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Did National HIV Prevention Programs Contribute to HIV Decline in Eastern Zimbabwe? Evidence From a Prospective Community Survey

Simon Gregson, DPhil^{*,†}, Constance Nyamukapa, PhD^{*,†}, Christina Schumacher, PhD[†], Owen Mugurungi, MSc, MD[‡], Clemens Benedikt, PhD[§], Phyllis Mushati, MSc^{*}, Catherine Campbell, PhD[¶], and Geoffrey P. Garnett, PhD[†]

^{*}Manicaland HIV/STD Prevention Project, Biomedical Research and Training Institute, Harare, Zimbabwe

[†]Department of Infectious Disease Epidemiology, Imperial College London, London, United Kingdom

[‡]Zimbabwe Ministry of Health and Child Welfare, Harare, Zimbabwe

[§]United Nations Population Fund (UNFPA), Harare, Zimbabwe

[¶]Department of Social Psychology, London School of Economics and Political Science, London, United Kingdom

Abstract

Objective—To add to the evidence on the impact of national HIV prevention programs in reducing HIV risk in sub-Saharan African countries.

Methods—Statistical analysis of prospective data on exposure to HIV prevention programs, relatives with AIDS and unemployment, and sexual behavior change and HIV incidence, in a population cohort of 4047 adults, collected over a period (1998–2003) when HIV prevalence and risk-behavior declined in eastern Zimbabwe.

Results—Exposure to HIV prevention programs and relatives with AIDS—but not unemployment—increased from 1998 to 2003. Men and women exposed to media campaigns and HIV/AIDS meetings had greater knowledge and self-efficacy, attributes that were concomitantly protective against HIV infection. Women attending community HIV/AIDS meetings before recruitment were more likely than other women to adopt lower-risk behavior (96.4% vs. 90.8%; adjusted odds ratio, 3.09; 95% confidence interval [CI], 1.27–7.49) and had lower HIV incidence (0.9% vs. 1.8%; adjusted incidence rate ratio, 0.63; 95% CI, 0.32–1.24) during the intersurvey period. Prior exposure to relatives with AIDS was not associated with differences in behavior change. More newly unemployed men as compared with employed men adopted lower-risk behavior (84.2% vs. 76.0%; adjusted odds ratio, 2.13; 95% CI, 0.98–4.59).

Conclusions—Community-based HIV/AIDS meetings reduced risk-behavior amongst women who attended them, contributing to HIV decline in eastern Zimbabwe.

There is evidence of declines in HIV prevalence associated with changes in sexual behavior in an increasing number of countries in sub-Saharan Africa.^{1,1a} However, HIV prevalence declines can occur in the absence of behavior change due to the natural dynamics of

epidemics² and changes in reported behavior may be largely due to changes in social desirability bias resulting from the impact of AIDS mortality on social norms.³ Thus, establishing whether declines in HIV prevalence have been caused by reductions in risk behavior is not straightforward.⁴ Where declines in HIV prevalence can be attributed to changes in behavior, a further question arises as to whether these changes resulted from HIV prevention activities. This is a particular concern given that community randomized trials have yielded disappointing results on the effectiveness of behavioral interventions.^{5–8} As a result of these difficulties—and limited possibilities for ecological comparisons due to the similarity of programmatic responses in countries with and without declines in HIV prevalence—there is still very little scientific evidence for the success of HIV prevention programs in reducing infection rates in sub-Saharan African countries.

HIV prevalence has fallen in Zimbabwe from 25.3% (uncertainty bounds, 23.6%–27.1%) in 1997 to 13.7% (11.9%–15.0%) in 2009.^{9,10} HIV incidence has also declined⁹ and fitting a mathematical model to surveillance data suggests an acceleration in this decline because of reductions in risk behavior occurring between 1999 and 2004.¹¹ Survey data show reductions in reports of multiple sexual partnerships and sustained high levels of condom use in casual partnerships over the same period.^{9,12} These epidemiologic and behavior trends coincided with a period of scale-up of national HIV control programs in Zimbabwe.¹³ However, this period was also marked by high AIDS mortality^{9,14} and the beginning of a severe economic downturn¹⁵ in the country. Thus, as elsewhere, the contribution of HIV control programs to the reductions in HIV infection rates and associated risk behavior in Zimbabwe remains unclear.

One less explored approach to assess the contribution of national HIV prevention programs to reductions in HIV risk is to examine their coverage and effect in prospective community surveys. In this article, we use prospective data from a large-scale general population cohort of initially uninfected individuals in eastern Zimbabwe, collected between 1998 and 2003 (i.e., covering the period when the most rapid reductions in HIV incidence and high-risk sexual behavior were observed) to describe patterns of association between exposure to HIV prevention programs, relatives with AIDS and unemployment, and psychological factors believed to mediate behavior change, observed changes in reported behavior, and levels of HIV incidence.

METHODS

Theoretical Framework

We use a simplified theoretical model structure for our exploration of the effects of HIV prevention programs and changes in epidemiologic and socioeconomic context on individuals' adoption of behaviors that are less risky for HIV infection (Fig. 1). Adoption of safer behaviors is taken to be mediated by a number of psychological attributes including knowledge about HIV/AIDS, perceived personal risk of infection,¹⁶ and self-efficacy.¹⁷ Individuals' sociodemographic characteristics, including their gender, age, education, marital status, and income levels, may influence these psychological attributes, along with aspects of their social networks such as partner, household and extended family characteristics, and membership of social groups.¹⁸ These local networks are influenced, in turn, by the social norms that prevail within the wider community.

A change in the socioeconomic environment, such as an increase in poverty, could lead to changes in behavior patterns. For example, in a setting where men are the main cash income earners and transactional sex is common, reductions in male incomes (through job loss and high inflation) could lead to safer behavior. Other things being equal, the increase in poverty might also be expected to draw more women into unprotected transactional sex; however,

the combination of extensive HIV/AIDS prevention programming and high AIDS mortality could limit this effect. A distinction in programs can be drawn between those that are directed primarily to individuals (e.g., television and radio campaigns) and those that are directed to the local community (e.g., HIV/AIDS meetings), although changes in individual attitudes and behavior may eventually generate feedbacks into the community. Indeed, these 2 forms of programs may have synergistic effects, in that the first program typically focus on improving knowledge, whereas the second often seek to increase levels of risk perception and self-efficacy¹⁹ and could lead to collective renegotiation of social norms.²⁰ This seems particularly likely where there is high exposure to AIDS mortality.

In this article, we begin to test this framework by using regression models to investigate the separate effects of exposure to HIV programs, relatives with AIDS and unemployment on psychological status, sexual risk behavior, and HIV incidence.

Data

Data from the first 2 rounds of the Manicaland General Population Cohort Survey were used in this study. The detailed procedures followed in the survey have been published.¹² In brief, we conducted a baseline census of all households in 12 predominantly rural study sites in a phased manner (1 site at a time) between July 1998 and February 2000. Random samples of men aged 15 to 54 years and women aged 17 to 44 years, residing within the study households, were recruited into an open cohort. A follow-up census and survey were conducted in each of the same sites 3 years later (July 2001–February 2003). All baseline respondents were included amongst those considered eligible at follow-up. Data on onset of sexual activity were collected in standard face-to-face interviews. However, to reduce social desirability bias in reports on numbers of sexual partnerships and unprotected casual sex, in most cases, these data were collected using Informal Confidential Voting Interviews.²¹ HIV serological testing was done on dried blood spot specimens using a highly sensitive and specific antibody dipstick assay. Written informed consent was sought as a condition of enrolment and continuation in the study. Prior ethical approval for the study was obtained from the Research Council of Zimbabwe (Number 02187) and the Applied and Qualitative Research Ethics Committee in Oxford, United Kingdom (N97.039).

After these procedures, 98% and 94% of the households identified in the survey areas at baseline and follow-up, respectively, were enumerated. Individual participation rates were 79% in both the rounds of the survey. Among those interviewed at baseline (and not known to have died subsequently), 61% were reinterviewed at follow-up period. Outmigration was the principal reason for loss to follow-up with only 1% of baseline respondents declining to participate in the next round of the survey.

Statistical Analysis

The analysis of the reported exposures, behaviors, and HIV incidence was conducted using data from the closed cohort of individuals who were uninfected at baseline and were reinterviewed and retested at follow-up. Coverage of program activities, exposure to relatives who are sick with or dying from AIDS and unemployment were estimated and compared for members of this cohort at baseline and follow-up. Individuals who reported having heard HIV/AIDS messages through the national media (television, radio, or newspapers) 5 or more times in the last month were treated as having been exposed to media campaigns, making the results for this indicator conservative because individuals with lower and/or less recent exposure were included in the comparison group. In 6 of the 12 sites, an intensive program of peer education meetings with women engaging in commercial sex work and their prospective male clients was implemented between 1998 and 2003.⁶ This intervention reduced unprotected casual sex and HIV incidence in men exposed to the

program but did not reduce risk behavior or HIV incidence at the community level. Because these activities have been evaluated separately⁶ and were not representative of the national response in rural areas,²² survey participants from the intervention sites in this trial were excluded from the analysis of the effects of HIV/AIDS meetings.

Associations between reported primary exposures (i.e., AIDS mortality, HIV/AIDS programs etc.) and psychological status at recruitment were measured for men and women separately using logistic regression. This was done so that the mediating effects on behavior and HIV incidence of improved psychological status resulting from the primary exposures could be measured over the subsequent intersurvey period. Knowledge about HIV/AIDS was measured using an index constructed from responses to a series of questions about modes of transmission, protective measures, and symptoms.²³ Risk perception and self-efficacy were measured using responses to the questions: “Do you think you could become infected with HIV yourself in the future?” and “Do you think there are things you can do to avoid becoming infected?” respectively. Tests for effects on subsequent sexual behavior were measured using prospective data spanning the 3-year intersurvey period (1998–2000 to 2001–2003). Four sexual risk behavior outcomes were investigated using logistic regression—initiation of sexual activity, multiple sexual partners, unprotected sex with a casual partner, and (for married respondents) spouse being unfaithful. Poisson regression was used to test for associations with subsequent sexual behavior and incident HIV infection. All tests were controlled for gender, age, and clustering at the village level with results being considered significant at the 95% confidence level. Tests that included sexual behavior indicators as independent or dependent variables were also controlled for interview method and tests that measured associations with subsequent behavior and incident HIV infection were adjusted for prior sexual risk behavior (number of new partners in the year before baseline interview and, where necessary, onset of sexual relations). In analyzing the effects of program and other exposures on having an unfaithful spouse, women with polygamous husbands were excluded and results were adjusted for whether the respondent reported an unfaithful spouse at baseline. Our analysis of national HIV prevalence trends shows that risk of HIV changed around the period of data collection,¹¹ and we are interested in the behavior changes after an exposure; therefore, in this part of the analysis, for each exposure variable, individual participants who had not been exposed at baseline but who were exposed during the intersurvey period were excluded. Therefore, for example, sexual behavior and HIV incidence were compared between individuals who had had a relative with AIDS before baseline and those who still reported not having had a relative with AIDS when interviewed again in the follow-up survey.

In addition, to assess the contributions of HIV prevention programs and background factors to behavior change, multivariable logistic regression was used to calculate adjusted odds ratios for decreasing or maintaining (adopting) low-risk behavior between the baseline and follow-up survey interviews in the intervention control areas, by presence and timing of exposure (i.e., before or only after recruitment). Decreasing risk was defined as having reduced the number of new sexual partners in the past year and low-risk behavior was defined as having no new partners in the past year. Odds ratios were adjusted for age group, education, marriage, competing factors, interview method, and clustering at the village level.

RESULTS

Associations Between Psychological Status, Sexual Risk Behavior, and HIV Incidence

Consistent with the theoretical framework, increased knowledge about HIV/AIDS was associated with lower HIV incidence (adjusted incidence rate ratio [aIRR], 0.72; 95% CI, 0.51–1.00) and greater self-efficacy showed a nonsignificant protective association (aIRR, 0.76; 0.44–1.31), whilst respondents perceiving a risk of HIV infection experienced higher

incidence (aIRR, 1.68; 1.16–2.42). As reported previously, self-reports of initiating sex amongst respondents who were virgins at baseline (1.75% vs. 0.6%; adjusted odds ratio [aOR], 3.59; 95% CI, 1.42–9.02), multiple sexual partners (3.2% vs. 1.4%; aOR, 2.08; 1.44–3.00), and unprotected casual sex (3.2% vs. 1.6%; aOR, 1.70; 1.19–2.43) during the 3-year intersurvey period were each associated with higher risk of having acquired HIV infection during this period.²⁴ Among married respondents, having an unfaithful spouse showed a nonsignificant association (1.9% vs. 1.7%; aOR, 1.36; 0.89–2.08).

Exposure to HIV Prevention Programs, Relatives With AIDS and Unemployment

At baseline, 30% (95% CI, 29%–32%) of the cohort reported recent repeated exposure to HIV/AIDS messages through the national media (Fig. 2). At follow-up, this figure had increased to 39% (37%–40%). Baseline exposure was greater for males (42%; 40%–45%) than for females (22%; 20%–24%) but increases over time were recorded for both the genders. A much smaller nonsignificant increase was observed in lifetime attendance at HIV/AIDS meetings (from 27%; 25%–29% to 29%; 27%–31%) with both the genders reporting similar levels of attendance at each interview.

A substantial increase was recorded in the proportion of the cohort reporting having had a relative with AIDS between the first (30%; 95% CI, 29%–32%) and second (47%; 46%–49%) rounds of the survey. More women than men reported relatives with AIDS at baseline (34% [32%–36%] vs. 25% [23%–27%]) but both the genders reported increases of approximately 50% during the intersurvey period. Unemployment decreased from 75% (74%–77%) at baseline to 70% (68%–71%) at follow-up, possibly reflecting selective out-migration of individuals who were made redundant or left their jobs. More women (90%; 89%–92%) than men (54%; 52%–56%) were unemployed at baseline and similar modest reductions over time were observed in both the genders.

Program Exposure, Psychological Status, and Subsequent Risk of HIV Infection

Tables 1 and 2 show the results of the analysis of the effects on psychological status, subsequent sexual risk behavior, and HIV incidence of individual level characteristics (including unemployment), having a relative with AIDS, and programmatic activities suggested in the theoretical model as influencing behavior.

Men and women with more education had better knowledge, lower risk perception (for men), and greater self-efficacy. More educated men had similar behavior and HIV risk to less educated men during the 3-year intersurvey period but more educated women were more likely to report multiple sexual partnerships and showed a trend toward higher risk of acquiring HIV (2.1% vs. 1.1%; aIRR, 1.44; 95% CI, 0.96–2.16). Married men were more likely to express self-efficacy than unmarried men, whereas married women had less knowledge and lower self-efficacy than unmarried women. However, marriage was associated with fewer multiple sexual partnerships and less unprotected casual sex for both the genders and with a lower risk of having recently acquired infection, particularly for women (1.2% vs. 2.2%; aIRR, 0.49; 95% CI, 0.33–0.73).

Unemployed men had less risk perception and showed a trend toward lower HIV incidence compared to those in employment (1.7% vs. 2.4%; aIRR, 0.75; 95% CI, 0.47–1.20) but no differences in behavior were observed. In women, unemployment also showed a nonsignificant negative association with HIV incidence (1.5% vs. 2.1%; aIRR, 0.70; 95% CI, 0.34–1.46) and was associated with fewer reports of multiple sexual partnerships and unprotected casual sex during the intersurvey period. In men, having relatives with AIDS was associated with greater self-efficacy but did not show an effect on behavior or HIV incidence. Women with relatives with AIDS had enhanced levels of knowledge, risk

perception, and self-efficacy and showed a trend toward reduced risk of becoming infected with HIV (1.2% vs. 2.0%; aIRR, 0.66; 95% CI, 0.40–1.08); however, no clear behavioral pathway was apparent in the data.

Exposure to media campaigns and HIV/AIDS meetings was associated with better knowledge and greater self-efficacy for men (borderline significant for the effect of HIV/AIDS meetings on self-efficacy) and for women. Exposure to media campaigns did not translate into safer behaviors or reduced HIV incidence for either gender. However, women who had attended HIV/AIDS meetings showed nonsignificant but consistent trends toward fewer multiple sexual partners (aOR, 0.65; 95% CI, 0.37–1.13), less unprotected casual sex (aOR, 0.59; 95% CI, 0.33–1.07), and lower HIV incidence (0.9% vs. 1.8%; aIRR, 0.63; 95% CI, 0.32–1.24) in the intersurvey period. The trend toward reduced HIV incidence remained after further adjustment for AIDS mortality and individual characteristics as potential confounders (aIRR, 0.66; 95% CI, 0.34–1.28).

Program Exposure and Behavior Change

A substantial reduction was recorded in the mean number of new sexual partners reported in the past year over the period 1998 to 2003 by individuals who were uninfected at baseline. Amongst men, the mean number reduced by 50% from 1.02 (95% CI, 0.90–1.15) to 0.52 (0.46–0.57), whilst, in women, there was a reduction of 53% from 0.19 (0.15–0.23) to 0.09 (0.07–0.11). In general, men and women exposed to HIV prevention programs, relatives with AIDS and unemployment, before or during the intersurvey period, did not show greater reductions in risk behavior than those who did not report exposure (Fig. 3). However, women who had attended HIV/AIDS meetings before recruitment were more likely than those who had never attended these meetings to reduce their risk behavior or to maintain low risk behavior (96.4% vs. 90.8%; aOR, 3.09; 95% CI, 1.27–7.49). Newly unemployed men (84.2% vs. 76.0%; aOR, 2.13; 95% CI, 0.98–4.59) tended to be more likely than men in employment to adopt or maintain safer behavior.

DISCUSSION

The results of this analysis provide some encouragement that HIV prevention programs may have contributed to the decline in HIV prevalence and the associated reductions in risk behavior seen in eastern Zimbabwe in the late 1990s and early 2000s.¹² In the predominantly rural study settings, program coverage increased during this period and was associated, for both the genders, with better knowledge and greater self-efficacy; attributes that, in turn, were protective against HIV infection. For women, attendance at community-based HIV/AIDS meetings was directly associated with increased adoption of safer behaviors and a substantial (one-third) but nonsignificant reduction in HIV incidence.

Exposure to relatives dying from AIDS is associated with lower HIV incidence in women in this cohort.²⁴ However, we found no evidence for differences in rates of adoption of less risky sexual behaviors by exposure to AIDS mortality. Previously, we have found that greater poverty (measured using an asset index) is associated with higher HIV incidence in men.²⁵ In this analysis, we explored the effect of unemployment (possibly a better indicator of current income). Overall, unemployment rates were high (75%) but did not increase between the period 1998 to 2003. Unemployment showed a trend toward lower HIV incidence in both the genders and we found a borderline significant association between recent loss of employment and adoption of safer behavior in men. Caution is needed in interpreting these findings because individuals who lost their jobs but remained in the study areas may differ from those who migrated and were lost to follow-up.

In a context of high exposure to AIDS mortality and escalating poverty,¹⁵ HIV prevention program activities (and particularly community-based HIV/AIDS meetings¹⁸) may have led to changes in social norms which, in turn, could have influenced the behavior of individuals who were not themselves exposed to these activities—both directly and through changes in the availability and characteristics of prospective partners. If so, we may have underestimated the impact of HIV programs since those affected indirectly in this way were included in the reference categories in our analysis. This analysis is also limited in that the data on HIV prevention programs were restricted to exposure to media campaigns and HIV/AIDS meetings. Sexual risk behavior can be reduced after counseling and testing, particularly amongst those who receive HIV-positive results, but uptake was low in this population during the study period.²⁶ Nevertheless, other programs such as HIV prevention activities in schools, initiated in the early 1990s, may have resulted in adoption of safer behaviors.²²

In some instances we found evidence for associations between individual characteristics and HIV incidence without there being clear behavioral pathways explaining these associations. This could be due to limited statistical power to conduct subgroup analyses, limitations in the behavioral variables examined (e.g., no data were collected on position within local sexual networks), or to reporting bias. The data covering the 3-year intersurvey period may be subject to recall bias. Social desirability bias may increase with exposure to HIV programs leading to overestimation of their effects on behavior; we minimized this bias, however, by using the Informal Confidential Voting Interviews method.

These limitations notwithstanding, this study provides an example of how prospective data from a population-based cohort can be used in evaluations of HIV prevention programs. Community randomized controlled trials can help in establishing the effectiveness of interventions in specific epidemiologic contexts²⁷ under carefully controlled conditions.²⁸ However, these trials are becoming increasingly complex and expensive to implement, particularly given the ethical requirement to provide HIV prevention services already proven to be effective to participants in both intervention and control groups.²⁹ Furthermore, alternative methods such as those applied in the current study, are needed when the aim is to evaluate the effect of HIV prevention programs when scaled-up in “real world” circumstances that extend beyond the confines of a trial setting. More studies of this nature could be useful and, especially, when done in combination with mathematical modeling³⁰ to examine the impact of behavior changes associated with particular interventions (including treatment) on trends in HIV infection.

This study was undertaken in eastern province of Manicaland, Zimbabwe. Patterns of program implementation and coverage are likely to have varied across the country. However, the increase in program coverage observed here coincided with a period when the National AIDS Council and National AIDS Trust Fund were established in Zimbabwe to coordinate and promote the national response to HIV/AIDS. Following this initiative, similar increases in program coverage were observed in national surveys.¹³ Furthermore, the declines in HIV prevalence and risk behavior found in the current study sites have also been observed in the national population.³¹ Therefore, HIV prevention programs could have had similar effects in other parts of the country as observed here in Manicaland.

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Figure 1. Theoretical framework for the effect of HIV prevention programs on adoption of safer behavior. The individual is nested within both a social network and a community with characteristics of the individual, social network and community influencing behaviors, and changes in behavior generated by programs, mortality, and socioeconomic change.

Figure 2.

Exposure to HIV prevention programs, having relatives with AIDS, and unemployment in a closed cohort of 1673 men (17–54 years) and 2374 women (15–44 years) uninfected at baseline, Manicaland, Zimbabwe, 1998–2003. TV, radio, and newspaper: exposed 5 or more times in the past month; meetings: ever having attended an HIV/AIDS meeting (in trial control sites only); relative with AIDS: ever had a relative sick with or died from AIDS; unemployed: not in formal sector employment.

Figure 3.

Exposure to HIV prevention programs, having relatives with AIDS, and unemployment, and behavior change in Manicaland, Zimbabwe, 1998–2003. A, Males (N = 569); (B) Females (N = 851). Closed cohort, started sex but HIV negative at baseline, trial control sites only; aOR, odds ratios for decreasing or maintaining low-risk behavior in a multivariable logistic regression model adjusted for age group and other individual characteristics, competing causes, interview method, and village (i.e., aOR >1 means more likely to decrease or maintain low risk). Decreased risk indicates reducing number of new partners in the past year; low risk, no new partners in the past year.

TABLE 1
Impact of Exposure to HIV Control Program Activities and AIDS Mortality on Risk of Acquiring HIV Infection, Manicaland, Zimbabwe, 1998–2000 to 2001–2003 (Men, 17 to 54 Years)

Exposure/Status at Round 1	Psychological Status (at Round 1)				Sexual Risk Behavior (During 3-yr Intersurvey Period)								HIV Incidence	
	Knowledge		Risk Perception		Self-efficacy		Newly Started Sex		Multiple Partners		Unprotected Casual Sex		Spouse Unfaithful	
	aOR (95% CI)	N	aOR (95% CI)	N	aOR (95% CI)	N	aOR (95% CI)	N	aOR (95% CI)	N	aOR (95% CI)	N	aOR (95% CI)	Person-Years
Individual characteristics														
Secondary education—some vs. none	2.23 (1.74–2.86)	1551	0.78 (0.64–0.94)	1673	3.33 (2.31–4.80)	1673	1.49 (0.81–2.75)	315	1.11 (0.82–1.52)	1305	0.82 (0.62–1.08)	1328	1.14 (0.61–2.13)	669
Marriage—married vs. unmarried	1.05 (0.78–1.40)	1551	0.89 (0.68–1.17)	1673	1.82 (1.06–3.11)	1673	—	—	0.57 (0.44–0.76)	1305	0.68 (0.52–0.91)	1328	—	—
Income—unemployed vs. employed	0.98 (0.76–1.25)	1189	0.63 (0.50–0.79)	1277	0.66 (0.42–1.03)	1277	0.51 (0.24–1.09)	221	1.02 (0.79–1.31)	1019	0.95 (0.73–1.24)	1034	0.85 (0.38–1.91)	548
Epidemiological impact														
Relative with AIDS	1.19 (0.96–1.47)	1551	1.02 (0.83–1.25)	1673	1.74 (1.12–2.70)	1673	1.09 (0.58–2.06)	234	1.28 (0.95–1.72)	982	1.03 (0.80–1.34)	1002	1.04 (0.59–1.82)	508
Programs														
Media campaigns	1.74 (1.38–2.18)	1544	1.07 (0.89–1.30)	1665	2.25 (1.50–3.36)	1665	1.43 (0.87–2.33)	212	1.28 (0.96–1.72)	969	1.05 (0.80–1.38)	983	0.86 (0.47–1.59)	503
HIV/AIDS meetings	1.62 (1.18–2.37)	772	1.29 (0.95–1.75)	840	1.95 (0.99–3.86)	840	1.21 (0.66–2.22)	144	0.94 (0.67–1.32)	523	1.14 (0.77–1.69)	535	0.88 (0.41–1.86)	212

Exposure/status—prior (i.e., at Round 1) versus none; those with new exposure at Round 2 excluded from analyses.

Effects of programs on psychosocial status measured at Round 1.

All tests controlled for age and clustering at the village level. Tests for association with incidence and behavior also controlled for behavior at Round 1. Tests for effects on behavior also controlled for interview method.

HIV indicates human immunodeficiency virus; AIDS, acquired immune deficiency syndrome; aOR, adjusted odds ratio; CI, confidence interval; aIRR, adjusted incidence rate ratio.

TABLE 2
Impact of Exposure to HIV Control Program Activities and AIDS Mortality on Risk of Acquiring HIV Infection, Manicaland, Zimbabwe, 1998–2000 to 2001–2003 (Women, 15 to 44 Years)

Exposure/Status at Round 1	Psychological Status (at Round 1)				Sexual Risk Behavior (During 3-yr Intersurvey Period)								HIV Incidence	
	Knowledge		Risk Perception		Self-efficacy		Newly Started Sex		Multiple Partners		Unprotected Casual Sex		Spouse Unfaithful	
	aOR (95% CI)	N	aOR (95% CI)	N	aOR (95% CI)	N	aOR (95% CI)	N	aOR (95% CI)	N	aOR (95% CI)	N	aIRR (95% CI)	Person-Years
Individual characteristics														
Secondary education—some vs. none	2.00 (1.64–2.44)	2069	1.10 (0.90–1.35)	2373	2.08 (1.64–2.64)	2373	0.75 (0.47–1.21)	408	1.62 (1.06–2.48)	1933	1.18 (0.78–1.79)	1941	0.91 (0.68–1.20)	1401
Marriage—married vs. unmarried	0.75 (0.61–0.91)	2068	2.85 (2.28–3.54)	2372	0.37 (0.30–0.48)	2372	—	—	0.17 (0.12–0.24)	1932	0.29 (0.19–0.44)	1940	—	0.49 (0.33–0.73)
Income—unemployed vs. employed	0.61 (0.42–0.88)	1808	0.89 (0.62–1.28)	2081	0.55 (0.35–0.87)	2081	0.89 (0.12–6.44)	327	0.26 (0.17–0.41)	1726	0.46 (0.27–0.79)	1732	0.96 (0.58–1.58)	1283
Epidemiological impact														
Relative with AIDS	1.32 (1.08–1.61)	2070	1.22 (0.99–1.51)	2374	1.21 (0.99–1.48)	2374	1.02 (0.58–1.79)	301	1.22 (0.83–1.79)	1386	1.22 (0.82–1.83)	1391	1.23 (0.96–1.58)	1011
Programs														
Media campaigns	1.41 (1.14–1.76)	2060	1.09 (0.88–1.36)	2364	1.48 (1.15–1.90)	2364	1.04 (0.62–1.73)	311	0.96 (0.61–1.51)	1603	0.88 (0.52–1.49)	1608	0.96 (0.72–1.29)	1169
HIV/AIDS meetings	1.67 (1.25–2.24)	970	1.32 (0.96–1.81)	1171	1.82 (1.36–2.44)	1171	1.46 (0.79–2.71)	183	0.65 (0.37–1.13)	781	0.59 (0.33–1.07)	783	0.91 (0.62–1.34)	562

Exposure/status—prior (i.e., at Round 1) versus none; those with new exposure at Round 2 excluded from analyses.

Effects of programs on psychosocial status measured at Round 1.

All tests controlled for age and clustering at the village level. Tests for association with incidence and behavior also controlled for behavior at Round 1. Tests for effects on behavior also controlled for interview method.

HIV indicates human immunodeficiency virus; AIDS, acquired immune deficiency syndrome; aOR; adjusted odds ratio; CI, confidence interval; aIRR, adjusted incidence rate ratio.