

Predictors of HIV, HIV Risk Perception, and HIV Worry Among Adolescent Girls and Young Women in Lilongwe, Malawi

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Background: Adolescent girls and young women (AGYW) in sub-Saharan Africa have high HIV prevalence and incidence. We sought to understand which HIV risk factors individually and in combination contribute to risk, and whether these factors are associated with HIV worry and risk perception.

Setting: This study is ongoing at 4 public health centers in Lilongwe, Malawi (2016–2017).

Methods: AGYW of 15–24 years old were recruited to participate in a study assessing 4 models of service delivery. At each health center, participants completed a baseline survey assessing socioeconomic, behavioral, biomedical, and partnership characteristics; self-reported HIV status; and, if HIV-uninfected, HIV risk perception (high versus low or none) and HIV worry (any versus none). We analyzed associations between baseline characteristics and HIV prevalence, risk perception, and worry.

Results: Among 1000 AGYW, median age was 19 years (IQR: 17–21). Thirty-three participants reported being HIV-infected. Fifteen characteristics were associated with HIV infection. Having more risk factors was associated with higher HIV prevalence (≤ 4 factors, 0.5%; 5–8 factors, 6%; > 8 factors, 21%). Having more risk factors

was also associated with higher risk perception ($P < 0.001$) and higher worry ($P < 0.001$). However, among those with ≥ 8 risk factors, 52% did not consider themselves to be at high risk and 21% did not report any HIV worry.

Conclusions: Most AGYW perceive little risk of HIV acquisition, even those at highest risk. As a critical gap in the HIV prevention cascade, accurate risk perception is needed to tailor effective and sustained combination prevention strategies for this vulnerable population.

Key Words: HIV prevention, risk factors, risk perception, adolescent girls, young women, Malawi

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BACKGROUND

Adolescent girls and young women (AGYW) in sub-Saharan Africa (SSA) shoulder a disproportionate burden of the HIV epidemic.¹ Nearly three-quarters of people aged 15–24 years living with HIV in SSA are AGYW, and they acquire HIV nearly a decade before men.¹ The high prevalence among AGYW has been attributed to behavioral,^{2–4} biological,^{5–8} and socioeconomic⁹ vulnerabilities. Although HIV incidence has declined in SSA overall,¹ gains have been slower for AGYW.^{10–12}

In Malawi, although the overall HIV prevalence has decreased from 10.6% to 8.8% from 2010 to 2015, it remains higher among women—particularly young women and adolescent girls—than among their male counterparts. Over 5 years, HIV prevalence in AGYW has remained at approximately 5%, whereas among young men and boys, it has decreased from 1.9% to 1.0%.^{13,14} In urban Malawi, the disparity is starker: 9.1% of AGYW are HIV-infected compared with 1.0% of young men and boys.¹³

HIV risk is not evenly distributed in all AGYW. The World Health Organization recommends pre-exposure prophylaxis (PrEP) to reduce the HIV risk in populations with incidence ≥ 3 per 100 person-years and for individuals at substantial risk.¹⁵ Determining which AGYW in SSA meet these definitions is challenging, yet important.^{10,16} Much of the analysis to date has been conducted in South Africa among trial participants,^{17–19} and understanding regional variation is critical.

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Risk perception is a key element in the HIV prevention cascade and is especially important in light of new biomedical technologies. For example, despite PrEP being efficacious among adherent young women, PrEP effectiveness has varied among AGYW, largely because of adherence challenges.^{20–22} Ensuring sustained adherence to proven effective strategies, including PrEP, relies on accurate individual risk perception as a first step in the prevention cascade.^{23,24} Despite widespread education on HIV transmission and behavioral risk reduction, and an emerging focus on biomedical prevention in Malawian media and institutional discourse,^{25–27} only 41% of AGYW demonstrate comprehensive basic behavioral knowledge of HIV.¹³ Poor understanding of partnership and structural factors that may increase risk could sustain high rates of incidence in some groups and render preventive interventions ineffective. Thus, before scaling up new prevention programs, there is an urgent need to determine whether high-risk individuals accurately perceive their HIV risk.¹⁷

In this paper, we aimed (1) to identify the socioeconomic, behavioral, biomedical, and partnership factors associated with HIV infection among AGYW in Lilongwe, Malawi; (2) to understand the factors associated with risk perception and worry; and (3) to determine whether presence of more risk factors predicts higher prevalence of HIV infection, risk perception, and worry.

METHODS

Study Design, Setting, and Population

The Girl Power study was conducted at 4 health centers each in Lilongwe, Malawi and Western Cape, South Africa. This analysis is restricted to the Malawi sites. Girl Power is assessing 4 different models of service delivery for AGYW: (1) standard of care (no intervention), (2) youth-friendly health services (YFHS), (3) YFHS + empowerment sessions, (4) YFHS + empowerment sessions + cash transfer. Four comparable clinics were selected and randomly assigned to one service delivery model.

At each site, 250 AGYW were enrolled. Participants were recruited from the community and were eligible if they were 15–24 years old, from the clinic’s catchment area, and willing to provide locator information. Sexually active AGYW were purposively recruited. Participants were followed for 1 year. This is a cross-sectional analysis of baseline self-reported behavioral survey data.

Data Collection and Management

We performed a baseline survey in the full Malawian cohort assessing socioeconomic, individual behavioral and biomedical, and partnership characteristics; self-reported HIV status; and HIV risk perception and worry. Trained young female research officers administered surveys on electronic tablets using Open Data Kit software.²⁸ Interviews were conducted in Chichewa and lasted 1–1.5 hours.

Outcomes of Interest

Baseline HIV status was elicited by asking participants if they had ever been tested for HIV and, if so, the most recent

result. A dichotomous variable indicated those who reported being HIV-infected versus either HIV-uninfected or HIV status unknown. This specification was selected because all HIV-uninfected and HIV-unknown persons could perceive themselves to be at risk. HIV “risk perception” was elicited from those who did not report being HIV-infected. These participants were asked their perceived lifetime chance of acquiring HIV, with possible responses: “no chance,” “small chance,” or “high chance.” This variable was dichotomized into those participants who perceived a “high chance” versus all other responses. A second question asked participants how much they agreed or disagreed with the statement, “I worry a lot about getting infected with HIV,” with possible responses: “strongly disagree,” “disagree,” “neutral,” “agree,” and “strongly agree.” This variable (HIV worry) was dichotomized as those who agreed or strongly agreed versus other responses.

Exposures of Interest

Exposures of interest were obtained from questions in 4 domains: socioeconomic, individual behavioral, individual biomedical, and sexual partnership factors. Each exposure variable associated with HIV infection and not already dichotomous was then dichotomized to allow for an analysis of association between having multiple risk factors and HIV prevalence, HIV risk perception, and HIV worry.

Socioeconomic Factors

- Participant age was dichotomized into 15–19 years old versus 20–24 years old.
- Educational attainment was dichotomized into those who had completed primary school versus those who had not.
- Type of flooring in the participant’s house was indicated as either earth or sand versus cement, tile or other types.
- Running water and electricity were each dichotomous variables indicating whether participants had access in the home.
- Asset score was the sum of household assets from a list of 14 items.¹³ This was dichotomized into ≤ 2 versus > 2 .
- Marital status was dichotomized into single and not living with a partner versus married and/or living with a partner.
- Orphan status was dichotomized into either one or both parents still alive versus both parents deceased (double orphan).
- Participant travel was defined as having slept away from home on ≥ 3 nights during the past year.

Individual Behavioral Factors

- Age at first sexual intercourse was elicited from each participant and dichotomized into < 15 versus ≥ 15 years.
- Forced first sex was a dichotomous variable indicating whether the participants’ first sexual encounter was perceived as forced or consensual.

- Consistent condom use was a dichotomous variable indicating whether or not the participant reported “always” using male or female condoms.
- Number of sexual partners in the last year was dichotomized into either <3 versus ≥ 3 different sexual partners in the last year based on self report.
- Participants were asked about any drinking, frequency of drinking in a typical week, and quantity per occasion. Heavy drinking was defined as consuming ≥ 8 drinks per week or ≥ 4 drinks per occasion.²⁹

Individual Biomedical Factors

- Sexually transmitted infection (STI) symptoms were defined as reporting abnormal vaginal discharge and/or genital sores or ulcers within the past 6 months.
- Pregnancy history indicated whether or not the participant had ever been or was currently pregnant.

Sexual Partnership Factors

Participants were asked about their 3 most recent sexual partners in a partner grid.

- Partner travel was defined as the cohabiting partner having slept away from home ≥ 3 times during the past year.
- Partner financial or material support indicated whether any partner had given the participant money or items like groceries, clothes, or phone minutes to help her get by.
- Transactional sex was elicited by asking participants if they felt like they had to have sex with any partner in exchange for receiving money or other items.
- An uncircumcised partner was defined as any partner believed not to be circumcised.
- Partner concurrency was defined as the participant believing a sexual partner had one or more other partners during the time they were sexually active.
- An older partner was any partner the participant reported to be ≥ 10 years older than herself.
- Perceived HIV status of each sexual partner was elicited from the participants. An HIV-positive partner was one who the participant knew to be HIV-infected.
- The partner violence score was based on a validated 17-item scale that was adapted to this setting.¹³ Affirmative answers to yes and no questions were summed to produce a continuous variable that was subsequently categorized into 3 levels: 0–3; 4–7; and ≥ 8 .

Data Analysis

We examined frequencies and percentages of each categorical variable and assessed their relationship to HIV status using Pearson’s χ^2 tests. Variables associated with HIV status ($P \leq 0.15$) were considered risk factors. We fit individual models of each of these risk factors with self-reported HIV infection to estimate adjusted prevalence ratios

(aPR) and 95% confidence intervals (CI), adjusting each model for age as a continuous variable, a known confounder. We then assessed whether having more risk factors was associated with a higher probability of HIV infection.

Among participants who reported a negative or unknown HIV status, we performed bivariable tests of association between risk factors and HIV risk perception and HIV worry. We then fit models of each risk factor separately for HIV risk perception and HIV worry to estimate aPRs and 95% CIs, adjusting each model for age. Analyses were performed using Stata statistical software (release 14, College Station, TX).

Ethical Approvals

The University of North Carolina Institutional Review Board and Malawi’s National Health Sciences Research Committee granted approval to conduct this study. Voluntary written informed consent was obtained from persons 18–24 years old. Assent and permission by a parent, guardian, or authorized representative were obtained from adolescents 15–17 years old. All consent procedures were read aloud and, in cases of limited literacy, an impartial witness was present.

RESULTS

One thousand AGYW participated in the survey (Table 1). Median age was 19 years old (IQR: 17–21). Thirty-three participants reported being HIV-infected; of the remaining 967, 69% reported an HIV-negative test within the past 6 months, 17% reported an HIV-negative test >6 months prior, and 14% had never tested.

Socioeconomic Factors and HIV Infection

Self-reported HIV infection was higher among older participants: 2% of participants <20 years reported HIV infection compared with 5% of those ≥ 20 years old. Most participants (71%) had finished primary school. A majority (57%) reported not having running water in their home; 61% reported having ≤ 2 household assets. Two-thirds reported both parents being alive; 26% were single orphans and 8% were double orphans. Not having running water, having ≤ 2 household assets, and being a double orphan were associated with HIV infection in bivariable analysis. After adjusting for age, not having running water (aPR 3.10, 95% CI: 1.26 to 7.63) remained associated with prevalent HIV.

Individual Behavioral Factors and HIV Infection

First sexual intercourse <15 years old was reported by 18% of participants. Forced first sexual intercourse was reported by 45%. HIV status was not associated with either of these variables. Most participants either never used condoms (19%) or used them inconsistently (50%). HIV status was not associated with consistent condom use. In the past year, most (78%) respondents had ≤ 1 sexual partner, 16% had 2, and 6% had ≥ 3 partners. Respondents with ≥ 3 sexual partners in the past year had higher prevalence of HIV

TABLE 1. Baseline Characteristics of Adolescent Girls and Young Women in Lilongwe, Malawi by Self-Reported HIV Status, N = 1000

Characteristic	Reported HIV- or Unknown (N = 967)		Reported HIV+ (N = 33)		P†
	N	%*	N	%*	
Socioeconomic factors					
Age, yrs					
15–19	566	58	11	33	0.004
20–24	401	42	22	67	
Educational attainment					
No	273	29	14	42	0.08
Yes	684	71	19	58	
Missing	10		0		
Type of flooring in house					
Earth/Sand	291	30	12	36	0.4
Cement/Tile/Other	675	70	21	64	
Missing	1		0		
Running water in house					
No	542	56	27	82	0.003
Yes	425	44	6	18	
Electricity in house					
No	603	62	20	61	0.8
Yes	362	38	13	39	
Missing	2		0		
Household asset score					
≤2	376	39	19	58	0.03
>2	591	61	14	42	
Marital status					
Single and/or not living with partner	755	78	24	72	0.5
Married and/or living with partner	212	22	9	27	
Orphan status					
One or both parents alive	888	92	26	79	0.006
Both parents deceased	76	8	7	21	
Missing	3		0		
Participant travel in last year					
<3 times	737	76	23	70	0.4
≥3 times	229	24	10	30	
Missing	1		0		
Individual behavioral factors					
Age at first sexual intercourse					
<15	170	18	8	24	0.3
≥15	791	82	25	76	
Missing	6		0		
Forced first sex					
No	525	45	17	52	0.5
Yes	432	55	16	48	
Missing	6				
Consistent condom use					
No	666	69	22	67	0.7
Yes	296	31	11	33	
Missing	5				
No. of sexual partners in last year					
<3	915	95	27	82	0.002
≥3	52	5	6	18	
Heavy alcohol use					
No	925	96	25	76	<0.001
Yes	42	4	8	24	

TABLE 1. (Continued) Baseline Characteristics of Adolescent Girls and Young Women in Lilongwe, Malawi by Self-Reported HIV Status, N = 1000

Characteristic	Reported HIV- or Unknown (N = 967)		Reported HIV+ (N = 33)		P†
	N	%*	N	%*	
Individual biomedical factors					
Symptoms of STI					
No	725	75	21	64	0.1
Yes	240	25	12	36	
Missing	2		0		
Pregnancy history					
No	563	58	7	22	<0.001
Yes	401	42	25	78	
Missing	3		1		
Sexual partnership factors					
Partners' travel in last year					
<3 times	129	65	2	22	0.01
≥3 times	70	35	7	78	
Missing/No partner	768		24		
Partners' financial or material support					
No	42	4	1	3	0.7
Yes	919	95	32	97	
Missing	6		0		
Transactional sex					
No	763	79	20	61	0.01
Yes	201	21	13	39	
Missing	3		0		
Uncircumcised partner					
No	417	43	5	15	0.003
Yes	475	49	23	70	
Don't know	68	7	5	15	
Missing/no partner	7		0		
Partner concurrency					
No	358	37	2	6	<0.001
Yes	468	49	30	91	
Don't know	134	14	1	3	
Missing/no partner	7		0		
Older partner					
No	906	94	27	82	0.005
Yes	58	6	6	18	
Missing/no partner	3		0		
HIV-positive partner					
No	960	>99	28	85	<0.001
Yes	3	<1	5	15	
Missing/no partner	4		0		
Partner violence score					
0-3	417	43	10	30	0.3
4-7	335	35	14	42	
8+	215	22	9	27	

*Percents may not equal 100 because of rounding.

†Categorical correlations and P-values based on Pearson's χ^2 .

STI, sexually transmitted infection.

infection (10%) than those who had <3 partners in the past year (3%). Alcohol use was reported by 37% of respondents; 14% of those reported heavy drinking. HIV infection was more prevalent among those participants who reported heavy

drinking (16%) than those who did not (3%). After adjusting for age, ≥3 sexual partners in past year (aPR: 3.49, 95% CI: 1.35 to 9.02) and heavy alcohol use (aPR: 5.80, 95% CI: 2.40 to 14.02) were associated with HIV infection.

Individual Biomedical Factors and HIV Infection

One quarter of participants reported sexually transmitted infection symptoms in the past 6 months. HIV prevalence was higher among women who reported sexually transmitted infection symptoms (5%) than among those who did not (3%). Participants who had ever been pregnant had higher HIV prevalence (6%) than those who had never been pregnant (1%). Pregnancy history remained associated with HIV infection after adjusting for age (aPR: 2.97, 95% CI: 1.16 to 7.61).

Sexual Partnership Factors and HIV Infection

Approximately one-third of the 221 participants with a cohabiting partner reported that their partner slept away from home ≥ 3 times over the past year. HIV prevalence was higher among those reporting partner travel (9%) than those not (2%). Half reported that ≥ 1 partner was uncircumcised. Respondents who reported having an uncircumcised partner had higher HIV prevalence (5%) than those reporting partner circumcision (2%).

Eight participants reported having a partner with known HIV infection. HIV infection was more common among participants with an HIV-positive partner (15%) than among those with unknown or HIV-negative partners (0.3%). Half of participants reported that their partner had a concurrent partner, 14% reported not knowing, and 36% reported that their partners did not have another partner. Participants reporting partner concurrency had higher prevalence of HIV infection (6%) compared with those who did not (0.6%). Most participants (94%) had partners who were < 10 years older. Those who reported a partner ≥ 10 years older had higher HIV prevalence (9%) than those who did not (3%). Transactional sex was reported by 21%. HIV infection was more common among those reporting transactional sex (6%) than among those denying transactional sex (3%). Partner violence was prevalent—82% reported emotional violence, 36% reported physical violence, and 46% reported sexual violence—but no type of violence was associated with HIV infection.

After adjusting for age, partner travel (aPR: 7.00, 95% CI: 1.37 to 35.78), transactional sex (aPR: 2.26, 95% CI: 1.10 to 4.67), uncircumcised partner (aPR: 2.40, 95% CI: 1.00 to 5.80), partner concurrency (aPR: 8.27, 95% CI: 2.48 to 27.60), and an HIV-positive partner (aPR: 51.70, 95% CI: 10.78 to 248.01) were each associated with reported HIV.

Multiple Risk Factors and HIV Infection

In total, 15 risk factors were associated with HIV infection. Among all respondents, the median number of risk factors was 4 (IQR: 2–6). Fifty-nine percent had ≤ 4 , 37% had 5–8, and 4% had > 8 risk factors. Having more risk factors was associated with a higher prevalence of HIV infection: 0.5% among those with ≤ 4 risk factors; 6% among those with 5–8 risk factors; and 21% among those with > 8 risk factors ($P < 0.001$) (Fig. 1).

HIV Risk Perception

Of the participants who reported being HIV-uninfected or of unknown HIV status, 27% ($n = 831$) and 26% ($n = 135$),

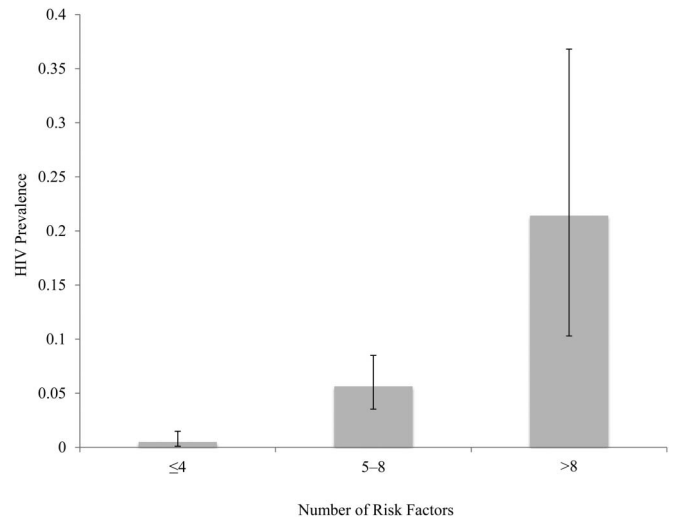


FIGURE 1. Prevalence of HIV infection increases with number of risk factors among adolescent girls and young women in Lilongwe, Malawi, $N = 1000$.

reported high HIV risk perception, respectively. Ten of the 15 risk factors associated with HIV infection were individually associated with high HIV risk perception (Table 2). The presence of more HIV risk factors was associated with higher HIV risk perception ($P < 0.001$) (Fig. 2). However, 63% of 384 women with ≥ 5 risk factors did not perceive themselves to be at high risk of HIV; and 52% of 33 women with > 8 risk factors did not perceive themselves to be at high risk.

After adjusting for age, no running water (aPR: 1.82, 95% CI: 1.35 to 2.45), ≤ 2 household assets (aPR: 1.55, 95% CI: 1.16 to 2.07), pregnancy history (aPR: 1.77, 95% CI: 1.27 to 2.47), partner travel (aPR: 2.48, 95% CI: 1.34 to 4.61), partner concurrency (aPR: 2.33, 95% CI: 1.72 to 3.15), and transactional sex (aPR: 1.92, 95% CI: 1.37 to 2.67) were associated with high HIV risk perception (Table 3). These six variables remained significant predictors of risk perception when the analysis was restricted to participants who reported being HIV-uninfected.

HIV Worry

Among participants who reported being HIV-negative or of unknown HIV status, 62% ($n = 813$) and 60% ($n = 131$) reported worrying about acquiring HIV, respectively. Nine of the 15 risk factors associated with HIV infection were associated with HIV worry (Table 2). Having more risk factors was associated with a higher probability of HIV worry ($P < 0.001$) (Fig. 2). However, 33% of those with ≥ 5 risk factors and 21% with > 8 risk factors did not worry about acquiring HIV.

After adjusting for age, partner travel (aPR: 2.87, 95% CI: 1.43 to 5.77), partner concurrency (aPR: 1.98, 95% CI: 1.50 to 2.60), and an older partner (aPR: 2.96, 95% CI: 1.42 to 6.16) were each significant predictors of HIV worry (Table 3). These 3 variables remained significant predictors of worry after restricting the analysis to participants who reported being HIV-uninfected.

TABLE 2. Bivariable Analysis of HIV Risk Perception (N = 966) and Worry (N = 944) by Risk Factors Associated With HIV Infection Among At-Risk Adolescent Girls and Young Women in Lilongwe, Malawi

Risk Factor	HIV Risk Perception*			HIV Worry*		
	No/Small Risk, % (N = 706)†	High Risk, % (N = 260)†	P‡	No Worry, % (N = 361)†	Worry, % (N = 583)†	P‡
Age 15–19	61	51	0.005	66	55	0.001
Age 20–24	39	49		34	45	
Completed primary school	74	64	0.002	71	71	0.9
Did not complete primary school	26	36		29	29	
Running water	48	33	<0.001	44	43	0.8
No running water	52	67		56	57	
>2 household assets	64	53	0.001	61	61	0.8
≤2 household assets	36	47		38	39	
One or both parents alive	92	92	0.9	90	94	0.02
Both parents deceased	8	8		10	6	
<3 sexual partners in past year	95	93	0.1	97	94	0.04
≥3 sexual partners in past year	5	7		3	6	
Not heavy alcohol	96	95	0.8	97	95	0.2
Heavy alcohol use	4	5		3	5	
No STI symptoms	75	76	0.8	79	73	0.06
STI symptoms	25	24		21	27	
Never pregnant	63	47	<0.001	64	55	0.004
Ever pregnant	37	53		36	45	
Partner slept <3 nights away	72	51	0.003	80	58	0.002
Partner slept ≥3 nights away§	28	49		20	42	
No transactional sex	82	71	<0.001	82	77	0.06
Transactional sex	18	29		18	23	
Partner circumcised	45	40	0.2	45	42	0.2
Partner uncircumcised/Unknown	55	60		55	58	
Partner has no other partners	42	23	<0.001	48	31	<0.001
Partner has other partners/Unknown	58	77		52	69	
Partner <10 yrs older	95	90	0.002	98	92	<0.001
Partner ≥10 yrs older	5	10		3	8	
No known HIV+ partner	100	100	0.3	100	100	0.9
Partner HIV+	0	0		0	0	

*Missing answer to question on HIV risk perception N = 1; missing answer to question on HIV worry N = 23.

†Percents may not equal 100 because of rounding.

‡P-values based on Pearson's χ^2 .

§N = 212, reflecting only cohabiting participants.

STI, sexually transmitted infection.

DISCUSSION

In this cross-sectional analysis of HIV risk factors, risk perception, and worry among AGYW in Malawi, we found 15 socioeconomic, behavioral, biomedical, and partnership factors associated with HIV infection. Having more of these factors predicted higher prevalence of HIV infection, higher

lifetime HIV risk perception, and higher HIV infection worry. Despite these associations, most AGYW, including the majority of those at highest risk for HIV, did not report high risk perception.

Our findings suggest that the context of sexual behavior may predict HIV prevalence more than individual behaviors

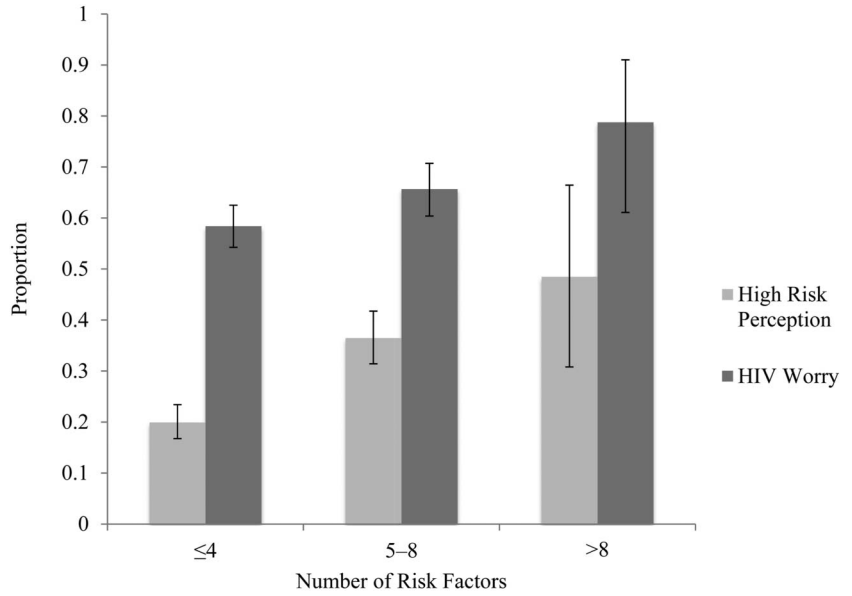


FIGURE 2. Prevalence of high HIV risk perception (N = 966) and HIV worry (N = 944) increases with number of HIV risk factors among adolescent girls and young women in Lilongwe, Malawi.

themselves. Although number of sexual partners in the past year was predictive of HIV infection, 2 other key female sexual behaviors—age of debut and consistent condom use—each a focus of HIV prevention programs among young women,^{30,31} were not associated with HIV status in our study.

Causal associations are difficult to infer using cross-sectional data alone. Condom use may have a strong reciprocal relationship with both perceived risk and risky sexual behavior, and it is possible that other factors such as the circumstances of sexual initiation and partner factors may be more salient than age at debut. We noted a strong association between HIV status and heavy alcohol use, a contextual behavior that may result in disinhibited sexual activity with high-risk partners.³²⁻³⁴ Similarly, no running water was associated with HIV status, suggesting that socioeconomic status may play a role in HIV risk. Although particular socioeconomic risk factors may vary across settings, many are modifiable through social protection approaches.³⁵

In our study, more sources of vulnerability were associated with higher HIV prevalence, consistent with risk scores demonstrating that more risk factors are associated with higher risk of HIV acquisition^{17,19} and with observations that more sources of social protection are associated with fewer risky behaviors, better utilization of preventive strategies, and lower probability of unintended pregnancy among AGYW.^{36,37} Social protection, behavioral, and biomedical interventions that aim to mitigate vulnerabilities in combination could produce greater impacts on HIV prevention than single-domain HIV prevention.³⁵

Although the majority of HIV-uninfected participants had at least one risk factor, few had >8, the level associated with the highest HIV prevalence. This observation suggests that identifying a small subset of women at highest risk of HIV infection is possible. Such identification is important because it would allow for PrEP targeting to those at highest risk. Replicating these findings in a larger cohort with an HIV incidence outcome is a critical next step.

HIV risk factors were moderately aligned with HIV risk perception and worry among uninfected AGYW. Overall, partnership factors (eg, partner travel, partner concurrency, transactional sex, older partner) were more strongly correlated with HIV risk perception and worry than individual behavioral factors (eg, heavy alcohol use, ≥ 3 sexual partners over the past year, older partner). Previous research has shown that Malawian women worry most about infection from partners; and primary individual behavioral strategies to prevent HIV often focus on modifying key partnership characteristics.^{25,38} Partner-specific risk factors are known to influence individual risk perception and can drive safer sex behavior and willingness to use biomedical prevention strategies.³⁹ Even so, perception of partner concurrency was associated with an 8-fold increase in HIV prevalence, but only a 2-fold increase in risk perception or worry. Heavy alcohol use, strongly predictive of HIV infection in our study and the region,^{17,32,33,40,41} predicted neither high perceived risk nor worry. Similarly, although female HIV prevalence increases with number of sexual partners in our study and in the region,^{13,19} having ≥ 3 sexual partners in the past year did not predict HIV risk perception or worry. Discrepancies between the presence or magnitude of association between factors associated with HIV infection and factors predictive of risk perception or worry represent opportunities for education in vulnerable populations.

A large proportion of women with multiple HIV risk factors did not perceive themselves to be at high risk. This may be because risk is multifactorial, with a number of the identified factors (eg, no running water, household assets, orphanhood) being demographic and/or structural rather than more proximal behavioral factors. The successful application of prevention services depends on at-risk individuals first perceiving risk, accessing services, and adopting behavioral changes and biomedical interventions designed to mitigate that risk.²⁴ Furthermore, long-term effectiveness of preventive strategies will depend on maintained risk perception among those who face ongoing risk. In PrEP trials among

TABLE 3. Adjusted Prevalence Ratios of Factors Associated With Known HIV Infection (N = 1000), High HIV Risk Perception (N = 966) and HIV Infection Worry (N = 944) Among Adolescent Girls and Young Women in Lilongwe, Malawi

Risk Factor	Reported HIV Infection	HIV Risk Perception*	HIV Worry*
	Adjusted PR,† (95% CI)	Adjusted PR,† (95% CI)	Adjusted PR,† (95% CI)
Completed primary school	1.00	1.00	1.00
Did not complete primary school	1.88 (0.92 to 3.83)	1.68 (1.23 to 2.29)	1.05 (0.78 to 1.41)
Running water	1.00	1.00	1.00
No running water	3.10 (1.26 to 7.63)	1.82 (1.35 to 2.45)	1.01 (0.78 to 1.32)
>2 assets	1.00	1.00	1.00
≤2 assets	1.79 (0.88 to 3.67)	1.55 (1.16 to 2.07)	0.98 (0.75 to 1.29)
One or both parents alive	1.00	1.00	1.00
Both parents deceased	2.21 (0.91 to 5.41)	0.92 (0.54 to 1.57)	0.49 (0.30 to 0.79)
<3 sexual partners in past year	1.00	1.00	1.00
≥3 sexual partners in past year	3.49 (1.35 to 9.02)	1.58 (0.88 to 2.84)	1.92 (0.98 to 3.75)
Not heavy alcohol use	1.00	1.00	1.00
Heavy alcohol use	5.80 (2.40 to 14.02)	1.06 (0.53 to 2.11)	1.85 (0.89 to 3.84)
No STI symptoms in past 6 mo	1.00	1.00	1.00
STI symptoms in past 6 mo	1.66 (0.80 to 3.46)	0.94 (0.67 to 1.31)	1.34 (0.98 to 1.83)
Never pregnant	1.00	1.00	1.00
Ever pregnant	2.97 (1.16 to 7.61)	1.77 (1.27 to 2.47)	1.23 (0.90 to 1.68)
Partner slept <3 nights away	1.00	1.00	1.00
Partner slept ≥3 nights away‡	7.00 (1.37 to 35.78)	2.48 (1.34 to 4.61)	2.87 (1.43 to 5.77)
No transactional sex	1.00	1.00	1.00
Transactional sex	2.26 (1.10 to 4.67)	1.92 (1.37 to 2.67)	1.36 (0.98 to 1.91)
Partner circumcised	1.00	1.00	1.00
Partner uncircumcised	2.40 (1.00 to 5.80)	1.13 (0.83 to 1.53)	1.07 (0.81 to 1.42)
Partner has no other partners	1.00	1.00	1.00
Partner has ≥1 other partners/Unknown	8.27 (2.48 to 27.60)	2.33 (1.72 to 3.15)	1.98 (1.50 to 2.60)
Partner <10 yrs older	1.00	1.00	1.00
Partner ≥10 yrs older	2.20 (0.84 to 5.77)	2.03 (1.17 to 3.52)	2.96 (1.42 to 6.16)
No known HIV+ Partner	1.00	—§	1.00
Partner HIV+	51.70 (10.78 to 248.01)		1.35 (0.12 to 15.14)

*Analyses only completed among the 967 respondents who did not report known HIV infection. Missing HIV risk perception responses N = 1; missing HIV worry responses N = 23.

†All PRs adjusted for age.

‡N = 221, reflecting only cohabiting participants. For PR calculations, this variable was transformed into a 3-level variable: (1) not cohabiting; (2) cohabiting partner slept <3 nights away in the past year; (3) cohabiting partner slept ≥3 nights away in the past year and the reported PR reflects the ratio of the outcome variable between the latter 2 categories.

§PR could not be calculated given zero observations in one category (zero responses of “high risk perception” among 3 women who reported having a HIV-positive partner). PR, prevalence ratio; STI, sexually transmitted infection.

young women in SSA, risk perception was associated with pill adherence,^{42–45} the strongest predictor of PrEP efficacy.^{46–50} In the FEM-PrEP trial, half the participants who seroconverted had not perceived themselves to be at any risk of HIV infection, despite participation in an HIV prevention trial targeted at a high-risk population.⁴³

More participants reported HIV acquisition worry than high lifetime risk perception. By including one cognitive measure (perceived likelihood of infection) and one intuitive measure (worry of becoming infected), we aimed to explore whether one metric was more sensitive in measuring participants’ understanding of individual risk.⁵¹ Although worry was more common than high risk perception, some factors associated with worry were not associated with risk perception (eg, older partner), whereas others predicted high risk perception but not worry (eg, transactional sex). Given the discrepancies between worry and perceived risk, future

studies could determine the optimal metric or set of metrics that best aligns risk perception with likelihood of HIV acquisition.

Our study design presents several limitations. First, because of the cross-sectional nature of the data, we cannot infer causality between participant characteristics and HIV prevalence. Whereas in young women many infections are likely to be recent, a few of those infected may have been perinatally infected, such that the identified risk factors would not be relevant. However, based on staff interactions with participants, perinatal infection was uncommon in our study and most participants with HIV reported that their most recent diagnostic HIV test had been within the last 2 years. Second, these results are based on self report, and AGYW may have been HIV-infected, but not known it or reported it. Although a cross-sectional survey based on self report may have limited our risk factor analysis, it had less effect on our analyses of

risk perception and worry because persons with unknown HIV status could still perceive themselves as at-risk. Third, interviewer-administered surveys can cause misreporting of HIV status, sexual behaviors, and socioeconomic markers because of social desirability or memory challenges. Finally, although single-item HIV risk perception assessments are common,^{52–55} multidimensional tools may elicit perceived risk more accurately.^{56,57}

It has long been recognized that HIV incidence is disproportionately high among AGYW in SSA, but less clear which women are at highest risk and whether these women accurately perceive this risk. Our work shows that it is indeed possible to identify these women, but additional work is needed to help them appreciate their own risk and then seek and adhere to appropriate prevention strategies. Identifying the most vulnerable and developing strategies to enhance risk perception will bring us one step closer to reducing HIV incidence.

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