007) (112)				representative sample		women aged 12-49 years old)			
Mohan et al. (2015) (113)	HIV/AIDS	PMTCT	Cross-sectional	Rural areas of Morogoro District Council, Mvomero, Kilosa, Ulanga districts, Morogoro Region, Tanzania	August-November 2011	"Rural women who had a childbirth in the preceding 2–14 months"	1,931	Community	Use of postnatal care
Msisha et al. (2008) (11)	HIV/AIDS	Context-ual influences	Cross-sectional	Tanzania-nationally representative sample	2003-2004	"women and men aged 15–49 years"	8,010	Region, Community	HIV serostatus
Mulawa et al. (2016) (114)	Risky Sexual Behavior	Social Networks	Cross-sectional	Urban social networks, locally referred to as “camps,” in Dar es Salaam, Tanzania	October 8, 2013-March 23, 2014	Men 15 years of age or older, who were camp members for more than 3 months, visited the camp at least once a week, and planned on residing in Dar es Salaam for the next 30 months	1,249	Social Network	Normative beliefs, risk behaviors
Nash et al.	HIV/AIDS	CD4 Counts	Cross-sectional	HIV care clinics in	2003, 2004,	Patient cohorts, including	1,690	Region	Low median CD4+ cell count at

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
(2011) (115)				Ethiopia, Kenya, Lesotho, Mozambique, Nigeria, Rwanda, South Africa, Tanzania	2005, 2007-2008	patients 6 years old and older			antiretroviral therapy initiation
Ngome et al. (2014) (38)	Risky Sexual Behavior	Contra-ception	Cross-sectional	Zimbabwe-nationally representative sample	2010-2011	Non-pregnant, adolescent women ages 15-19 years old who had their last sex within 12 months prior to the survey	457	Community	Use of modern contraception
Ota et al. (2014) (116)	HIV/AIDS	PMTCT	Cross-sectional	29 countries (6 countries in sub-Saharan Africa: Angola, Democratic Republic of the Congo, Kenya, Niger, Nigeria, Uganda)	2010-2012	Pregnancies of at least 28 gestational weeks, singleton births with no congenital malformation	245,773	Country, Health Facility	Fresh stillbirths, early neonatal death, perinatal death, neonatal near miss
Paek et al. (2008) (44)	Risky Sexual Behavior	Contracep tion	Cross-sectional	Villages within 5 km of health centers, Uganda	2001	Adults older than 18 years old	350	Community	Family planning behavior

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
Robertson et al. (2010) (20)	Risky Sexual Behavior	OVCs	Cross-sectional	Democratic Republic of Congo, Cote d'Ivoire, Lesotho, Liberia, Malawi, Rwanda, Swaziland, Tanzania, Zambia, Zimbabwe-nationally representative samples	2004, 2005, 2006, 2007	Adolescents ages 15-17 years old	889	Country, Community	Ever had sex, HIV serostatus
Robinson et al. (2008) (59)	Risky Sexual Behavior	Condom use	Cross-sectional	KwaZulu-Natal, South Africa	1999	Sexually experienced youth ages 14-22 years old	1,178	Community	Condom use
Sagna et al. (2015) (117)	HIV/AIDS	PMTCT	Cross-sectional	Swaziland-nationally representative sample	2006-2007	"Women age 15–49 with a live birth in the past 5 years preceding the survey who received antenatal care for the most recent birth"	1,788	Community	HIV pre-test counseling during antenatal care, uptake of HIV testing during antenatal care
Schwandt et al. (2016) (118)	Risky Sexual Behavior	IPV	Cross-sectional	"...four communities in the Thyolo district of	September - December 2010	Adolescent girls ages 11–18 living in households in	1,249 (Botswana-352, Malawi-	Community	"...increase, no change, or decrease in teachers: encouraging girls

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
				Malawi, four communities in the Francistown district of Botswana, and eight communities in Mozambique – four in Zambezia Province and four in Nampula Province."		the intervention communities	372, Mozambique-525)		to participate in class, encouraging girls to excel in math, encouraging girls to stay in school, mostly calling on boys in class, using physical punishment, and in asking for sex in exchange for good grades or other ‘‘favors.’ Girls were also asked how safe they felt in school: very safe, somewhat safe, neutral, not very safe, and not at all safe."
Shi et al. (2013) (24)	HIV/AIDS	IPV	Cross-sectional	Kenya-nationally representative sample	2008-2009	Women ages 15-49, currently married or living with someone, who completed the IPV questions and obtained HIV testing	1,904	Location, Ethnicity	HIV serostatus
Smolak (2014) (28)	HIV/AIDS	Female Genital Mutilation	Cross-sectional	Mali-nationally	Not specified	Women of reproductive	13,015	Community, Household	HIV serostatus, number of partners,

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
				representative sample		age, 15-49 years old			sexual debut, premarital sex
Snelling et al. (2007) (119)	Risky Sexual Behavior	Women	Cross-sectional	23 countries (18 in sub-Saharan Africa: Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Gabon, Ghana, Côte d'Ivoire, Kenya, Madagascar, Mali, Mozambique, Niger, Nigeria, Tanzania, Togo, Zambia, Zimbabwe-nationally representative samples)	1994-2000	Women aged 15–49 years	163,903	Country	Ever using a condom, ever having sex with only one partner
Stephenson (2009) (51)	Risky Sexual Behavior	Adol-escents	Cross-sectional	Burkina Faso, Ghana, Zambia-nationally	2001-2002, 2003	Women and men ages 15-24 years old who reported ever having sex	Burkina Faso-3,105; Ghana-3,160;	Community, Household	Engaging in risky sexual behavior-sexual intercourse without condom

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
				representative samples			Zambia-2,687		use with 1 or more partners
Stephenson (2010) (43)	Risky Sexual Behavior	Concurrent sexual partners	Cross-sectional	Chad, Ghana, Malawi, Nigeria, Tanzania, Uganda, Zambia, Zimbabwe-nationally representative sample	2001-2002, 2003, 2004, 2005, 2006	Married or cohabiting, sexually active men ages 15-59 years old	13,162 (Chad-1,062, Ghana-1,821, Malawi-2,114, Nigeria-1,196, Tanzania-1,379, Uganda-1,443, Zambia-780, and Zimbabwe-3,367)	Community	Engaging in high-risk marital and extramarital sexual activity
Stephenson et al. (2007) (42)	Risky Sexual Behavior	Contra-ception	Cross-sectional	Burkina Faso, Côte d'Ivoire, Ghana, Kenya, Malawi, Tanzania-nationally representative sample	1998, 1999, 2000	Women of reproductive age (15-49 years old) who were not currently pregnant and were sexually active	30,532 (Burkina Faso-4,960, Côte d'Ivoire-2,437, Ghana-3,784, Kenya-6,013, Malawi-10,291,	District, Community	Use of a modern contraceptive method

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
							Tanzania -3,047)		
Stephenson et al. (2008) (120)	Risky Sexual Behavior	Contra-ception	Cross-sectional	Eastern Cape, South Africa	1998	Non-pregnant, sexually active women ages 15-49 years old utilizing contraception	1,165	Community	Choice of contraceptive method type
Stephenson et al. (2013) (121)	HIV/AIDS	Testing	Cross-sectional	Chad, Ghana, Malawi, Nigeria, Tanzania, Uganda, Zambia, Zimbabwe-nationally representative sample	2001-2002, 2003, 2004, 2005, 2006	Married, sexually active men ages 15-59 years old	13,162 (Chad-1,062, Ghana-1,821, Malawi-2,114, Nigeria-1,196, Tanzania -1,379, Uganda-1,443, Zambia-780, and Zimbabwe-3,367)	Community	HIV testing
Stringer et al. (2013) (122)	HIV/AIDS	PMTCT	Cross-sectional	Health facilities in Cameroon, Côte d'Ivoire, South Africa, Zambia	April 2007-May 2009	Household mother of a child born within the prior 2 years		Country, Community	HIV-free survival among HIV-exposed infants
Suzan-Monti et	HIV/AIDS	Status Disclosure	Cross-sectional	Cameroon-nationally	2006-2007	Patients attending HIV	1,673	Health Facility	HIV status disclosure

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
al. (2011) (123)				representative survey		facilities who had a main partner at the time of the survey			
Tabana et al. (2012) (124)	HIV/AIDS	Knowl-edge of Status	Cross-sectional	Communities in Sisonke district, KwaZulu-Natal, South Africa	September - November 2008	Household members 18 years old or older	5,821	Unspecified	HIV testing
Taha et al. (2012) (125)	HIV/AIDS	PMTCT	Cross-sectional	Participants in 6 mother-to-child transmission studies in Blantyre, Malawi	1989-1994, 2000-2007	Infants born to mothers participating in the studies	8,874	Study Cohort	Low birth weight, preterm birth
Tenk-orang et al. (2011) (126)	Risky Sexual Behavior	Socio-economic Resources	Cross-sectional	Cape Town, South Africa	April 2005-February 2006	Young adults responding to the survey	1,319	Community	Sexual risk taking
Tenk-orang et al. (2013) (127)	HIV/AIDS	Testing	Cross-sectional	Secondary schools in the Central, Coast, Eastern, Nairobi, and Rift Valley provinces, Kenya	December 2005-January 2006	Form 1-3 students, ages 13-20 years old	14,173	School	HIV testing

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
Tenk-orang et al. (2014) (128)	Risky Sexual Behavior	Risk Perception	Cross-sectional	160 public schools in Nyanza Province, Kenya	2002-2003	Standard 6 and 7 students	8,183	Community/ School	HIV/AIDS risk perception
Trinitap-oli (2009) (129)	Risky Sexual Behavior	Abstin-ence	Cross-sectional	Households in Rumphi, Mchinji, and Balaka Districts, Malawi	Summer 2004; May-August 2005	Ever married women ages 15–49 years old and their husbands, and young adults ages 15–29 years old	3,386	Congre-gation	Abstinence, being faithful, using condoms
Uchudi et al. (2012) (53)	Risky Sexual Behavior	Context-ual influences	Cross-sectional	Burkina Faso, Cameroon, Cote d'Ivoire, Democratic Republic of the Congo, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Liberia, Malawi, Mali, Niger, Rwanda, Senegal, Sierra Leone, Swaziland, Tanzania, Zambia,	2003, 2004, 2005, 2006, 2007, 2008	Sexually active women ages 15-49 years old and men ages 15-59 years old	144,983	Country, Community	Multiple sexual partners

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
				Zimbabwe-nationally representative samples					
Ukwuani et al. (2003) (34)	Risky Sexual Behavior	Condom use	Cross-sectional	Uganda, Tanzania-nationally representative samples	1995, 1996	Women ages 15-49 years old and men ages 15-59 years old who were sexually active in the past year and ever used condoms	5,842 (Uganda-3,816, Tanzania -2,026)	Community	Condom use
Underwood et al. (2015) (130)	HIV/AIDS	Women	Cross-sectional	"...four communities in the Thyolo district in Malawi, four communities in the Francistown district of Botswana, and eight in Mozambique (four in Zambezia and four in Nampula province)."	September - December 2010	Adolescent girls ages 11–18 years old	1,418	Community	Situation for girls has improved, confident to ask partner to use a condom, refuse unwanted sex with a boyfriend…
Uthman (2008) (50)	Risky Sexual Behavior	Sexual Debut	Cross-sectional	Nigeria-nationally	2003	Women ages 15-49 years old, ever or	5,531	State, Community	Early sexual debut

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
				representative sample		currently married, with at least one episode of sexual intercourse			
Uthman et al. (2008) (131)	Risky Sexual Behavior	Socio-economic Resources	Cross-sectional	Nigeria-nationally representative sample	2003	Women ages 15-49 years old, never, ever or currently married, with at least one episode of sexual intercourse	6,362	Community	High risk sexual behaviour (2 or more partners in the last year)
Uthman et al. (2009) (33)	Risky Sexual Behavior	IPV	Cross-sectional	Benin, Burkina Faso, Ethiopia, Ghana, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mozambique, Namibia, Nigeria, Rwanda, Swaziland, Tanzania, Uganda, Zimbabwe-nationally	2003, 2004, 2005, 2006, 2007	Women aged 15–49 years old and men aged 15–59 years old	234,484	Country, Community	Attitudes towards intimate partner violence against women (IPVAW)

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
				representative samples					
Uthman et al. (2010) (41)	Risky Sexual Behavior	IPV	Cross-sectional	Benin, Burkina Faso, Ethiopia, Ghana, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mozambique, Namibia, Nigeria, Rwanda, Swaziland, Tanzania, Uganda, Zimbabwe-nationally representative samples	2003, 2004, 2005, 2006, 2007	Ever-married women, 15-49 years old	120,467	Country, Community	Attitudes towards intimate partner violence against women (IPVAW)
Uthman et al. (2013) (132)	HIV/AIDS	Health Promotion /Communication	Cross-sectional	Nigeria-nationally representative sample	2008	Women ages 15-49 years old and men ages 15-59 years old	48,871	District, Community	HIV prevention knowledge
Van Stam et al. (2014) (18)	Risky Sexual Behavior	Education	Cross-sectional	Kenya, Malawi, Tanzania, Zambia-nationally representative samples	2007-2011	Women and men ages 15-49 years old with information on HIV serostatus and indicators	45,802	Community, Household	HIV serostatus, condom use at last intercourse, current contraceptive use, lifetime number of sexual partners, age at first intercourse,

Author (Year)	Broad Topic	Narrow Topic	Study Design	Study Setting	Study Time Period	Participant Characteristics	Sample Size	Random Effect	Individual-Level Outcome(s)
						included in the study			child mortality, age at first birth, fertility
Whetten et al. (2009) (133)	HIV/AIDS	OVCs	Cross-sectional	Communities and institutions in 6 countries, 3 in sub-Saharan Africa (Ethiopia, Kenya, Tanzania)	May 2006-February 2008	Children ages 6-12 years old	2,837	Study Site, Care setting	Subjective health, objective health growth, behavior and emotional health, cognitive development
Yahaya et al. (2013) (134)	Risky Sexual Behavior	IPV	Cross-sectional	Ghana, Liberia, Nigeria, Uganda, Zambia, Zimbabwe-nationally representative sample	2006-2008	Women and men younger than 18 years old	6,351	Community	Child sexual abuse

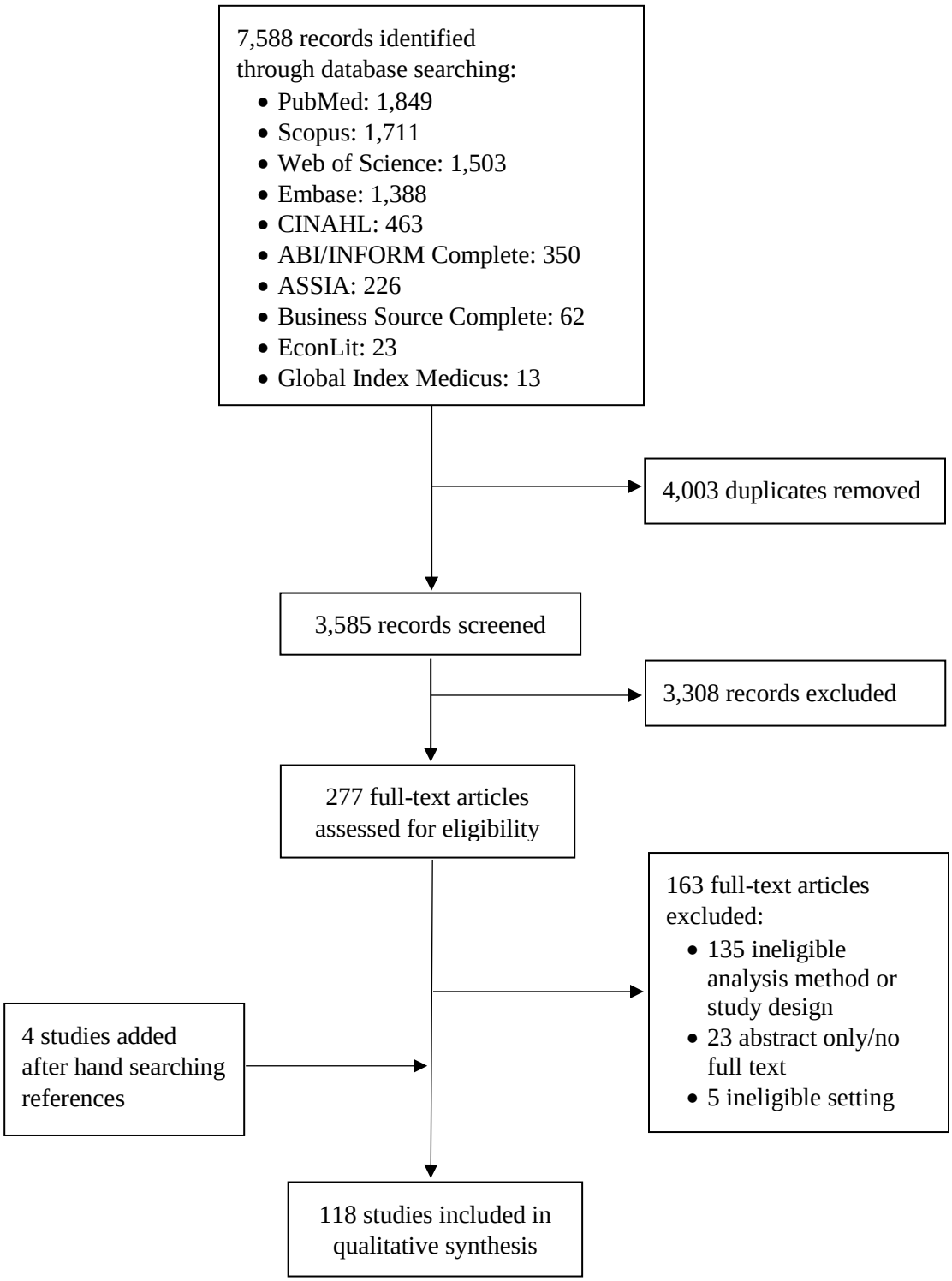
Table 1-4. Ratings for randomized controlled trials or cohort studies using the Quality Assessment Tool for Quantitative Studies

Author (Year)	Selection Bias Rating	Study Design Rating	Confounders Rating	Blinding Rating	Data Collection Rating	Withdrawals/ Dropouts Rating	Global Rating
Ahonkhai et al. (2012)(72)	Weak	Moderate	Strong	Moderate	Weak	Moderate	Weak
Aliyu et al. (2016)(67)	Weak	Strong	Strong	Weak	Weak	Strong	Weak
Carlson et al. (2012)(68)	Strong	Strong	Strong	Moderate	Weak	Strong	Moderate
Charalambous et al. (2016)(73)	Moderate	Moderate	Strong	Moderate	Weak	Moderate	Moderate
Ezeanolue et al. (2015)(69)	Weak	Strong	Strong	Moderate	Weak	Strong	Weak
Kaljee et al. (2016)(71)	Moderate	Strong	Strong	Moderate	Weak	Moderate	Moderate
Lahuerta et al. (2012)(74)	Moderate	Moderate	Strong	Moderate	Weak	Moderate	Moderate
Lessells et al. (2011)(75)	Moderate	Moderate	Weak	Moderate	Weak	Moderate	Weak
Yao et al. (2014)(76)	Moderate	Moderate	Weak	Moderate	Weak	Moderate	Weak

Table 1-5. Ratings for cross-sectional studies using an adapted Quality Assessment Tool for Quantitative Studies

Author (Year)	Selection Bias Rating	Confounders Rating	Data Collection Rating
Allen et al. (2007)(77)	Weak	Strong	Weak
Andersson et al. (2012)(56)	Moderate	Strong	Weak
Babalola et al. (2009)(80)	Moderate	Strong	Weak
Birungi et al. (2011)(83)	Weak	Strong	Weak
Boyer et al. (2011)(86)	Strong	Strong	Weak
Boyer et al. (2011)(85)	Strong	Strong	Weak
Denison et al. (2015)(89)	Moderate	Strong	Weak
Gari et al. (2013)(54)	Strong	Strong	Weak
Geary et al. (2015)(92)	Weak	Strong	Weak
Kamndaya et al. (2015)(58)	Moderate	Strong	Weak
Kayeyi et al. (2009)(17)	Moderate	Strong	Weak
Lerebo et al. (2014)(103)	Weak	Strong	Weak
Maticka-Tyndale et al. (2010)(35)	Moderate	Strong	Moderate
Medema-Wijnveen et al. (2012)(111)	Moderate	Strong	Moderate
Mohan et al. (2015)(113)	Moderate	Strong	Weak
Mulawa et al. (2016)(114)	Moderate	Weak	Weak
Schwandt et al. (2016)(118)	Moderate	Strong	Weak
Tabana et al. (2012)(124)	Moderate	Strong	Weak
Tenkorang et al. (2013)(127)	Moderate	Strong	Moderate
Whetten et al. (2009)(133)	Moderate	Weak	Moderate

Figure 1-1. Flowchart of search for studies using multilevel models to evaluate the influence of contextual factors on HIV/AIDS, STIs, and risky sexual behavior in sub-Saharan Africa



MANUSCRIPT 2

Assessing the influence of women's empowerment and economic resources on risky sexual behavior among young women in Zomba district, Malawi: A multilevel exploration

Abstract

This study's objective was to explore associations between individual and community economic resources and women's empowerment with risky sexual behavior (RSB) among young women in Zomba, Malawi. Four measures of RSB were examined: ever had sex, condom use, and two indices measuring age during sexual activity and partner history. Multilevel regression models and regression models with cluster-robust standard errors were used to estimate associations, stratified by school enrollment status. Among the schoolgirl strata, the percent of girls enrolled in school at the community level was associated with ever having sex and consistent condom use. Belief in the right to refuse sex was protective against ever having sex. Among the dropout strata, individual education was associated with riskier scores related to age and partner history. These results suggest that while RSB is complex, women's empowerment and education at individual and community levels play a role.

Keywords: Risky sexual behavior; contextual factors; economic resources; women's empowerment; education

Introduction

Malawi has made progress in its control of the human immunodeficiency virus (HIV) epidemic. In 2010, Malawi's HIV prevalence was 11% (1); 2015–2016 estimates

place national HIV prevalence at 8.8% (2). However, disparities by region and gender remain. HIV prevalence in the Southern Region is twice as high as that in the Northern and Central Regions (12.8%, 5.1%, and 5.6%, respectively) (2). Gender disparities among youth are particularly concerning; HIV prevalence is 4.9% among women ages 15–24 years old, compared to 1% among men of the same age (2). Gender disparities are even more pronounced in the southern Zomba district, where among women ages 15–49, HIV prevalence is 16.8%, compared to 9.3% among men of the same age (2). While these most recent estimates represent a considerable improvement from a decade ago (in 2004, HIV prevalence in Zomba district was 24.4% and 10.5% for women and men, respectively (3)), it is critical that research and intervention efforts continue to focus on women and eliminating HIV gender disparities.

The structural factors associated with risky sexual behavior leading to HIV infection are complex. One known driver of risky sexual behavior among young women is transactional sex. Due to economic hardships, adolescent women may decide to date and have sex with older men in exchange for gifts or economic support (4-6). Women living in communities or households with more resources may not face the same economic pressures to engage in risky sexual behavior (6). Sociocultural norms may also be drivers; women residing in communities where they are given more autonomy may be more empowered to negotiate condom use in sexual encounters, and may have more autonomy in choosing their partners (6-9).

The objective of this study was to explore associations between factors related to economic resources and women's empowerment, at both individual and community levels, with risky sexual behavior among young women in Zomba district, Malawi.

Materials and Methods

Conceptual Framework

The conceptual framework in Figure 1, adapted from work by Barnett and Whiteside as well as Sweat and Denison (10, 11), guided study design and analyses. In this framework, factors that may be part of the causal pathway for risky sexual behavior are represented in relation to HIV status at four different levels (superstructural, structural/macroenvironmental, microenvironmental, and individual). These factors occur at varying distances from risky sexual behavior, ranging from distal to proximal. Factors from all but the superstructural level were included in these analyses.

Study Design

Secondary analysis was carried out on cross-sectional data from the Schooling, Income, and Health Risk (SIHR) study conducted by Baird et al. among young women in Zomba district, Malawi; full study methodology is available elsewhere (12). Briefly, a randomized controlled trial of a cash transfer intervention was carried out in 176 randomly selected enumeration areas (EAs; approximately 4-5 villages) of Zomba district among two strata of unmarried young women: those enrolled in school at baseline (referred to throughout as schoolgirls), and those who were school dropouts at baseline (referred to throughout as dropouts) (12). The baseline survey (Round 1) was conducted in 2007. After program implementation began and allocation to intervention or control

group was completed, a follow-up survey (Round 2) was conducted approximately 12 months after Round 1 in 2008. During Round 2 and later during Round 3, data on community characteristics and women's autonomy in the community were collected from leaders of villages included in the SIHR study. The analyses presented here are limited to participants in the control group with data at Round 2, which consisted of 1,407 schoolgirls and 407 dropouts in 88 enumeration areas with 59 community surveys. (It should be noted that the terms "schoolgirls" and "dropouts" refer to the participants' status at baseline of the SIHR study, and may not be representative of participants' school enrolment status at Round 2. For example, participants who were dropouts at baseline may have returned to school by Round 2.)

Measures

Outcomes

Risky sexual behavior was examined using a total of four different outcomes. The first outcome was if the individual had ever had sex; the second outcome, for those who reported sexual activity, was if the individual consistently used condoms. Recognizing these outcomes might represent an over-simplified approach to risky sexual behavior, indices for participants reporting sexual activity were created using exploratory factor analysis. Variables loaded on two distinct factors, one related to partner history (which included number of lifetime partners, number of partners in the last year, frequency of sex with last partner, and an age difference with last partner of greater than five years; referred to here as partner history factor) and one related to age (girls' age at sexual debut and age when sexual relationship with last partner began; referred to here as age factor).

To create a standardized score for each index, a z-score (with a mean of 0 and a standard deviation of 1) for the values of each variable was generated. The score for each factor was generated by taking the mean of these z-scores (13, 14). A higher score on the Partner History Factor indicated more risky sexual behavior. Since, for the original age variables, lower ages indicated higher risk, the age factor score was reverse coded whereby a higher age factor score indicated higher risk. (See Supplement 1 for further details.)

Multilevel Factors Related to Economic Resources

Two variables related to economic resources at the community level were included: a community resources score and the number of development projects in the community in the past five years. The community resources score was derived from principal components analysis of four variables: children typically wear neat clothes; children under 10 years old typically wear shoes; type of housing (traditional, semi-permanent, or permanent); and distance from Zomba Town (the urban center). All variables loaded on to one factor; a z-score for each variable was then calculated, and the mean of those z-scores generated the community resources score. (See Supplement 2 for further details.) Data related to community resource scores were available from 55 community surveys.

Variables related to economic resources at the individual level included household consumption quintiles (monthly consumption, per person, in market unit prices, U.S. dollars); number of shocks experienced by the household in the past three years (such as low crop yields, loss of employment, large rise in the price of food, or death of a

household member); and the number of safety nets used by the household in the past three years (such as free food distribution, scholarships for education, or direct cash transfers).

Multilevel Factors Related to Women's Empowerment

Two variables related to women's empowerment at the community level were included: a score of women's autonomy in the community and the percent of girls in school. The score for women's autonomy in the community was derived from principal components analysis of four variables: how land is transferred within families; how individuals trace descent (through their mother, father, or both); if a wife can inherit land after her husband dies; and if either the man or woman must move out of the community after a divorce. All variables loaded on to one factor; a z-score for each variable was then calculated, and the mean of those z-scores generated the women's autonomy score. (See Supplement 2 for further details.) Data for the women's autonomy scores were available from 59 community surveys

Variables related to women's empowerment at the individual level included: her belief in her right to refuse unprotected sex and perceived household support for her health. Belief in the right to refuse unprotected sex was based on an aggregate count of the statements the participant agreed with—"Does a woman have the right to refuse unprotected sex with her husband when she thinks her husband may have HIV/AIDS" and "Does a woman have the right to refuse unprotected sex with her husband when she doesn't want to risk getting pregnant"—and ranged from zero to two. Perceived household support was based on the question, "Compared to 12 months ago, would you

say your household cares about your health: more than one year ago, same as one year ago, and less than one year ago." Since religion and tribe may also play a role in women's empowerment, these variables were controlled for as well, with religion categorized as Protestant, Catholic, or Muslim and tribe categorized as Yao, Chewa, Lomwe, and Other (which included Tumbuka, Ngoni, Sena, Tonga, Nyanja, and Mang'anja).

Additional Covariates

Additional covariates included the girl's age (measured continuously), her highest level of education (primary school vs. secondary or higher), and the household's highest level of education (primary school vs. secondary or higher); all participants and households achieved at least primary school. Age was excluded from analysis examining the age factor as an outcome.

Data Source

With two exceptions, the cross-sectional data set utilized for analysis was composed of information from Round 2 of the SIHR study. The first exception was related to characteristics of last sexual partner. If a participant reported ever having sex in Round 2 but had not had a partner in the last 12 months (and therefore information related to the most recent sexual partner was not present in Round 2), information on the last partner reported in the Round 1 survey was used. Finally, for 8 of 59 communities in the control group, data were not available from Round 2 of data collection; SIHR survey enumerators completed data collection from these communities during Round 3, and that data were utilized in this study.

Statistical Analysis

The sampling strategy for Baird et al. considered baseline schoolgirls and baseline dropouts as separate strata, so that procedure was followed here (12). Descriptive statistics included frequency distributions or means with standard deviations. Given the hierarchical nature of the data, multilevel regression models were used (multilevel logistic regression for binary outcomes and multilevel linear regression for continuous outcomes). Initially, an empty model was estimated (using the GLIMMIX procedure for binary outcomes and the MIXED procedure for continuous outcomes) in order to partition the variance and calculate the intraclass correlation coefficient (ICC). Next, a random intercepts model was estimated, using community as the level of the random effect. If the multilevel regression models did not converge, regression with cluster-robust standard errors (using the SURVEYLOGISTIC procedure for binary outcomes and the SURVEYREG procedure for continuous outcomes) was carried out (15, 16). Multilevel models for the odds of ever having sex and the age factor score converged for the schoolgirl strata (Table 2-3). The remaining regression models utilized cluster-robust standard errors (Tables 2-4 and 2-5). Age was centered at the grand mean for all models. Final models included variables as follows: Model 1 incorporated variables related to economic resources, Model 2 incorporated variables related to women's empowerment, and Model 3 incorporated variables related to both economic resources and women's empowerment. In all models, weights were used to account for SIHR sampling design (in which probability of inclusion varied by age and rural or urban residence). SAS 9.4 (Cary, North Carolina) was used for all analyses.

This research was approved by the Florida International University Social and Behavioral Institutional Review Board.

Results

Tables 2-1 and 2-2 show descriptive statistics for the baseline schoolgirls and dropouts. Compared to schoolgirls, dropouts were older and less educated (achieving primary school as their highest level of education). Schoolgirls resided in communities with higher resource scores, came from better educated and wealthier households, reported increased household support for health more frequently, were less likely to have ever had sex, and more likely to consistently use condoms.

Schoolgirls

Ever Having Sex and Age Factor Score

Table 2-3 shows the final adjusted multilevel regression models for ever having sex and age factor score among schoolgirls. In Model 3, which controlled for both economic factors and factors related to women's autonomy, the odds of ever having sex increased by 73% with each increasing year of age (OR=1.73; 95% CI: 1.61, 1.86). Participants from households with a highest education level of primary school had 59% higher odds of ever having sex compared to those from households with a secondary school education or higher (OR=1.59; 95% CI: 1.14, 2.22). The odds of having sex decreased with increased belief in a woman's right to refuse unprotected sex (OR=0.76; 95% CI: 0.60, 0.96). Perceived household support for health was strongly associated with ever having sex, with those reporting less support or the same level of support as one year ago having increased odds of ever having sex compared to those reporting increased

support (OR=3.23; 95% CI: 2.16, 4.84, and OR=1.97; 95% CI: 1.51, 2.56, respectively). Increasing household consumption quintile was also associated with higher odds of ever having sex (OR=1.11; 95% CI: 1.01, 1.23). At the community level, the odds of ever having sex decreased with each increasing percentage point of girls enrolled in school (OR=0.97; 95% CI: 0.95, 0.996).

In the combined Model 3 for age factor score, participants who had achieved a primary school level of education had a higher age factor score compared to those achieving secondary school or higher (β=0.47; 95% CI: 0.23, 0.71), indicating higher risk. At the community level, increasing scores for women's autonomy were associated with a higher age factor score (β=0.22; 95% CI: 0.05, 0.40).

Consistent Condom Use and Partner History Factor Score

Table 2-4 shows the final adjusted regression models, utilizing cluster-robust standard errors, for consistent condom use and partner history factor score among schoolgirls. In Model 3, the odds of consistent condom use decreased by 16% for each additional year of age (OR=0.84; 95% CI: 0.71, 0.98). Perceived household support for health was strongly associated with consistent condom use, with those reporting less support or the same level of support as one year ago having decreased odds of consistent condom use compared to those reporting increased support (OR=0.37; 95% CI: 0.16, 0.86, and OR=0.58; 95% CI: 0.34, 0.99, respectively). At the community level, the odds of consistent condom use increased with each increasing percentage point of girls enrolled in school (OR=1.06; 95% CI: 1.01, 1.11).

In the combined Model 3 for partner history factor score, participants who had achieved a primary school level of education had a higher partner history factor score compared to those with a secondary school education or higher (β=0.26; 95% CI: 0.08, 0.44), indicating higher risk.

Dropouts

Table 2-5 shows the final adjusted regression models, utilizing cluster-robust standard errors, for risky sexual behavior among dropouts. In Model 3, the odds of ever having sex increased by 80% for each increasing year of age (OR=1.80; 95% CI: 1.52, 2.13). Participants who had achieved a primary school level of education had higher age factor and partner history factor scores compared to those with a secondary school education or higher (β=0.51; 95% CI: 0.23, 0.79, and β=0.24; 95% CI: 0.07, 0.41, respectively). Additionally, participants from households with only a primary school level of education had higher age factor scores compared to those from households with a secondary school education or higher (β=0.26; 95% CI: 0.03, 0.48).

Discussion

Our results suggest that the various aspects of risky sexual behavior are associated with different factors. Among schoolgirls, the percent of girls enrolled in school at the community level was negatively associated with the odds of ever having sex and positively associated with the odds of consistent condom use. Interestingly, increasing scores for women's autonomy in the community were associated with riskier scores related to age of sexual activity. At the individual level, increased perceived household support for health lowered the odds of ever having sex and improved the odds of condom

use. Belief in the right to refuse sex was protective against ever having sex. Lower educational attainment among the participants was associated with riskier scores related to age and partner history factors, while lower education in households increased the odds of ever having sex. In contrast, among the dropout strata, age was the only variable associated with ever having sex, while individual and household education were the only variables associated with riskier scores related to age and partner history factors.

Our results differed considerably between the schoolgirl and dropout strata, suggesting the underlying mechanisms related to risky sexual behavior vary based on one's history of school enrollment. Since age was a consistent predictor of ever having sex in both strata, our findings suggest that keeping girls in school so that they may achieve a secondary level of education in a timely manner may be an effective intervention to reduce risky sexual behavior. These findings align with existing literature on the topic in sub-Saharan Africa (17). There is strong evidence that low educational attainment negatively impacts condom use (17). There is also evidence that, for women, low educational attainment increases the risk of early sexual debut (17). Our findings also suggest that the percentage of girls enrolled in school at the community level and household education play important roles in risky sexual behavior.

Among schoolgirls, an increased perception of household support for health was protective for ever having sex and improved consistent condom use. These finding deserve further exploration, particularly because existing evidence related to social support and HIV risk behaviors is mixed (18). Additionally, further research is needed to

fully explore the sociological phenomenon underlying our results related to tribe and religion.

The finding that, among schoolgirls, belief in women's right to refuse unprotected sex was associated with lower odds of ever having sex aligns with existing theoretical frameworks (19). However, the finding that increasing community-level scores related to women's autonomy were associated with riskier scores related to age of sexual activity requires further exploration, since literature on this topic is scarce (6, 20-23). Data were not available to fully assess this potentially complex dynamic.

We found that belonging to households in higher quintiles of household consumption (a measure of wealth) increased the odds of ever having sex among the schoolgirl strata. This finding is consistent with other studies, although the literature on the topic is mixed. Some have hypothesized that associations between wealth and risky sexual behavior are due to increases in the likelihood of mobility or having multiple partners (19). At the community level, we found no associations between our measures of economic resources and risky sexual behavior. This may be because, as one of the poorest countries in the world, poverty is ubiquitous in Malawi (24). Our null findings may be accounted for by the lack of variation in community-level economic resources across our sample.

A strength of this study includes the use of indices for assessing risky sexual behavior. Risky sexual behavior is a multifaceted outcome that cannot be fully measured simply by looking at the presence of any sexual behavior or the use of condoms. Our use of indices represents an attempt to move away from oversimplified constructs of risky

sexual behavior. Additionally, we created and utilized composite indicators at the community level to more fully measure community resources and women's autonomy. While other studies have utilized multilevel analysis to examine risky sexual behavior in Malawi (25-33), to our knowledge this is the first to utilize such a composite for women's autonomy in the community.

There are several limitations to this study. First, the risky sexual behavior indices and community composite measures presented here require further validation in other data sets. Additionally, limited variation across communities for condom use and partner history factor score among the schoolgirl strata and for all outcomes among the dropout strata may have contributed to the failure of the multilevel models to converge. Finally, the cross-sectional nature of this data set prohibits any inferences related to causality.

Conclusions

Risky sexual behavior is multifaceted and complex. While various factors related to women's empowerment played a role, the most consistent variables associated with risky sexual behavior were those related to education, including the girl's level of education, the highest level of education of her household of origin, and the community percentage of girls enrolled in school. Interventions and programs seeking to reduce risky sexual behavior among young women, thereby reducing their risk of HIV infection, should continue to focus on improving access to education at multiple levels.

Supplement 1. Methods for computing risky sexual behavior indices

Exploratory factor analysis (EFA) with principal factor analysis and varimax rotation was used to generate composite indicators for risky sexual behavior. The Kaiser

criterion (number of eigenvalues greater than 1) was used for determining the number of factors to retain. EFA was performed on a total of six variables: girls' age at sexual debut; age when sexual relationship with last partner began; number of lifetime partners; number of partners in the last year; frequency of sex with last partner; and an age difference with last partner of greater than five years. EFA was performed in SAS 9.4 separately for the schoolgirl and dropout strata. In both strata, results were two distinct factors, one related to the age variables (referred to as Age Factor) and one related to the remaining variables (referred to as Partner History Factor).

Among the schoolgirl strata, eigenvalues were 2.05 and 1.15. For the Age Factor, rotated factor scores were 0.88 for age at sexual debut and 0.82 for age when sexual relationship with last partner began. For the Partner History Factor, rotated factor scores were as follows: number of lifetime partners, 0.74; number of partners in the last year, 0.64; frequency of sex with last partner, 0.54; and age difference with last partner of greater than five years, 0.46. Among the dropout strata, eigenvalues were 1.52 and 1.13. For the Age Factor, rotated factor scores were 0.83 for age at sexual debut and 0.79 for age when sexual relationship with last partner began. For the Partner History Factor, rotated factor scores were as follows: number of lifetime partners, 0.67; number of partners in the last year, 0.58; frequency of sex with last partner, 0.44; and age difference with last partner of greater than five years, 0.36. The scores were then computed using a simple method, which has been shown to be more stable than methods based on factor loadings (13, 14). To create a standardized score for each index, a z-score (with a mean of 0 and a standard deviation of 1) for the values of each variable was generated, by strata. The score for each factor was then generated by taking the mean of these z-scores.

A higher score on the Partner History Factor indicated more risky sexual behavior; conversely, a lower score on the Age Factor indicated more risky sexual behavior.

Supplement 2. Methods for computing community-level composite indicators

Principal components analysis (PCA) with varimax rotation was used to create community-level composite indicators for community resources and the status of women. The Kaiser criterion (number of eigenvalues greater than 1) was used for determining the number of factors to retain. SAS 9.4 was used for all analyses.

For community resources, PCA was performed on four variables: do children typically wear neat clothes; do children under 10 years old typically wear shoes; type of housing (traditional, semi-permanent, or permanent); and distance from Zomba town (the urban center) in kilometers. Type of housing was constructed based on Malawi's Integrated Household Survey Household Socio-Economic Characteristics Report, which classifies dwellings based on the type of materials used for construction of the walls and roof (34). Variables were coded so that increasing values indicated more favorable conditions, except for Zomba Town. For this variable, the further one resided from Zomba Town, the least favorable. Variables loaded onto one factor with an eigenvalue of 2.12. Factor scores were as follows: children typically wear neat clothes, 0.59; children under 10 years old typically wear shoes, 0.86; type of housing, 0.68; and distance to Zomba Town, -0.76. The composite indicator was computed using a simple method, which has been shown to be more stable than methods based on factor loadings (13, 14). After the PCA was completed, distance to Zomba Town (the urban center) was given negative values, so that living closer to Zomba Town was considered more favorable than

living in a rural area. A z-score for each variable was then calculated, and the mean of those z-scores generated the community resources score.

PCA was performed on four variables in the community survey hypothesized to be related to the status of women on the community: method of land transfer within families (always/almost always transferred through father, usually transferred through father, sometimes through father/sometimes through mother, usually through mother, always/almost always through mother); method individuals use to trace their descent (father, both father and mother, mother); if it is customary for a woman to inherit land when her husband dies; and if it is customary for either the man or woman to have to move out of the community after a divorce (woman, either woman or man, man, neither). Variables were coded so that increasing values indicated more favorable conditions for women. Variables loaded onto one factor with an eigenvalue of 2.42. Factor scores were as follows: method of land transfer, 0.70; method to trace descent, 0.75; land inheritance, 0.89; and move after divorce, 0.75. As with community resources, the composite indicator was computed using a simple method. A z-score for each variable was calculated, and the mean of those z-scores then generated the community resources score.

References

1. National Statistical Office (NSO) and ICF Macro. Malawi Demographic and Health Survey 2010. Zomba, Malawi, and Calverton, Maryland, USA: NSO and ICF Macro; 2011.

2. National Statistical Office (NSO) [Malawi] and ICF, editor. Malawi Demographic and Health Survey 2015-16. Zomba, Malawi, and Rockville, Maryland, USA: NSO and ICF; 2017.

3. National Statistical Office (NSO) and ORC Macro. Malawi Demographic and Health Survey 2004. Calverton, Maryland: NSO and ORC Macro; 2005.

4. Nagoli J, Holvoet K, Remme M. HIV and AIDS vulnerability in fishing communities in Mangochi district, Malawi. Afr J AIDS Res. 2010;9(1):71-80.

5. Chersich MF, Rees HV. Vulnerability of women in southern Africa to infection with HIV: biological determinants and priority health sector interventions. AIDS. 2008;22(Suppl 4):S27-40.

6. Krishnan S, Dunbar MS, Minnis AM, Medlin CA, Gerdts CE, Padian NS. Poverty, Gender Inequities, and Women's Risk of Human Immunodeficiency Virus/AIDS. Ann N Y Acad Sci. 2008;1136(1):101-10.

7. Gilbert L, Walker L. Treading the path of least resistance: HIV/AIDS and social inequalities a South African case study. Soc Sci Med. 2002;54(7):1093-110.

8. Gupta GR. How men's power over women fuels the HIV epidemic. BMJ. 2002;324(7331):183-4.

9. Zierler S, Krieger N. Reframing women's risk: social inequalities and HIV infection. Annu Rev Public Health. 1997;18:401-36.

10. Whiteside A, Barnett T. AIDS in the twenty-first century: disease and globalization. Basingstoke: Palgrave Macmillan; 2002.

11. Sweat MD, Denison JA. Reducing HIV incidence in developing countries with structural and environmental interventions. AIDS. 1995;9(Suppl A):S251-7.

12. Baird SJ, Garfein RS, McIntosh CT, Ozler B. Effect of a cash transfer programme for schooling on prevalence of HIV and herpes simplex type 2 in Malawi: a cluster randomised trial. Lancet. 2012;379(9823):1320-9.

13. Grice JW. Computing and evaluating factor scores. Psychol Methods. 2001 Dec;6(4):430-50.

14. DiStefano C, Zhu M, Mîndrilă D. Understanding and Using Factor Scores: Considerations for the Applied Researcher. Prac Assess Res Eval.. 2009;14(20).

15. McNeish D, Stapleton LM, Silverman RD. On the Unnecessary Ubiquity of Hierarchical Linear Modeling. Psychol Methods. 2017;22(1):114-140.

16. Schempf AH, Kaufman JS. Accounting for context in studies of health inequalities: a review and comparison of analytic approaches. Ann Epidemiol. 2012;22(10):683-90.

17. Zuilkowski SS, Jukes MC. The impact of education on sexual behavior in sub-Saharan Africa: a review of the evidence. AIDS Care. 2012;24(5):562-76.

18. Qiao S, Li X, Stanton B. Social support and HIV-related risk behaviors: a systematic review of the global literature. AIDS Behav.2014;18(2):419-41.

19. Gillespie S, Kadiyala S, Greener R. Is poverty or wealth driving HIV transmission? AIDS. 2007;21(Suppl 7):S5-S16.

20. Pettifor A, Measham D, Rees H, Padian N. Sexual Power and HIV Risk, South Africa. Emerg Infect Dis. 2004;10(11):1996-2004.

21. Rahman M, Mostofa M, Hoque M. Women's household decision-making autonomy and contraceptive behavior among Bangladeshi women. Sex Reprod Healthc. 2014;5(1):9-15.

22. Hindin M. Women's autonomy, women's status and fertility-related behavior in Zimbabwe. Pop Res Pol Rev. 2000;19(3):255-82.

23. Hogan DP, Berhanu B, Hailemariam A. Household Organization, Women's Autonomy, and Contraceptive Behavior in Southern Ethiopia. Stud Fam Plann. 1999;30(4):302-14.

24. GDP per capita (current US$) [Internet].: World Bank [cited July 1, 2017]. Available from: http://data.worldbank.org/indicator/NY.GDP.PCAP.CD?year_high_desc=false.

25. Uthman OA, Moradi T, Lawoko S. The independent contribution of individual-, neighbourhood-, and country-level socioeconomic position on attitudes towards intimate partner violence against women in sub-Saharan Africa: A multilevel model of direct and moderating effects. Soc Sci Med. 2009;68(10):1801-9.

26. Uthman OA., Lawoko S., Moradi T. The role of individual, community and societal gender inequality in forming women's attitudes toward intimate-partner violence against women: a multilevel analysis. World health & population. 2010;12(2):5-17.

27. Hung KJ, Scott J, Ricciotti HA, Johnson TR, Tsai AC. Community-Level and Individual-Level Influences of Intimate Partner Violence on Birth Spacing in Sub-Saharan Africa. Obstet Gynecol. 2012;119(5):975-82.

28. Uchudi J., Magadi M., Mostazir M. A multilevel analysis of the determinants of high-risk sexual behaviour in sub-Saharan Africa. J Biosoc Sci. 2012;44(3):289-311.

29. Magadi MA., Uchudi J. Onset of sexual activity among adolescents in HIV/AIDS-affected households in sub-Saharan Africa. J Biosoc Sci. 2015;47(2):238-57.

30. Stephenson R. Community-level gender equity and extramarital sexual risk-taking among married men in eight African countries. Int Perspect Sex Reprod Health. 2010;36(4):178-88.

31. Kamndaya M, Kazembe LN, Vearey J, Kabiru CW, Thomas L. Material deprivation and unemployment affect coercive sex among young people in the urban slums of Blantyre, Malawi: A multi-level approach. Health Place. 2015;33:90-100.

32. Andersson N., Paredes-SolÃs S., Milne D., Omer K., Marokoane N., Laetsang D., et al. Prevalence and risk factors for forced or coerced sex among school-going youth: national cross-sectional studies in 10 southern African countries in 2003 and 2007. BMJ open. 2012;2(2):e000754.

33. Robertson L., Gregson S., Garnett GP. Sexual risk among orphaned adolescents: is country-level HIV prevalence an important factor? AIDS Care. 2010;22(8):927-38.

34. National Statistical Office (NSO). Integrated Household Survey 2010-2011: Household Socio-Economic Characteristics Report. Zomba, Malawi: NSO; 2012.

Tables and Figures

Table 2-1. Characteristics of baseline schoolgirls and dropouts in the control group of the Schooling, Income, and Health Risk study in Zomba District Malawi

	Schoolgirls N=1,407 Weighted %[a]	**Dropouts** N=407 Weighted %[a]
Ever Had Sex		
Yes	24.22	78.38
No	75.78	21.62
Consistent Condom Use[b]		
Never/Sometimes/At the Beginning	65.17	86.14
Always/Almost Always	34.83	13.86
Girl's Highest Education Level		
Primary	54.09	72.73
Secondary or Higher	45.91	27.27
Household's Highest Education Level		
Primary	26.98	45.91
Secondary or Higher	73.02	54.09
Perceived Household Support for Health		
Less than 1 year ago	8.38	13.37
Same as 1 year ago	30.53	52.23
More than 1 year ago	61.09	34.41
Religion		
Muslim	19.68	22.11
Catholic	22.70	23.10
Protestant	57.62	54.79
Tribe		
Yao	36.06	41.23
Chewa	26.65	29.14
Lomwe	18.10	12.10
Other	19.19	17.53

[a]Weights were used to account for the sampling design of the Schooling, Income, and Health Risk study.
[b]Among those who had ever had sex (Schoolgirls: n=348; Dropouts: n=303).

Table 2-2. Characteristics of baseline schoolgirls and dropouts in the control group of the Schooling, Income, and Health Risk study in Zomba District Malawi

		Schoolgirls N=1,407 Mean (SD)[a]	**Dropouts** N=407 Mean (SD)[a]
Individual Variables			
Age		16.23 (2.34)	18.57 (2.36)
Household Consumption[b]			
	Quintile 1	7.00 (1.98)	5.67 (1.41)
	Quintile 2	12.04 (1.53)	10.11 (1.32)
	Quintile 3	17.66 (2.47)	15.52 (1.71)
	Quintile 4	25.34 (3.48)	23.08 (3.12)
	Quintile 5	48.50 (22.55)	43.37 (15.92)
Number of Household Shocks		3.78 (2.70)	3.88 (2.30)
Number of Safety Nets Used by Household		1.40 (1.30)	1.65 (1.10)
Number of Statements of Agreement: Women's Right to Refuse Unprotected Sex[c]		1.77 (0.62)	1.70 (0.59)
Partner History Factor[d]		0.02 (0.74)	0.00 (0.62)
Age Factor[d]		0.05 (0.99)	0.00 (0.89)
Community Variables			
Community Resource Score		0.52 (0.97)	0.27 (0.73)
Number of Development Programs		2.04 (1.40)	2.23 (1.19)
Community Women's Autonomy Score		0.13 (0.64)	0.14 (0.58)
Percentage of Girls Enrolled in School		85.76 (8.53)	81.99 (8.05)

SD=standard deviation.

[a]Weights were used to account for the sampling design of the Schooling, Income, and Health Risk study.

[b]Monthly consumption, per person, in market unit prices, U.S. dollars.

[c]Statements included: "Does a woman have right to refuse unprotected sex with her husband when she thinks her husband may have HIV/AIDS" and "Does a woman have right to refuse unprotected sex with her husband when she doesn't want to risk getting pregnant."

[d]Among those who had ever had sex and had information available on all variables used to estimate the score (Schoolgirls: n=347; Dropouts: n=30)

Table 2-3. Associations between multilevel factors related to economic factors and women's empowerment with ever having sex and age factor score among schoolgirls in Zomba district, Malawi

	Ever Had Sex[a]			Age Factor Score[b]		
	Model 1[c]	**Model 2**[d]	**Model 3**[e]	**Model 1**[f]	**Model 2**[g]	**Model 3**[f]
	OR (95% CI)	OR (95% CI)	OR (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Individual & Household Variables						
Age	1.73 (1.61, 1.86)	1.77 (1.64, 1.91)	1.73 (1.61, 1.86)	--	--	--
Girl's Highest Education Level						
Primary	1.42 (1.04, 1.96)	1.15 (0.76, 1.73)	1.28 (0.93, 1.78)	0.45 (0.22, 0.69)	0.47 (0.24, 0.70)	0.47 (0.23, 0.71)
Secondary or Higher	ref	ref	ref	ref	ref	ref
Household's Highest Education Level						
Primary	1.55 (1.12, 2.14)	1.56 (1.10, 2.22)	1.59 (1.14, 2.22)	0.19 (-0.07, 0.45)	0.16 (-0.09, 0.42)	0.18 (-0.07, 0.44)
Secondary or Higher	ref	ref	ref	ref	ref	ref
Household Consumption Quintile[h]	1.12 (1.02, 1.23)	--	1.11 (1.01, 1.23)	-0.02 (-0.09, 0.05)	--	-0.02 (-0.09, 0.05)
Number of Household Shocks	1.02 (0.96, 1.08)	--	1.02 (0.96, 1.08)	0.01 (-0.03, 0.06)	--	0.01 (-0.04, 0.06)
Number of Safety Nets Used by Household	1.15 (1.02, 1.30)	--	1.13 (1.00, 1.28)	-0.11 (-0.20, -0.02)	--	-0.09 (-0.18, 0.00)
Belief in Women's Right to Refuse Unprotected Sex	--	0.78 (0.61, 0.99)	0.76 (0.60, 0.96)	--	0.05 (-0.12, 0.21)	0.00 (-0.16, 0.17)

Perceived Household Support for Health						
Less than 1 year ago	--	3.41 (2.25, 5.16)	3.23 (2.16, 4.84)	--	-0.12 (-0.38, 0.14)	-0.10 (-0.37, 0.16)
Same as 1 year ago	--	2.09 (1.59, 2.73)	1.97 (1.51, 2.56)	--	0.03 (-0.17, 0.22)	0.00 (-0.20, 0.20)
More than 1 year ago	ref	ref	ref	ref	ref	ref
Religion						
Muslim	--	0.92 (0.64, 1.34)	0.99 (0.69, 1.41)	--	-0.05 (-0.31, 0.21)	-0.06 (-0.32, 0.15)
Catholic	--	1.00 (0.73, 1.37)	1.02 (0.75, 1.39)	--	-0.13 (-0.36, 0.10)	-0.09 (-0.32, 0.20)
Protestant	ref	ref	ref	ref	ref	ref
Tribe						
Yao	ref	ref	ref	ref	ref	ref
Chewa	--	0.96 (0.67, 1.36)	0.93 (0.67, 1.30)	--	0.20 (-0.05, 0.45)	0.16 (-0.09, 0.41)
Lomwe	--	0.86 (0.57, 1.28)	0.93 (0.63, 1.39)	--	0.11 (-0.16, 0.38)	0.10 (-0.18, 0.38)
Other	--	0.75 (0.50, 1.13)	0.82 (0.55, 1.21)	--	0.30 (0.01, 0.59)	0.29 (0.00, 0.58)
Community Variables						
Community Resources Score	0.99 (0.79, 1.23)	--	1.13 (0.89, 1.45)	0.02 (-0.12, 0.16)	--	0.01 (-0.15, 0.17)
Number of Development Programs	1.01 (0.89, 1.15)	--	1.01 (0.89, 1.15)	0.02 (-0.06, 0.11)	--	0.02 (-0.06, 0.11)
Women's Autonomy Community Score	--	1.20 (0.89, 1.63)	1.20 (0.92, 1.58)	--	0.19 (0.03, 0.36)	0.22 (0.05, 0.40)
Percentage of girls in school	--	0.98 (0.95, 1.00)	0.97 (0.95, 0.996)	0.00 (-0.01, 0.02)	0.00 (-0.01, 0.02)	0.00 (-0.01, 0.02)

OR = odds ratio. CI = confidence interval. [a]Estimated using PROC GLIMMIX. Intraclass correlation coefficient (ICC) was 0.037 in empty model. [b]Estimated using PROC MIXED. ICC was 0.005 in empty model [c]Monthly consumption, per person, in market unit prices, U.S. dollars. [c]N=1332; observations were dropped from the final model if they had incomplete information on the variables included. [d]N=1353; observations were dropped from the final model if they had incomplete information on the variables included. [e]N=1318; observations were dropped from the final model if they had incomplete information on the variables included. [f]N=333; observations were dropped from the final model if they had incomplete information on the variables included

(348 schoolgirls reported ever having sex). [g]N=340; observations were dropped from the final model if they had incomplete information on the variables included (348 schoolgirls reported ever having sex). [h]Monthly consumption, per person, in market unit prices, U.S. dollars.

Table 2-4. Associations between multilevel factors related to economic conditions and women's empowerment with condom use and partner history factor score among schoolgirls in Zomba district, Malawi

	Condom Use[a]			Partner History Factor Score[b]		
	Model 1[c]	**Model 2**[d]	**Model 3**[e]	**Model 1**[f]	**Model 2**[g]	**Model 3**[f]
	OR (95% CI)	OR (95% CI)	OR (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Individual & Household Variables						
Age	0.79 (0.68, 0.92)	0.84 (0.72, 0.99)	0.84 (0.71, 0.98)	0.05 (-0.01, 0.12)	0.04 (-0.02, 0.11)	0.05 (-0.02, 0.13)
Girl's Highest Education Level						
Primary	0.56 (0.29, 1.07)	0.54 (0.27, 1.10)	0.68 (0.37, 1.25)	0.22 (0.06, 0.39)	0.24 (0.10, 0.38)	0.26 (0.08, 0.44)
Secondary or Higher	ref	ref	ref	ref	ref	ref
Household's Highest Education Level						
Primary	0.74 (0.39, 1.42)	0.83 (0.36, 1.90)	0.73 (0.37, 1.45)	-0.12 (-0.30, 0.07)	-0.12 (-0.31, 0.07)	-0.12 (-0.31, 0.07)
Secondary or Higher	ref	ref	ref	ref	ref	ref
Household Consumption Quintile[h]	1.05 (0.89, 1.24)	--	1.05 (0.87, 1.26)	0.01 (-0.04, 0.07)	--	0.02 (-0.04, 0.08)
Number of Household Shocks	0.90 (0.79, 1.03)	--	0.88 (0.77, 1.01)	0.01 (-0.03, 0.05)	--	0.01 (-0.03, 0.04)
Number of Safety Nets Used by Household	0.79 (0.58, 1.07)	--	0.79 (0.56, 1.10)	-0.04 (-0.14, 0.06)	--	-0.03 (-0.13, 0.06)
Belief in Women's Right to Refuse Unprotected Sex	--	0.84 (0.54, 1.30)	0.75 (0.48, 1.16)	--	0.05 (-0.09, 0.19)	0.04 (-0.10, 0.19)
Perceived Household Support						
Less than 1 year ago	--	0.50 (0.21, 1.18)	0.37 (0.16, 0.86)	--	-0.02 (-0.27, 0.23)	0.02 (-0.23, 0.28)
Same as 1 year ago	--	0.61 (0.38, 0.98)	0.58 (0.34, 0.99)	--	-0.09 (-0.21, 0.04)	-0.09 (-0.23, 0.04)

More than 1 year ago	ref	ref	ref	ref	ref	ref
Religion						
Muslim	--	1.02 (0.45, 2.30)	0.99 (0.44, 2.24)	--	-0.07 (-0.25, 0.11)	-0.09 (-0.29, 0.11)
Catholic	--	1.48 (0.89, 2.47)	1.93 (1.09, 3.44)	--	-0.02 (-0.21, 0.17)	-0.04 (-0.24, 0.15)
Protestant	ref	ref	ref	ref	ref	ref
Tribe						
Yao	ref	ref	ref	ref	ref	ref
Chewa	--	1.25 (0.68, 2.31)	1.00 (0.53, 1.87)	--	-0.20 (-0.38, -0.02)	-0.18 (-0.35, 0.00)
Lomwe	--	1.50 (0.81, 2.80)	1.42 (0.71, 2.84)	--	-0.03 (-0.30, 0.24)	-0.01 (-0.29, 0.26)
Other	--	2.98 (1.22, 7.28)	2.88 (1.19, 6.97)	--	-0.19 (-0.39, 0.01)	-0.20 (-0.39, -0.02)
Community Variables						
Community Resources Score	1.16 (0.94, 1.42)	--	0.87 (0.64, 1.18)	0.03 (-0.05, 0.11)	--	0.01 (-0.08, 0.10)
Number of Development Programs	1.10 (0.92, 1.32)	--	1.15 (0.98, 1.35)	0.04 (-0.02, 0.10)	--	0.03 (-0.02, 0.09)
Women's Autonomy Community Score	--	1.18 (0.78, 1.78)	1.27 (0.74, 2.18)	--	0.08 (-0.04, 0.20)	0.07 (-0.06, 0.20)
Percentage of girls in school	--	1.06 (1.02, 1.09)	1.06 (1.01, 1.11)	--	0.00 (0.00, 0.01)	0.01 (0.00, 0.01)

OR = odds ratio. CI = confidence interval. [a]Estimated using PROC SURVEYLOGISTIC. [b]Estimated using PROC SURVEYREG. [c]N=338; observations were dropped from the final model if they had incomplete information on the variables included (348 schoolgirls reported ever having sex). [d]N=345; observations were dropped from the final model if they had incomplete information on the variables included (348 schoolgirls reported ever having sex). [e]N=338; observations were dropped from the final model if they had incomplete information on the variables included (348 schoolgirls reported ever having sex). [f]N=334; observations were dropped from the final model if they had incomplete information on the variables included (348 schoolgirls reported ever having sex). [g]N=341; observations were dropped from the final model if they had incomplete information on the variables included (348 schoolgirls reported ever having sex). [h]Monthly consumption, per person, in market unit prices, U.S. dollars.

Table 2-5. Associations between multilevel factors related to economic conditions and women's empowerment with risky sexual behavior among dropouts in Zomba district, Malawi

	Ever Had Sex[a]			Condom Use[a]		
	Model 1[c]	**Model 2**[d]	**Model 3**[e]	**Model 1**[f]	**Model 2**[g]	**Model 3**[h]
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Individual & Household Variables						
Age	1.78 (1.53, 2.06)	1.74 (1.47, 2.06)	1.80 (1.52, 2.13)	1.00 (0.83, 1.20)	1.00 (0.82, 1.21)	0.99 (0.80, 1.21)
Girl's Highest Education Level						
Primary	1.79 (0.67, 4.81)	1.30 (0.51, 3.33)	1.66 (0.57, 4.87)	0.36 (0.14, 0.97)	0.38 (0.14, 1.02)	0.37 (0.13, 1.04)
Secondary or Higher	ref	ref	ref	ref	ref	ref
Household's Highest Education Level						
Primary	1.06 (0.59, 1.90)	1.12 (0.60, 2.08)	0.99 (0.54, 1.82)	0.75 (0.29, 1.98)	0.73 (0.27, 1.97)	0.73 (0.26, 2.00)
Secondary or Higher	ref	ref	ref	ref	ref	ref
Household Consumption Quintile[i]	1.22 (0.99, 1.51)	--	1.23 (0.96, 1.58)	1.15 (0.88, 1.51)	--	1.15 (0.86, 1.54)
Number of Household Shocks	1.02 (0.87, 1.18)	--	1.02 (0.87, 1.20)	0.95 (0.81, 1.11)	--	0.93 (0.78, 1.12)
Number of Safety Nets Used by Household	1.21 (0.92, 1.60)	--	1.20 (0.92, 1.57)	0.88 (0.62, 1.26)	--	0.86 (0.56, 1.32)
Belief in Women's Right to Refuse Unprotected Sex	--	1.06 (0.73, 1.54)	1.13 (0.76, 1.67)	--	1.98 (0.94, 4.19)	1.96 (0.92, 4.16)
Perceived Household Support						

Less than 1 year ago	--	1.04 (0.40, 2.72)	0.80 (0.31, 2.08)	--	0.85 (0.27, 2.73)	0.60 (0.15, 2.39)
Same as 1 year ago	--	1.24 (0.67, 2.31)	1.27 (0.66, 2.42)	--	0.99 (0.46, 2.12)	0.86 (0.37, 1.98)
More than 1 year ago	ref	ref	ref	ref	ref	ref
Religion						
Muslim	--	1.11 (0.50, 2.47)	1.04 (0.42, 2.56)	--	1.52 (0.47, 4.88)	1.79 (0.47, 6.79)
Catholic	--	0.93 (0.51, 1.72)	0.86 (0.44, 1.68)	--	1.06 (0.37, 3.08)	1.20 (0.40, 3.57)
Protestant	ref	ref	ref	ref	ref	ref
Tribe						
Yao	ref	ref	ref	ref	ref	ref
Chewa	--	0.76 (0.37, 1.53)	0.72 (0.33, 1.59)	--	1.15 (0.56, 2.36)	1.03 (0.47, 2.27)
Lomwe	--	0.57 (0.27, 1.21)	0.57 (0.24, 1.36)	--	0.85 (0.20, 3.55)	0.93 (0.22, 3.84)
Other	--	0.98 (0.39, 2.49)	0.97 (0.35, 2.67)	--	0.86 (0.32, 2.28)	1.19 (0.43, 3.36)
Community Variables						
Community Resources Score	0.83 (0.58, 1.19)	--	0.89 (0.57, 1.40)	1.23 (0.89, 1.69)	--	1.51 (0.94, 2.42)
Number of Development Programs	0.88 (0.73, 1.07)	--	0.89 (0.73, 1.09)	0.82 (0.66, 1.03)	--	0.78 (0.59, 1.03)
Women's Autonomy Community Score	--	0.82 (0.57, 1.20)	0.80 (0.54, 1.18)	--	0.89 (0.50, 1.58)	0.99 (0.57, 1.71)
Percentage of girls in school	--	0.98 (0.94, 1.01)	0.98 (0.93, 1.03)	--	1.01 (0.97, 1.05)	0.98 (0.93, 1.03)

OR = odds ratio. CI = confidence interval. [a]Estimated using PROC SURVEYLOGISTIC. [b]Estimated using PROC SURVEYREG. [c]N=385; observations were dropped from the final model if they had incomplete information on the variables included. [d]N=398; observations were dropped from the final model if they had incomplete information on the variables included. [e]N=380; observations were dropped from the final model if they had incomplete information on

the variables included. [f]N=289; observations were dropped from the final model if they had incomplete information on the variables included (303 dropouts reported ever having sex). [g]N=295; observations were dropped from the final model if they had incomplete information on the variables included (only 303 dropouts reported ever having sex). [h]N=284; observations were dropped from the final model if they had incomplete information on the variables included (only 303 dropouts reported ever having sex). [i]Monthly consumption, per person, in market unit prices, U.S. dollars.

Table 2-5 ctd. Associations between multilevel factors related to economic conditions and women's empowerment with risky sexual behavior among dropouts in Zomba district, Malawi

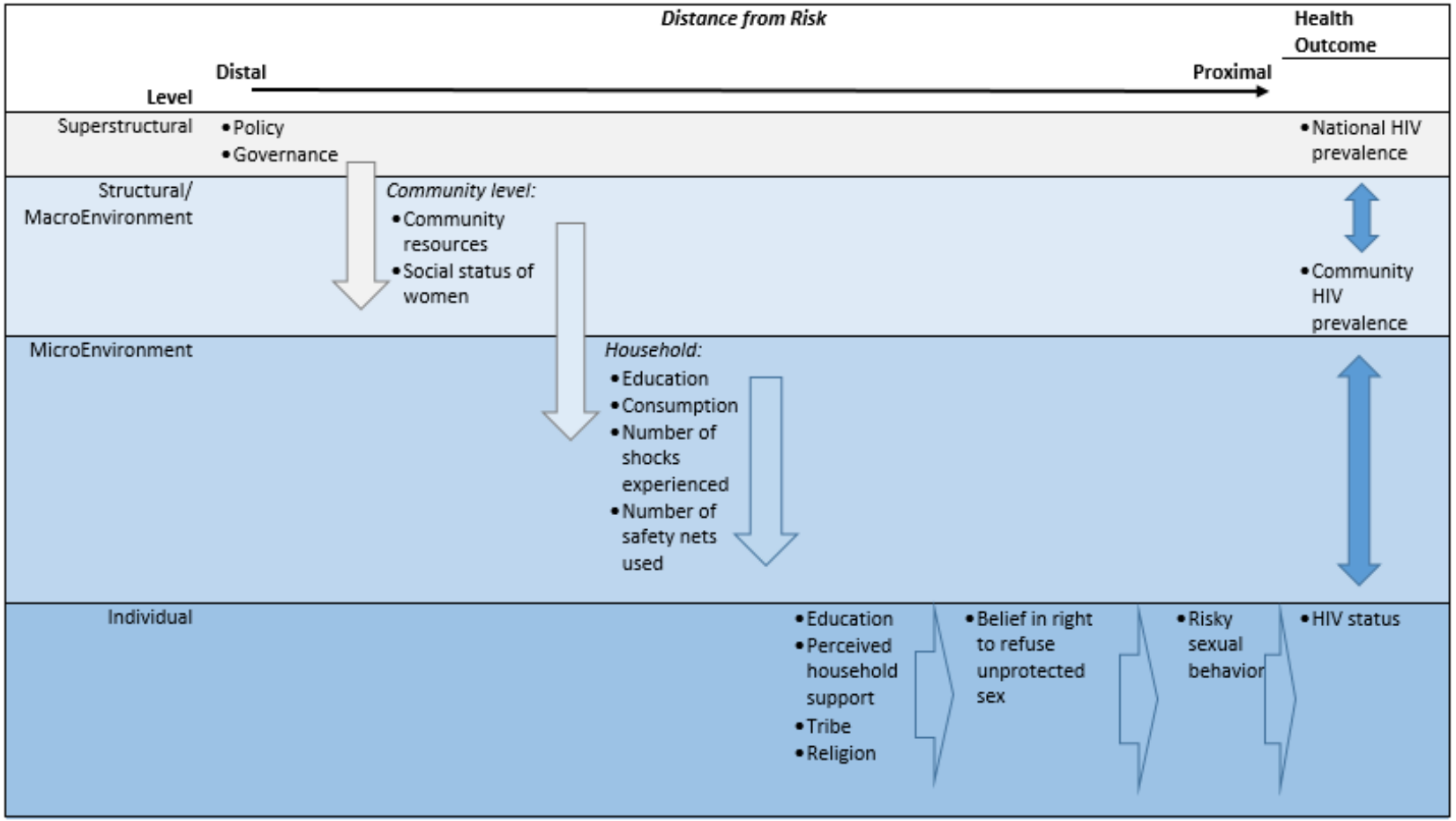
	Age Factor Score[b]			Partner History Factor Score[b]		
	Model 1[f]	**Model 2**[g]	**Model 3**[h]	**Model 1**[f]	**Model 2**[g]	**Model 3**[h]
	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Individual & Household Variables						
Age	--	--	--	0.03 (0.00, 0.07)	0.03 (0.00, 0.07)	0.04 (0.00, 0.07)
Girl's Highest Education Level						
Primary	0.50 (0.23, 0.78)	0.50 (0.23, 0.77)	0.51 (0.23, 0.79)	0.23 (0.05, 0.41)	0.19 (0.00, 0.38)	0.24 (0.07, 0.41)
Secondary or Higher	ref	ref	ref	ref	ref	ref
Household's Highest Education Level						
Primary	0.29 (0.06, 0.51)	0.26 (0.04, 0.48)	0.26 (0.03, 0.48)	0.06 (-0.14, 0.25)	0.06 (-0.14, 0.26)	0.04 (-0.17, 0.25)
Secondary or Higher	ref	ref	ref	ref	ref	ref
Household Consumption Quintile[i]	-0.07 (-0.14, -0.002)	--	-0.08 (-0.16, 0.00)	0.03 (-0.02, 0.09)	--	0.04 (-0.03, 0.10)
Number of Household Shocks	0.01 (-0.03, 0.05)	--	0.02 (-0.03, 0.07)	0.02 (-0.02, 0.05)	--	0.02 (-0.02, 0.05)
Number of Safety Nets Used by Household	0.05 (-0.04, 0.15)	--	0.04 (-0.06, 0.13)	-0.01 (-0.07, 0.05)	--	0.00 (-0.07, 0.07)
Belief in Women's Right to Refuse Unprotected Sex	--	-0.02 (-0.21, 0.18)	0.01 (-0.20, 0.22)	--	-0.08 (-0.22, 0.06)	-0.07 (-0.21, 0.06)
Perceived Household Support						
Less than 1 year ago	--	0.21 (-0.15, 0.57)	0.12 (-0.23, 0.46)	--	0.15 (-0.13, 0.43)	0.08 (-0.23, 0.38)

Same as 1 year ago	--	0.12 (-0.15, 0.40)	0.10 (-0.18, 0.37)	--	0.06 (-0.12, 0.24)	0.09 (-0.09, 0.28)
More than 1 year ago	ref	ref	ref	ref	ref	ref
Religion						
Muslim	--	0.11 (-0.15, 0.36)	0.05 (-0.21, 0.32)	--	-0.09 (-0.26, 0.08)	-0.15 (-0.31, 0.01)
Catholic	--	0.14 (-0.06, 0.33)	0.10 (-0.10, 0.30)	--	-0.02 (-0.17, 0.13)	-0.01 (-0.16, 0.14)
Protestant	ref	ref	ref	ref	ref	ref
Tribe						
Yao	ref	ref	ref	ref	ref	ref
Chewa	--	-0.02 (-0.24, 0.19)	-0.02 (-0.24, 0.20)	--	-0.07 (-0.25, 0.10)	-0.06 (-0.23, 0.12)
Lomwe	--	-0.16 (-0.39, 0.07)	-0.12 (-0.40, 0.17)	--	0.03 (-0.24, 0.30)	-0.02 (-0.31, 0.27)
Other	--	-0.11 (-0.42, 0.21)	-0.11 (-0.41, 0.20)	--	-0.14 (-0.36, 0.08)	-0.17 (-0.41, 0.08)
Community Variables						
Community Resources Score	0.05 (-0.08, 0.18)	--	0.05 (-0.11, 0.21)	-0.03 (-0.13, 0.08)	--	-0.04 (-0.17, 0.08)
Number of Development Programs	0.04 (-0.06, 0.14)	--	0.05 (-0.05, 0.15)	0.03 (-0.03, 0.09)	--	0.04 (-0.03, 0.10)
Women's Autonomy Community Score	--	0.21 (0.02, 0.39)	0.17 (0.00, 0.34)	--	0.03 (-0.08, 0.15)	0.07 (-0.03, 0.17)
Percentage of Girls in School	--	0.00 (-0.01, 0.01)	0.00 (-0.01, 0.02)	--	0.00 (-0.01, 0.01)	0.00 (-0.01, 0.01)

OR = odds ratio. CI = confidence interval. [a]Estimated using PROC SURVEYLOGISTIC. [b]Estimated using PROC SURVEYREG. [c]N=385; observations were dropped from the final model if they had incomplete information on the variables included. [d]N=398; observations were dropped from the final model if they had incomplete information on the variables included. [e]N=380; observations were dropped from the final model if they had incomplete information on the variables included. [f]N=289; observations were dropped from the final model if they had incomplete information on the variables included (303 dropouts reported ever having sex). [g]N=295; observations were dropped from the final model if they had incomplete information on the variables included (only 303

dropouts reported ever having sex). [h]N=284; observations were dropped from the final model if they had incomplete information on the variables included (only 303 dropouts reported ever having sex). [i]Monthly consumption, per person, in market unit prices, U.S. dollars.

Figure 2-1. Conceptual framework of the multilevel factors contributing to knowledge and awareness around risky sexual behavior and HIV status



Adapted from work by Barnett and Whiteside as well as Sweat and Denison (10,11).

MANUSCRIPT 3

Associations between health facility, household and individual factors related to HIV awareness and risky sexual behavior among young women in Zomba district, Malawi

Abstract

The objective of this study was to examine the association between multilevel factors related to HIV awareness and risky sexual behavior among young women in Zomba district, Malawi. Secondary analyses of the Schooling, Income, and Health Risk (SIHR) study were undertaken. Four outcomes related to risky sexual behavior were examined: if participants had ever had sex, consistent condom use, and two scores measuring risk related to partner history and age during sexual activity. Independent variables included individual factors such as education and type of residence, as well as household education and health facility characteristics. Regression models with cluster-robust standard errors and multilevel regression models were used to estimate associations; analyses were stratified by school enrolment status at baseline of the SIHR study. In both strata, increasing age and near rural residence (within 16 kilometers of urban center) increased odds of ever having sex; lower educational achievement was associated with lower age during sexual activity. A history of pregnancy was associated with lower odds of condom use and riskier partner history. For participants in school at baseline, lower household education was associated with higher odds of ever having sex (OR=1.48; 95% CI: 1.06, 2.07); near rural and far rural residence was associated with decreased odds of condom use (OR=0.47; 95% CI: 0.28, 0.78 and OR=0.27; 95% CI: 0.11, 0.65, respectively). For participants not in school at baseline, lower household education was associated with lower age during sexual activity (β=0.31, 95% CI: 0.05,

0.58). Also among this stratum, private or non-governmental health facilities were associated with decreased odds of condom use (OR=0.51; 95% CI: 0.39, 0.67) and higher age during sexual activity (β=-0.30; 95% CI: -0.52, -0.09). While individual factors were associated with risky sexual behavior in both strata, contextual factors differed. Further research is needed to elucidate mechanisms underlying these associations.

Keywords: Risky sexual behavior, multilevel models, contextual factors, educational attainment, HIV awareness, health facilities

Introduction

Prevalence of human immunodeficiency virus (HIV) in Malawi differs by gender; nationally, HIV prevalence is currently estimated to be 10.8% among women and 6.4% among men (1). The disparity begins among the young population: among 15–19 year olds, HIV prevalence is 3.3% for women and 1.0% for men. Among 20–24 year olds, HIV prevalence is 6.4% for women and 1.1% for men (1); these numbers represent an improvement for men since 2010, when HIV prevalence for this age group was estimated to be 2.8%, but there has been no improvement for women (in 2010, prevalence was also 6.4%) (2). Gender disparities are even more pronounced in the Southern Region; in the southern Zomba district, HIV prevalence among women ages 14–49 is 16.8%, compared to 9.3% among men (1).

Given such disparities, efforts to increase HIV knowledge and awareness among young women are crucial. Higher levels of HIV awareness may manifest in lower risky sexual behavior, a critical factor in the causal pathway for HIV. As has been documented using multilevel conceptual frameworks in the sub-Saharan African context, various

factors may contribute to higher levels of HIV knowledge and awareness. For example, at the individual level, a woman's educational attainment, perceived HIV risk, or age may all contribute (3-6). Her history of pregnancy and likely subsequent exposure to prevention of mother-to-child-transmission (PMTCT) programs may also play a role (7). The level of education in the household she grew up in could also contribute, as well as her health facility's capacity for voluntary counselling and testing (VCT) services (8-10). However, the role of these factors has not been fully explored using a multilevel approach within the context of Malawi.

The objective of this study was to add a multilevel perspective to the existing literature by examining individual, household, and health facility factors related to HIV awareness and their associations with risky sexual behavior among young women in Zomba district, Malawi.

Materials and Methods

Conceptual Framework

Study design and analyses were guided by a conceptual framework adapted from work by Barnett and Whiteside as well as Sweat and Denison (Figure 1) (11, 12). In this framework, factors that influence HIV awareness and may lead to the outcome of interest—risky sexual behavior—are represented in relation to HIV status at four different levels (superstructural, structural/macroenvironmental, microenvironmental, and individual). These factors occur at varying distances from risky sexual behavior, ranging from distal to proximal. Indicators from all but the superstructural level were included in this study.

Study Design and Data Source

Secondary analysis was carried out on cross-sectional data from the Schooling, Income, and Health Risk (SIHR) study conducted by Baird et al. among young women in Zomba district, Malawi (13). Full study methodology is available elsewhere. Briefly, a randomized controlled trial of a cash transfer intervention was carried out in 176 randomly selected enumeration areas (EAs; approximately 4-5 villages) of Zomba district among two strata of unmarried young women: those enrolled in school at baseline of the SIHR study (referred to throughout as schoolgirls), and those who were school dropouts at baseline (referred to throughout as dropouts) (13). The baseline survey (Round 1) was conducted in 2007. After program implementation began and allocation to intervention or control group was completed, a follow-up survey (Round 2) was conducted approximately 12 months after Round 1 in 2008; during Round 2, data were also collected from the health facilities serving the EAs included in the SIHR study. The analyses presented here are limited to participants in the control group with data at Round 2, which consisted of 1,407 schoolgirls and 407 dropouts in 88 EAs served by a total of 17 health facilities. (It should be noted that the terms "schoolgirls" and "dropouts" refer to the participants' status at baseline of the SIHR study, and may not be representative of participants' school enrolment status at Round 2. For example, participants who were dropouts at baseline may have returned to school by Round 2.)

Measures

Risky sexual behavior was operationalized using a total of four different outcomes. The primary outcomes of interest were if the individual had ever had sex and,

for those who reported sexual activity, if the individual consistently used condoms. Recognizing these outcomes might represent an over-simplified approach to risky sexual behavior, additional experimental indices for sexually active participants were created using exploratory factor analysis. Shown in Table 3-1, variables loaded on two distinct factors: one related to partner history (which included number of lifetime partners, number of partners in the last year, frequency of sex with last partner, and an age difference with last partner of greater than five years; referred to here as "Partner History Factor") and one related to age (girls' age at sexual debut and age when sexual relationship with last partner began; referred to here as "Age Factor"). To create a standardized score for each index, a z-score (with a mean of 0 and a standard deviation of 1) for the values of each variable was generated. The score for each factor was then generated by taking the mean of these z-scores (14, 15). Since, for the original age variables, lower ages indicated higher risk, the Age Factor score was reverse coded whereby a higher Age Factor score indicated higher risk.

Independent variables included participants' highest level of education (primary school vs. secondary or higher), age (measured continuously), HIV literacy, HIV risk perception (none/low vs. medium/high), the highest level of education in her household of origin (primary school vs. secondary or higher), and type of residence. HIV literacy was based on four true or false survey questions related to AIDS transmission and treatment; a maximum score of 4 was possible. Residence was categorized as urban, near rural (residing within 16 kilometers of the urban center), or far rural (residing outside of 16 kilometers of the urban center). Since, due to outreach efforts, PMTCT programming is widespread throughout Malawi and participation may increase one's HIV awareness,

history of pregnancy was controlled for in all models except for those examining if participants had ever had sex. Age was excluded from analysis examining Age Factor score as an outcome. Facility-level covariates included the number of VCT counsellors employed and the type of health care facility (government vs. private/non-governmental). If a participant was served by more than one health facility with differing numbers of VCT counsellors, data from the facility with the highest number of VCT counsellors was used. If a participant was served by two health facilities that employed the same number of VCT counsellors, the government facility was used.

Participants were linked to health facilities utilizing the EA they resided in at baseline of the SIHR study. With two exceptions, the cross-sectional data set utilized for analysis was composed of information from Round 2 of the SIHR study. The first exception was related to educational attainment of the household of origin. Because some participants were married between Rounds 1 and 2 of survey administration, results reported in the Round 1 survey were used for this variable, since it gave a more accurate description of the households the young women grew up in. The second exception was related to characteristics of last sexual partner. If a participant reported ever having sex in Round 2 but had not had a partner in the last 12 months (and therefore information related to the most recent sexual partner was not present in Round 2), information on the last partner reported in the Round 1 survey was used.

Statistical Analysis

The sampling strategy for Baird et al. considered baseline schoolgirls and baseline dropouts as separate strata, so that procedure was followed here (13). Descriptive

statistics included frequency distributions or means with standard deviations and ranges. Given the hierarchical nature of the data, multilevel regression models were used (multilevel logistic regression for binary outcomes and multilevel linear regression for continuous outcomes). Initially, an empty model was estimated (using the GLIMMIX procedure for binary outcomes and the MIXED procedure for continuous outcomes) in order to partition the variance and calculate the intraclass correlation coefficient (ICC). Next, a random intercepts model was estimated, using health facility as the level of the random effect. Where the multilevel regression models did not converge, regression with cluster-robust standard errors (using the SURVEYLOGISTIC procedure for binary outcomes and the SURVEYREG procedure for continuous outcomes) was carried out in three separate models, the first including only individual covariates, the second including only health facility covariates, and the third including both individual and health facility covariates (16). Multilevel models converged only for analysis related to Partner History Factor score among the schoolgirl strata; logistic or linear regression with cluster-robust standard errors was used for all other models. In all models, weights were used to account for SIHR sampling design. SAS 9.4 (Cary, North Carolina) was used for all analyses.

This study was reviewed and approved by the Florida International University Institutional Review Board.

Results

Table 3-2 presents descriptive statistics for the schoolgirls and dropouts. When compared to schoolgirls, dropouts were older, less educated (achieving primary school as their highest level of education), more likely to have ever been pregnant, have higher

levels of HIV literacy and perceived risk, come from less-educated households, and reside in near rural or far rural areas. They were also more likely to be served by government health facilities and facilities with fewer VCT counsellors on average. The schoolgirls were less likely to have ever had sex and more likely to use condoms; compared with dropouts, there was greater variation in Age Factor scores among schoolgirls. Participants were served by a total of 17 health facilities.

Schoolgirls

Table 3-3 shows the associations between individual and health facility factors and ever having sex, condom use, and the Age Factor score. The final model for ever having sex included a total of 1,373 observations (observations were dropped from the final model if they had incomplete information on the variables included). With each additional year of age, schoolgirls had 74% higher odds of becoming sexually active (OR=1.74; 95% CI: 1.55, 1.95). Young women coming from households with a primary school education had approximately 50% higher odds of ever having sex compared to those from households completing secondary school or higher (OR=1.48; 95% CI: 1.06, 2.07). Similarly, those residing in near rural areas had an OR of 1.52 (95% CI: 1.19, 1.94) compared with those residing in urban areas (the referent group).

The final model for condom use included a total of 346 observations (a total of 393 respondents indicated they had ever had sex; observations were dropped from the final model if they had incomplete information on the variables included). Among schoolgirls who were sexually active, increasing age reduced the odds of condom use (OR=0.85; 95% CI: 0.75, 0.97). Those who had never been pregnant were almost

seventeen times more likely to use condoms compared to those who had been pregnant (OR=16.93; 95% CI: 6.79, 42.26). Those residing in near rural and far rural areas were considerably less likely to use condoms consistently than those residing in urban areas, with ORs of 0.47 (95% CI: 0.28, 0.78) and 0.27 (95% CI: 0.11, 0.65), respectively.

The final model for Age Factor score included a total of 341 observations. Those with primary school as their highest level of education had an Age Factor score of 0.46 standard deviations above those achieving secondary school or higher (95% CI: 0.26, 0.67), indicating higher risk. Those residing in near rural areas had a significantly lower Age Factor score of 0.36 standard deviations below those residing in urban areas (95% CI: -0.56, -0.16), indicating lower risk.

Table 3-4 shows estimates produced by the multilevel models for the Partner History Factor score. The final model for Partner History Factor score included a total of 342 observations. Participants who had never been pregnant scored approximately half of a standard deviation below those who had been pregnant on the Partner History Factor score (β=-0.49; 95% CI: -0.63, -0.36), indicating lower risk.

Dropouts

Table 3-5 shows the associations between individual and health facility factors and the various risky sexual behavior outcomes. The final models examining associations between factors related to HIV awareness and ever having sex among the dropout strata included a total of 403 observations. Among the dropout strata, young women had a 70% higher odds of becoming sexually active with each additional year of age (OR=1.70; 95%

CI: 1.42-2.04). Those residing in a near rural area had 88% higher odds of ever having sex compared to those residing in urban areas (OR=1.88; 95% CI: 1.35, 2.62).

The final model examining the associations between factors related to HIV awareness and consistent condom use included a total of 300 observations (a total of 319 respondents indicated they had ever had sex; observations were dropped from the final model if they had incomplete information on the variables included). Those who had never been pregnant had approximately five times the odds of condom use compared to those who had been pregnant (OR=4.62; 95% CI: 2.25, 9.48). An increasing HIV literacy score increased the odds of consistent condom use (OR=1.93; 95% CI: 1.11, 3.35) and those with low levels of HIV risk perception were less likely to use condoms compared to those with medium or high risk perceptions (OR=0.35; 95% CI: 0.24, 0.53). Dropouts were also more likely to use condoms consistently as the number of VCT counsellors in the health facility they were served by increased (OR=1.15; 95% CI: 1.03, 1.29), and had decreased odds of consistent condom use if served by private or non-governmental health facilities (OR=0.51; 95% CI: 0.39, 0.67).

The final models examining Age Factor and Partner History Factor scores included a total of 300 observations. Those with primary school as their highest level of education had an Age Factor score of 0.47 standard deviations above those achieving secondary school or higher (95% CI: -0.19, 0.76), indicating higher risk. Similarly, those from households with primary school as their highest level of education had an Age Factor score of 0.31 standard deviations above those achieving secondary school or higher (95% CI: 0.05, 0.58). Those served by private or non-governmental health

facilities had lower Age Factor scores compared to those served by government facilities (β=-0.30; 95% CI: -0.52, -0.09), indicating lower risk.

Participants with a primary school education had a Partner History Factor score of 0.17 standard deviations greater than those with a secondary school education or greater (95% CI: 0.04, 0.31). Those who had never been pregnant had a Partner History Factor score of 0.20 standard deviations below those who had been pregnant (β=-0.20; 95% CI: -0.36, -0.05), and those residing in near rural areas had a similarly lower score compared to those residing in urban areas (β=-0.19; 95% CI: -0.28, -0.10). Dropouts had a slightly increased Partner History Factor score as the number of VCT counsellors in the health facility they were served by increased (β=0.02; 95% CI: 0.003, 0.04). Those served by private or non-governmental health facilities had a Partner History Factor score of 0.23 standard deviations below those served by a government facility (95% CI: -0.30, -0.15).

Discussion

In both groups, increasing age increased the odds of ever having sex, lower educational achievement was associated with higher Age Factor scores (indicating higher sexual risk), and pregnancy history was associated with condom use and increased Partner History Factor scores (also indicating higher sexual risk). However, the importance of contextual factors differed by strata. For schoolgirls, lower household education was associated with higher odds of ever having sex. Near rural residence was associated with ever having sex, and both near and far rural residence were associated with lower odds of condom use. For dropouts, lower household education was associated with riskier Age Factor scores, near rural residence was associated with ever having sex,

and health facility characteristics were associated with condom use, Partner History Factor scores, and Age Factor scores.

The findings related to formal educational attainment and condom use are supported by other studies conducted in sub-Saharan Africa, highlighted by a recent review on the topic by Zuilkowski & Jukes; consensus on the association between education and other measures of risky sexual behavior (such as sexual debut) is less clear (17). The findings of riskier sexual behavior (lower odds of condom use and higher Partner History Factor scores) among participants who had ever been pregnant partially align with findings of Mugo et al., who found riskier sexual behavior among pregnant women (18). These findings warrant further exploration and may present an opportunity for intervention. While extensive PMTCT efforts have been undertaken in Malawi (19, 20), it is possible women receiving educational benefits from these efforts are largely HIV positive already and are therefore specifically targeted by PMTCT programs. It is critical that sufficient educational programs related to risky sexual behavior and condom use be provided to all pregnant women, not just those that have tested positive for HIV.

Among the dropout stratum, there were seemingly conflicting results related to health facility type. While those served by private/non-governmental health facilities were less likely to use condoms consistently, they had better outcomes on the risky sexual behavior indices: slightly lower scores on the Age and Partner History Factors. This may be due to differences in services and risk communication strategies between the two types of facilities. For example, faith-based facilities may focus more attention on the abstinence and be faithful elements of the ABC (abstinence, be faithful, use condoms)

HIV prevention strategy, while government facilities may focus more attention on promoting condom use (21, 22). While better scores on the risky sexual behavior indices are desirable, they are unlikely to outweigh the close to 50% lower odds of using condoms among those served by private/non-governmental facilities, since condom use represents direct prevention of HIV transmission. On the other hand, different types of communities may give rise to different types of facilities; the differences observed may simply be due community differences rather than facility types. Further research is needed to fully explore these nuanced findings.

Findings related to area of residence were also mixed. While near rural residence was associated with higher odds of ever having sex and lower odds of condom use, within the schoolgirl stratum it was associated with a lower Age Factor score and within the dropout stratum it was associated with lower Partner History Factor scores, indicating lower risk when compared to the referent group of urban residents. The current literature on the association between area of residence and risky sexual behavior is mixed (23, 24). The data presented here suggest that area of residence may impact different aspects of risky sexual behavior; however, exploring the underlying reasons for these differences is beyond the scope of this paper. Future research should seek to understand these associations more extensively.

To the authors' knowledge, this is one of the only studies to examine the multilevel influence of health facility characteristics on risky sexual behavior in sub-Saharan Africa. Given their potential reach, health facilities provide a unique platform for behavioral interventions. The findings that health facility characteristics were only

associated with risky sexual behavior among the dropout stratum is particularly interesting; health facilities may fill a void when formal education is limited. Associations between services offered and behavioral outcomes warrant exploration in the field. Furthermore, while other studies have utilized multilevel analysis to examine risky sexual behavior in Malawi (25-33), this is the first multilevel study to the authors' knowledge to utilize indices for assessing risky sexual behavior. There are many aspects of risky sexual behavior that defy measurement by only examining the presence of any sexual activity or the use of condoms. The use of indices represents an attempt to move away from oversimplified constructs of risky sexual behavior.

There are several limitations to this study. First, the risky sexual behavior indices presented here were experimental and require further validation using data from other studies, collected in settings both similar to and different from this study sample. Future studies might use data from sources such as Demographic and Health Surveys to do so. Additionally, it should be noted that pregnancy may be an outcome of RSB, not vice versa. However, given the potential for participation in PMTCT programming to influence HIV awareness, the authors opted to include it in the conceptual framework. As indicated by the 95% CIs, estimates related to pregnancy history and condom use had poor precision; we suspect this was due to limited power, particularly among schoolgirls, because a relatively small proportion of them had ever been pregnant (Table 3-1). Furthermore, there were a relatively low number of health facilities available for analysis (17); low variation of the outcomes across this limited number of facilities may have contributed to the multilevel models not converging. Finally, scores on the risky sexual behavior indices were only estimated for respondents who had complete information on

all components and final models included participants who had complete information on all variables; this may have introduced some bias into the results and limited the precision of estimates.

Conclusions

While age, educational status, and pregnancy history were associated with measures of risky sexual behavior among both the schoolgirl and dropout strata, the types of contextual factors influencing risky sexual behavior varied by strata; dropouts had decreased odds of consistent condom use but less risky Age and Partner History Factor scores if served by private or non-governmental health facilities. Future research is needed to fully elucidate reasons for increased risky sexual behavior among women who have been pregnant and to explore differences in services provided by government and private/non-governmental health facilities.

References

1. National Statistical Office (NSO) [Malawi] and ICF. Malawi Demographic and Health Survey 2015-16. Zomba, Malawi, and Rockville, Maryland, USA: NSO and ICF; 2017.

2. National Statistical Office (NSO) and ICF Macro. Malawi Demographic and Health Survey 2010. Zomba, Malawi, and Calverton, Maryland, USA: NSO and ICF Macro; 2011.

3. Ukwuani FA., Tsui AO., Suchindran CM. Condom use for preventing HIV infection/AIDS in sub-Saharan Africa: a comparative multilevel analysis of Uganda and Tanzania. J Acquir Immune Defic Syndr. 2003;34(2):203-13.

4. Benefo KD. Determinants of condom use in Zambia: a multilevel analysis. Stud Fam Plann. 2010;41(1):19-30.

5. Stephenson R. Community influences on young people's sexual behavior in 3 African countries. Am J Public Health. 2009 Jan;99(1):102-9.

6. Chiao C. Community context and the prevalence of premarital sex among young women in Kenya and the Philippines: trends and differences from 1993 to 2003. Health Place. 2010;16(3):512-22.

7. Ngome E., Odimegwu C. The social context of adolescent women's use of modern contraceptives in Zimbabwe: a multilevel analysis. Reprod Health. 2014;11:64.

8. Van Stam M, Michielsen K, Stroeken K, Zijlstra B. The impact of education and globalization on sexual and reproductive health: retrospective evidence from eastern and southern Africa. AIDS Care. 2014;26(3):379-86.

9. Painter TM. Voluntary counseling and testing for couples: a high-leverage intervention for HIV/AIDS prevention in sub-Saharan Africa. Soc Sci Med. 2001;53(11):1397-411.

10. Bunnell R, Ekwaru JP, Solberg P, Wamai N, Bikaako-Kajura W, Were W, et al. Changes in sexual behavior and risk of HIV transmission after antiretroviral therapy and prevention interventions in rural Uganda. AIDS. 2006;20(1):85-92.

11. Sweat MD, Denison JA. Reducing HIV incidence in developing countries with structural and environmental interventions. AIDS. 1995;9(Suppl A):S251-7.

12. Whiteside A, Barnett T. AIDS in the twenty-first century: disease and globalization. Basingstoke: Palgrave Macmillan; 2002.

13. Baird SJ, Garfein RS, McIntosh CT, Ozler B. Effect of a cash transfer programme for schooling on prevalence of HIV and herpes simplex type 2 in Malawi: a cluster randomised trial. Lancet. 2012;379(9823):1320-9.

14. Grice JW. Computing and evaluating factor scores. Psychol Methods. 2001;6(4):430-50.

15. DiStefano C, Zhu M, Mîndrilă D. Understanding and Using Factor Scores: Considerations for the Applied Researcher. Prac Assess Res Eval. 2009;14(20).

16. McNeish D, Stapleton LM, Silverman RD. On the Unnecessary Ubiquity of Hierarchical Linear Modeling. Psychol Methods. 2017;22(1):114-140.

17. Zuilkowski SS, Jukes MC. The impact of education on sexual behavior in sub-Saharan Africa: a review of the evidence. AIDS Care. 2012;24(5):562-76.

18. Mugo NR, Heffron R, Donnell D, Wald A, Were EO, Rees H, et al. Increased risk of HIV-1 transmission in pregnancy: a prospective study among African HIV-1-serodiscordant couples. AIDS. 2011;25(15):1887-95.

19. van Lettow M, Bedell R, Landes M, Gawa L, Gatto S, Mayuni I, et al. Uptake and outcomes of a prevention-of mother-to-child transmission (PMTCT) program in Zomba district, Malawi. BMC Public Health. 2011;11:426,2458-11-426.

20. Cataldo F, Chiwaula L, Nkhata M, van Lettow M, Kasende F, Rosenberg NE, et al. Exploring the Experiences of Women and Health Care Workers in the Context of PMTCT Option B Plus in Malawi. J Acquir Immune Defic Syndr. 2017;74(5):517-22.

21. Okware S, Kinsman J, Onyango S, Opio A, Kaggwa P. Revisiting the ABC strategy: HIV prevention in Uganda in the era of antiretroviral therapy. Postgrad Med J. 2005;81(960):625-8.

22. Santelli JS, Speizer IS, Edelstein ZR. Abstinence promotion under PEPFAR: the shifting focus of HIV prevention for youth. Glob Public Health. 2013;8(1):1-12.

23. Voeten HACM, Egesah OB, Habbema JDF. Sexual Behavior Is More Risky in Rural Than in Urban Areas Among Young Women in Nyanza Province, Kenya. Sex Trans Dis. 2004;31(8):481-7.

24. Dodoo FN, Zulu EM, Ezeh AC. Urban–rural differences in the socioeconomic deprivation–Sexual behavior link in Kenya. Soc Sci Med. 2007 3;64(5):1019-31.

25. Uthman OA, Moradi T, Lawoko S. The independent contribution of individual-, neighbourhood-, and country-level socioeconomic position on attitudes towards intimate partner violence against women in sub-Saharan Africa: A multilevel model of direct and moderating effects. Soc Sci Med. 2009;68(10):1801-9.

26. Robertson L., Gregson S., Garnett GP. Sexual risk among orphaned adolescents: is country-level HIV prevalence an important factor? AIDS Care. 2010;22(8):927-38.

27. Stephenson R. Community-level gender equity and extramarital sexual risk-taking among married men in eight African countries. Int Perspect Sex Reprod Health. 2010;36(4):178-88.

28. Uthman OA., Lawoko S., Moradi T. The role of individual, community and societal gender inequality in forming women's attitudes toward intimate-partner violence against women: a multilevel analysis. World Health Popul. 2010;12(2):5-17.

29. Andersson N., Paredes-SolÃs S., Milne D., Omer K., Marokoane N., Laetsang D., et al. Prevalence and risk factors for forced or coerced sex among school-going youth: national cross-sectional studies in 10 southern African countries in 2003 and 2007. BMJ open. 2012;2(2):e000754.

30. Hung KJ, Scott J, Ricciotti HA, Johnson TR, Tsai AC. Community-Level and Individual-Level Influences of Intimate Partner Violence on Birth Spacing in Sub-Saharan Africa. Obstet Gynecol. 2012;119(5):975-82.

31. Uchudi J., Magadi M., Mostazir M. A multilevel analysis of the determinants of high-risk sexual behavior in sub-Saharan Africa. J Biosoc Sci. 2012;44(3):289-311.

32. Kamndaya M, Kazembe LN, Vearey J, Kabiru CW, Thomas L. Material deprivation and unemployment affect coercive sex among young people in the urban slums of Blantyre, Malawi: A multi-level approach. Health Place. 2015;33:90-100.

33. Magadi MA., Uchudi J. Onset of sexual activity among adolescents in HIV/AIDS-affected households in sub-Saharan Africa. J Biosoc Sci. 2015;47(2):238-57.

Tables and Figures

Table 3-1. Age and partner history factor loadings, by school enrolment status at baseline of the Schooling, Income, and Health Risk Study, Zomba, Malawi[a]

	Schoolgirls[b]		Dropouts[c]	
	Age Factor	Partner History Factor	Age Factor	Partner History Factor
Girls' age at sexual debut	0.88	--	0.83	--
Age when sexual relationship with last partner began	0.82	--	0.79	--
Number of lifetime partners	--	0.74	--	0.67
Number of partners in the last year	--	0.64	--	0.58
Frequency of sexual activity with last partner	--	0.54	--	0.44
An age difference with last partner of greater than five years	--	0.46	--	0.36

[a]Estimated using exploratory factor analysis (EFA) with principal factor analysis and varimax rotation. The number of eigenvalues greater than 1 was used as criteria for determining how many factors to retain. EFA was performed separately for the schoolgirl and dropout strata. Only participants indicating they were sexually active were included in the EFA. [b]Eigenvalues: 2.05 and 1.14. [c]Eigenvalues: 1.52 and 1.13.

Table 3-2. Characteristics of schoolgirls and dropouts in the control group at Round 2 of the Schooling, Income, and Health Risk study, Zomba district, Malawi

	Schoolgirls N=1,407 Weighted %[a]	**Dropouts** N=407 Weighted %[a]
Age- Mean (SD; range)	16.23 (2.34; 12-23)	18.57 (2.36; 13-25)
Girl's Highest Education Level		
Primary	54.09	72.73
Secondary or Higher	45.91	27.27
Ever Pregnant		
Yes	9.66	58.72
No	90.34	41.28
HIV Literacy Score- Mean (SD; range)	3.69 (0.67; 1-4)	3.67 (0.60; 1-4)
Risk Perception		
None/Low	92.94	89.19
Medium/High	7.06	10.81
Household's Highest Education Level		
Primary	26.98	45.91
Secondary or Higher	73.02	54.09
Residence		
Urban	34.95	18.67
Near Rural	55.83	68.55
Far Rural	9.23	12.78
Number of VCT Counsellors- Mean (SD; range)	6.03 (2.86; 0-11)	5.78 (2.32; 0-11)
Heath Care Facility Type		
Government	54.77	61.18
Other	45.23	38.82
Ever Had Sex		
Yes	24.22	78.38
No	75.78	21.62
Among those who had ever had sex:		
Condom Use		
Never/Sometimes/At the Beginning	65.17	86.14
Always/Almost Always	34.83	13.86
Partner History Factor- Mean (SD; range)	0.02 (0.74; -0.99-2.84)	0.00 (0.62; -1.09-2.10)
Number of Lifetime Partners- Mean (SD; range)	1.39 (0.81; 1.00-5.00)	1.76 (0.95; 1.00-6.00)
Number of Partners in the Last Year- Mean (SD; range)	0.76 (0.57; 0.00-3.00)	0.67 (0.56; 0.00-3.00)

Frequency of Sex with Last Partner		
Once or twice only	27.13	9.87
Less than twice per month	24.00	19.74
A couple of times per month	18.67	25.66
1-3 times per week	23.99	36.18
4 or more times per week	6.23	8.55
Had an Age Difference with Last Partner of Greater than Five Years	12.46	12.87
Age Factor- Mean (SD; range)	0.05 (0.99; -3.17-3.83)	0.00 (0.89; -2.57-2.26)
Age at Sexual Debut- Mean (SD; range)	15.69 (2.07; 1.00-22.00)	16.25 (1.86; 10.00-22.00)
Age when Sexual Relationship with Last Partner Began- Mean (SD; range)	16.34 (1.98; 11.00-22.00)	17.26 (2.26; 11.00-24.00)

SD = Standard Deviation. VCT = Voluntary Counselling and Testing.

[a]Weights were used to account for the sampling design of the Schooling, Income, and Health Risk study.

Table 3-3. Associations between multilevel factors and risky sexual behavior outcomes among young women in the schoolgirl stratum of the Schooling, Income, and Health Risk Study, Zomba district, Malawi

	Ever Had Sex[a,b] N=1,373 Adjusted OR (95% CI)	**Condom Use**[a,d] N=346 Adjusted OR (95% CI)	**Age Factor**[c,d] N=341 β (95% CI)
Age	1.74 (1.55, 1.95)	0.85 (0.75, 0.97)	--
Girl's Highest Education Level			
Primary	1.38 (0.97, 1.96)	0.55 (0.23, 1.35)	0.46 (0.26, 0.67)
Secondary or Higher	Ref	Ref	Ref
Ever Pregnant			
Yes	--	Ref	Ref
No	--	16.93 (6.79, 42.26)	0.06 (-0.17, 0.29)
HIV Literacy	1.19 (0.93, 1.53)	1.11 (0.68, 1.82)	0.03 (-0.09, 0.15)
Risk Perception			
None/Low	0.75 (0.51, 1.10)	1.26 (0.73, 2.03)	0.27 (-0.05, 0.59)
Medium/High	Ref	Ref	Ref
Household's Highest Education Level			
Primary	1.48 (1.06, 2.07)	0.68 (0.41, 1.12)	0.16 (-0.07, 0.39)
Secondary or Higher	Ref	Ref	Ref
Residence			
Urban	Ref	Ref	Ref
Near Rural	1.52 (1.19, 1.94)	0.47 (0.28, 0.78)	-0.36 (-0.56, -0.16)
Far Rural	1.35 (0.84, 2.17)	0.27 (0.11, 0.65)	-0.24 (-0.60, 0.13)
Number of VCT Counsellors	0.96 (0.88, 1.06)	1.04 (0.94, 1.14)	0.01 (-0.04, 0.06)
Health Care Facility Type[e]			
Government	Ref	Ref	Ref
Other	0.98 (0.66, 1.45)	0.98 (0.48, 1.98)	-0.18 (-0.40, 0.05)

OR=Odds Ratio. CI=Confidence Interval. VCT=Voluntary Counselling and Testing.

[a]Model estimated using logistic regression with cluster-robust standard errors. [b]34 observations were dropped from the final model due to incomplete information on the variables included. [c]Model estimated using linear regression with cluster-robust standard errors. [d]A total of 393 respondents indicated they had ever had sex. A complete case analysis was completed; observations were dropped from the models if they had incomplete information on the variables included. [e]If a participant was served by more than one health facility with differing numbers of VCT counsellors, data on facility type from the facility with the highest number of VCT counsellors was used. If a participant was served by two health facilities that employed the same number of VCT counsellors, the government facility was used. A sensitivity analysis using private facilities as the tie-breaker was conducted. Only four observations were affected, and there were virtually no changes in the estimates.

Table 3-4. Associations between multilevel factors and Partner History Factor score among young women in the schoolgirl stratum of the Schooling, Income, and Health Risk Study, Zomba district, Malawi

	Model 1[a] β (95% CI)	Model 2[b] β (95% CI)	Model 3[c] β (95% CI)
Age		0.02 (-0.02, 0.06)	0.02 (-0.02, 0.06)
Girl's Highest Education			
Primary	--	0.14 (-0.04, 0.31)	0.14 (-0.04, 0.31)
Secondary or Higher	--	Ref	Ref
Ever Pregnant	--		
Yes	--	Ref	Ref
No	--	-0.49 (-0.63, -0.36)	-0.49 (-0.63, -0.36)
HIV Literacy	--	0.04 (-0.09, 0.16)	0.04 (-0.09, 0.16)
Risk Perception	--		
None/Low	--	-0.01 (-0.23, 0.21)	-0.01 (-0.23, 0.21)
Medium/High	--	Ref	Ref
Household's Highest Education Level	--		
Primary	--	-0.05 (-0.24, 0.14)	-0.05 (-0.24, 0.14)
Secondary or Higher	--	Ref	Ref
Residence	--		
Urban	--	Ref	Ref
Near rural	--	-0.13 (-0.30, 0.05)	-0.11 (-0.29, 0.06)
Far Rural	--	-0.17 (-0.44, 0.10)	-0.16 (-0.43, 0.11)
Number of VCT Counsellors	--	--	0.01 (-0.03, 0.04)
Facility Type[d]			
Government	--	--	Ref
Other	--	--	0.01 (-0.20, 0.21)
Random Effects			
Individual-Level Variance	0.545 (p<0.001)	0.459 (p<0.001)	0.459 (p<0.001)
HF Variance	0.001 (p=0.441)	0.003 (p=0.327)	0.002 (p=0.391)

CI=Confidence Interval. VCT=Voluntary Counselling and Testing.

[a]Empty model. ICC=0.008. [b]Random intercepts model with individual covariates. [c]Random intercepts model with both individual and health facility covariates. Estimates of fixed effects were generally consistent with estimates from linear regression with cluster-robust standard errors; confidence intervals varied slightly but statistical significance did not change. In the final model, N=342. A total of 393 respondents indicated they had ever had sex. A complete case analysis was completed; observations were dropped from the models if they had incomplete information on the variables included. [d]If a participant was served by more than one health facility with differing numbers of VCT counsellors, data on facility type from the facility with the highest number of VCT counsellors was used. If a participant was served by two health facilities that employed the same number of VCT counsellors, the government facility was used. A sensitivity analysis using private facilities as the tie-breaker was conducted. Only four observations were affected, and there were virtually no changes in the estimates.

Table 3-5. Associations between multilevel factors and risky sexual behavior outcomes among young women in the school dropout stratum of the Schooling, Income, and Health Risk Study, Zomba district, Malawi

	Ever Had Sex[a] N=403 Adjusted OR (95% CI)	**Condom Use**[a,c] N=300 Adjusted OR (95% CI)	**Age Factor**[b,c] N=300 β (95% CI)	**Partner History Factor**[b,c] N=300 β (95% CI)
Age	1.70 (1.42, 2.04)	1.02 (0.81, 1.28)	--	0.03 (0.00, 0.06)
Girl's Highest Education				
Primary	1.41 (0.55, 3.62)	0.34 (0.11, 1.05)	0.47 (0.19, 0.76)	0.17 (0.04, 0.31)
Secondary or Higher	Ref	Ref	Ref	Ref
Ever Pregnant				
Yes	--	Ref	Ref	Ref
No	--	4.62 (2.25, 9.48)	-0.08 (-0.33, 0.17)	-0.20 (-0.36, -0.05)
HIV Literacy	1.27 (0.79, 2.03)	1.93 (1.11, 3.35)	-0.12 (-0.30, 0.06)	-0.08 (-0.18, 0.02)
Risk Perception				
None/Low	0.59 (0.28, 1.23)	0.35 (0.24, 0.53)	-0.02 (-0.31, 0.27)	-0.08 (-0.42, 0.25)
Medium/High	Ref	Ref	Ref	Ref
Household's Highest Education Level				
Primary	1.24 (0.62, 2.44)	0.78 (0.17, 3.71)	0.31 (0.05, 0.58)	0.08 (-0.09, 0.25)
Secondary or Higher	Ref	Ref	Ref	Ref
Residence				
Urban	Ref	Ref	Ref	Ref
Near Rural	1.88 (1.35, 2.62)	0.87 (0.59, 1.27)	0.01 (-0.27, 0.29)	-0.19 (-0.28, -0.10)
Far Rural	1.23 (0.48, 3.18)	0.43 (0.18, 1.00)	-0.05 (-0.37, 0.28)	-0.02 (-0.12, 0.09)
Number of VCT Counsellors	1.02 (0.91, 1.13)	1.15 (1.03, 1.29)	0.02 (-0.01, 0.05)	0.02 (0.003, 0.04)
Facility Type[d]				

Government	Ref	Ref	Ref	Ref
Other	1.05 (0.62, 1.79)	0.51 (0.39, 0.67)	-0.30 (-0.52, -0.09)	-0.23 (-0.30, -0.15)

OR=Odds Ratio. CI=Confidence Interval. VCT=Voluntary Counselling and Testing.

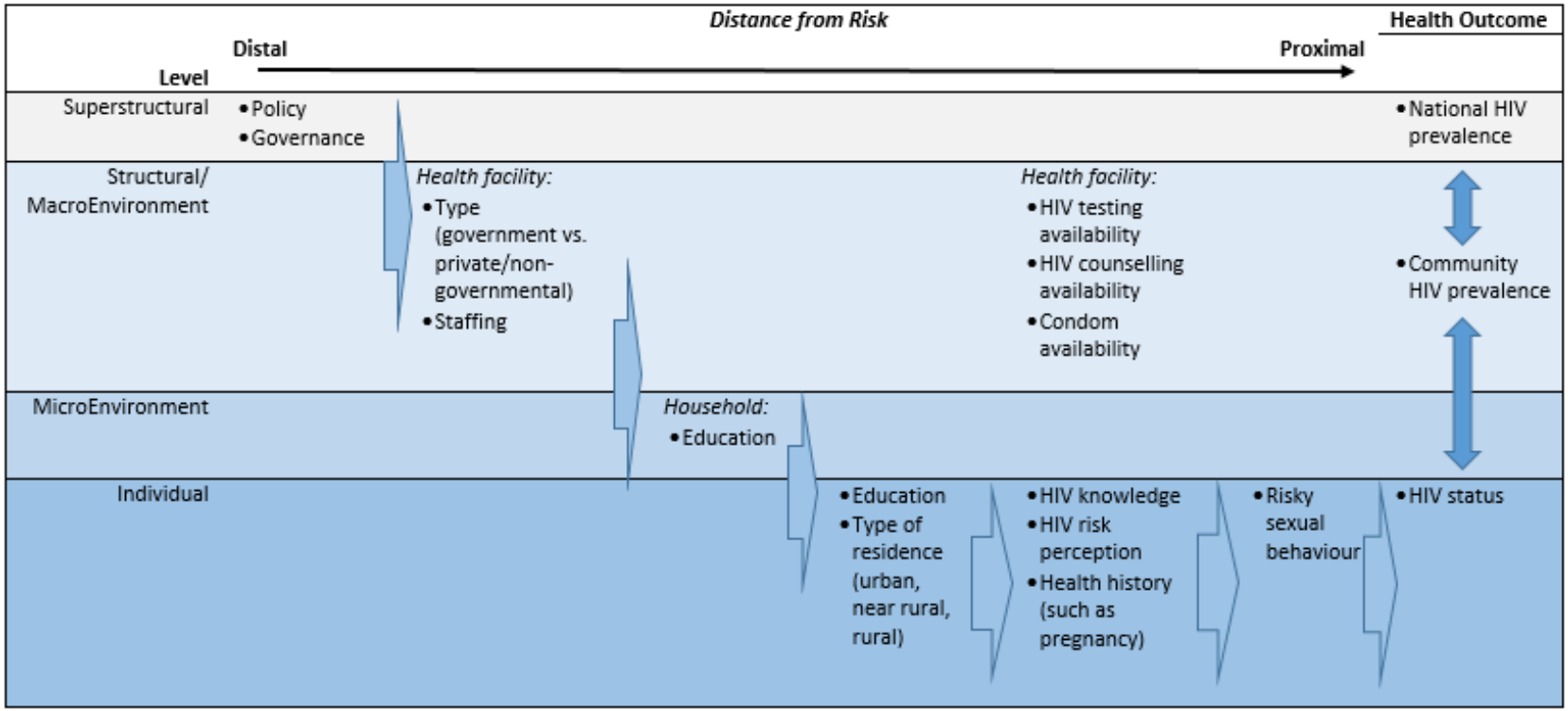
[a]Model estimated using logistic regression with cluster-robust standard errors.

[b]Model estimated using linear regression with cluster-robust standard errors.

[c]A total of 319 respondents indicated they had ever had sex. A complete case analysis was completed; observations were dropped from the models if they had incomplete information on the variables included.

[d]If a participant was served by more than one health facility with differing numbers of VCT counsellors, data on facility type from the facility with the highest number of VCT counsellors was used. If a participant was served by two health facilities that employed the same number of VCT counsellors, the government facility was used. A sensitivity analysis using private facilities as the tie-breaker was conducted. Only four observations were affected, and there were virtually no changes in the estimates.

Figure 3-1. Conceptual framework of the multilevel factors contributing to knowledge and awareness around risky sexual behavior and HIV status



Adapted from work by Barnett and Whiteside as well as Sweat and Denison (11,12).

CONCLUSIONS

Quantitatively, multilevel statistical models are utilized to examine the role of contextual factors in relation to health outcomes and to compare contextual factors to compositional, or individual-level, factors (1-6). Montgomery and Hewitt suggested the utility of such models has not been fully explored in developing nations (7). A systematic literature review was undertaken to describe their use in sub-Saharan Africa. Furthermore, data that were collected from the control group of the Schooling, Income and Health Risk study in Zomba District, Malawi, were analyzed from a multilevel perspective to assess the influence of contextual factors on risky sexual behavior (8).

To the author's knowledge, the systematic review presented in Manuscript 1 is the first to describe the use of multilevel models in evaluating the influence of contextual factors on HIV/AIDS, sexually transmitted infections, and risky sexual behavior in sub-Saharan Africa. The results of the studies included indicate numerous contextual factors, such as community-level poverty and education, are associated with a number of outcomes related to HIV/AIDS and risky sexual behavior. Nearly all studies consisted of a cross-sectional design, and most represented secondary data analysis, with Demographic and Health Surveys being the most frequently utilized data source. Only five of 118 included studies evaluated the impact of a contextual-level intervention for HIV/AIDS, representing the lack of evidence related to the causal mechanisms underlying associations between contextual factors and HIV/AIDS. Findings also highlighted the lack of standardized reporting guidelines for multilevel models and their potential value.

The results of the systematic review also revealed a lack of research evaluating indices of risky sexual behavior within the context of Malawi. Manuscript 2 set out to do so by examining as outcomes two indices measuring age during sexual activity and partner history, in addition to whether participants had ever had sex or regularly used condoms. The exposures of interest were measures of economic resources and women's empowerment at both individual and community levels. While various factors were associated with risky sexual behavior, the most consistent variables associated with risky sexual behavior were those related to education, including the girl's level of education and the highest level of education of her household of origin, and the community percentage of girls enrolled in school.

Manuscript 3 examined the same four measures of risky sexual behavior in relation to health facility characteristics and other factors related to HIV awareness. Age, educational status, and pregnancy history were associated with measures of risky sexual behavior among both schoolgirl and dropout strata. However, the types of contextual factors influencing risky sexual behavior varied by strata, with health facility characteristics being associated with risky behavior among the dropouts.

The use of indices related to age during sexual activity and partner history represent an attempt to move away from oversimplified constructs of risky sexual behavior. Findings from Malawi suggest that interventions and programs seeking to reduce risky sexual behavior among young women, thereby reducing their risk of HIV infection, should continue to focus on improving access to education at multiple levels. Further research is needed to fully elucidate reasons for increased risky sexual behavior

among women who have been pregnant and to explore differences in services provided by government and private/non-governmental health facilities. Given the recent focus on structural interventions to prevent HIV infection among adolescent women in sub-Saharan Africa, future studies utilizing multilevel statistical models should focus on contextual-level interventions in order to strengthen the evidence base for causality.

References

1. Larsen K, Merlo J. Appropriate assessment of neighborhood effects on individual health: integrating random and fixed effects in multilevel logistic regression. Am J Epidemiol. 2005 Jan 1;161(1):81-8.

2. Merlo J, Chaix B, Yang M, Lynch J, Rastam L. A brief conceptual tutorial of multilevel analysis in social epidemiology: linking the statistical concept of clustering to the idea of contextual phenomenon. J Epidemiol Community Health. 2005 Jun;59(6):443-9.

3. Merlo J, Chaix B, Yang M, Lynch J, Rastam L. A brief conceptual tutorial on multilevel analysis in social epidemiology: interpreting neighbourhood differences and the effect of neighbourhood characteristics on individual health. J Epidemiol Community Health. 2005 Dec;59(12):1022-8.

4. Merlo J, Yang M, Chaix B, Lynch J, Rastam L. A brief conceptual tutorial on multilevel analysis in social epidemiology: investigating contextual phenomena in different groups of people. J Epidemiol Community Health. 2005 Sep;59(9):729-36.

5. Merlo J, Chaix B, Ohlsson H, Beckman A, Johnell K, Hjerpe P, et al. A brief conceptual tutorial of multilevel analysis in social epidemiology: using measures of clustering in multilevel logistic regression to investigate contextual phenomena. J Epidemiol Community Health. 2006 Apr;60(4):290-7.

6. Sullivan LM, Dukes KA, Losina E. Tutorial in biostatistics. An introduction to hierarchical linear modelling. Stat Med. 1999 Apr 15;18(7):855-88.

7. Montgomery MR, Hewett PC. Urban poverty and health in developing countries: household and neighborhood effects. Demography. 2005 Aug;42(3):397-425.

8. Baird SJ, Garfein RS, McIntosh CT, Ozler B. Effect of a cash transfer programme for schooling on prevalence of HIV and herpes simplex type 2 in Malawi: a cluster randomised trial. Lancet. 2012 Apr 7;379(9823):1320-9.

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SELECTED PUBLICATIONS

Chen C, Baird S, Ssentongo K, Mehtsun S, Olapade-Olaopa, EO, Scott J, Sewankambo N, Talib Z, Ward-Peterson M, Haile Mariam D, & Rugarabamu, P. Physician tracking in sub-Saharan Africa: current initiatives and opportunities. Human Resources for Health. 2014;12:21.

Wilcox ML, Acuña JM, Ward-Peterson M, Alzayed A, Alghamdi M, Aldaham S. Racial/ethnic disparities in annual mammogram compliance among households in Little Haiti, Miami-Dade County, Florida: an observational study. Medicine. 2016;95(27):e3826.

Lupi C, Ward-Peterson M, Chang W**.** Advancing non-directive pregnancy options counseling skills: A pilot study on the use of blended learning with an online module and simulation. Contraception. 2016;94(4):348-352.

Lupi C, Ward-Peterson M, Coxe S, Minor S, Eliacin I, Obeso V. Furthering the validity of a tool to assess simulated pregnancy options counseling skills. Obstetrics & Gynecology. 2016;128(Suppl1):12S-16S.

Gauthreaux C, Negron J, Castellanos D, Ward-Peterson M**,** Castro, G, Rodriguez de la Vega, P, Acuña, JM. The association between pregnancy intendedness and post-partum depression in the United States, 2009-2011: A secondary analysis of PRAMS data. Medicine. 2017;96(6):e5851.

Pang H, Catald, M, Allseits E, Ward-Peterson M, Rodriguez de la Vega P, Castro G, Acuña JM. Association between possessing a continuous source of healthcare and adherence with cancer screenings among Haitian residents in Little Haiti, Miami-Dade County, Florida. Medicine. 2017; 96(32): e7706.

Ward-Peterson M, Fennie K, Baird S, Coxe S, Trepka M, Madhivanan P. Associations between health facility, household and individual factors related to HIV awareness and risky sexual behaviour among young women in Zomba district, Malawi. In Press, Journal of Biosocial Science.

Ward-Peterson M, Fennie K, Mauck D, Shakir M, Cosner C, Bhoite P, Trepka M, Madhivanan P. Using multilevel models to evaluate the influence of contextual factors on HIV/AIDS, STIs, and risky sexual behavior in sub-Saharan Africa: a systematic review. In Press, Annals of Epidemiology.

Ward-Peterson M, Fennie K, Baird S, Coxe S, Trepka M, Madhivanan P. Assessing the influence of women's empowerment and economic resources on risky sexual behavior among young women in Zomba district, Malawi: A multilevel exploration. Under Review, BMC Women's Health.