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RISKY BEHAVIOUR AND HIV PREVALENCE AMONG ZAMBIAN MEN

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Summary. The objective of this paper is to identify demographic, social and behavioural risk factors for HIV infection among men in Zambia. In particular, the role of alcohol, condom use and number of sex partners is highlighted as being significant in the prevalence of HIV. Multivariate logistic regressions were used to analyse the latest cross-sectional population-based demographic health survey for Zambia (2007). The survey included socio-economic variables and HIV serostatus for consenting men (N=4434). Risk for HIV was positively related to wealth status. Men who considered themselves to be at high risk of being HIV positive were most likely to be HIV positive. Respondents who, along with their sexual partner, were drunk during the last three times they had sexual intercourse were more likely to be HIV positive (adjusted odds ratio (AOR) 1.60; 95% confidence interval (CI) 1.00–2.56). Men with more than two sexual life partners and inconsistent condom use had a higher risk for being HIV positive (OR 1.89, 95% CI 1.45–2.46; and OR 1.49, 95% CI 1.10–2.02, respectively). HIV prevention programmes in Zambia should focus even more on these behavioural risk factors.

Introduction

Today, approximately 33 million people are living with HIV/AIDS throughout the world. Furthermore, HIV has not affected the world proportionately; sub-Saharan Africa continues to bear the bulk (67%) of the global HIV burden. Although some sub-Saharan African nations are experiencing stabilization or a decline in the spread of HIV, this has been counteracted by increasing rates of HIV prevalence in others (UNAIDS, 2008).

Several studies have attempted to identify the socio-demographic characteristics associated with HIV vulnerability. Some authors focused on the connection between HIV prevalence and wealth, which appears to be positively correlated for a number of sub-Saharan African nations (Mishra *et al.*, 2007). Other authors have pointed to education as a risk factor; however, its relationship to HIV seroprevalence is equivocal (Glynn *et al.*, 2004; Fortson, 2008). Marital status has also been shown to be associated with HIV infection: individuals who have been married at any time (i.e.

currently married, widowed or divorced) are more likely to be infected (Nunn *et al*., 1994; Hong *et al*., 2004; Clark, 2004; Johnson & Way, 2006). In addition, some authors have identified an association between biological factors and HIV. Sexually transmitted infections appear to be positively correlated with HIV infection (Nunn *et al*., 1994; Hong *et al*., 2004). Also, circumcision has been found to have a strong negative association with HIV prevalence in numerous studies (Gray *et al*., 2000; Agot *et al*., 2004; Auvert *et al*., 2005). Moreover, there is strong evidence for the role of alcohol in the spread of HIV (Zablotska *et al*., 2006).

Zambia is in the midst of one of sub-Saharan Africa's worst HIV/AIDS epidemics (Fig. 1). Although evidence points to a decline in incidence among the youth since the 1990s (Fylkesnes *et al*., 2001; Michelo *et al*., 2006), HIV prevalence in Zambia remains extremely high among men (12.3%) (Zambia Demographic and Health Survey, 2007). Furthermore, most Zambians have not undergone HIV testing, and many lack complete knowledge about HIV prevention (ICF Macro, 2009). Hence, this paper analyses the findings of the latest (2007) Zambia Demographic and Health Survey (ZDHS) (CSO *et al*., 2009), by examining the relationship between HIV seroprevalence and various demographic, social, biological and behavioural characteristics among Zambian men, age 15–59 years, who have had sex. The focus is on the association between HIV status and risk behaviour: in particular, lack of condom use, drunkard status during sexual intercourse, multiple partners and years of being sexually active. Alcohol consumption was found to be a significant factor, which may be explained by the fact that excessive drinking impairs judgement, leading to improper or negligent use of safer-sex methods. Also, individuals who are drunk may be more likely to engage in promiscuous behaviour.

Methods

The sample is drawn from the 2007 ZDHS, which targeted men age 15–59 from randomly selected households throughout Zambia. First conducted in 1992, the ZDHS aims to gather updated information on a wide variety of respondent characteristics including sexual activity, nutritional status, mortality rates and awareness and incidence of HIV/AIDS and other sexually transmitted infections. Blood samples for HIV and syphilis testing were collected in order to calculate national estimates of prevalence.

This analysis focuses on men aged 15–59 who have ever had sex (Table 1). Because many of the explanatory variables are associated with sexual behaviour, men who have never had sex are excluded from the study. The dependent variable is HIV serostatus. Of the 5513 total observations, 4434 had an HIV test result (either positive or negative). The explanatory variables can be divided into four categories: biological, behavioural, demographic and social. Multinomial logistic regressions are used to test the explanatory variables for association with HIV prevalence. STATA 11 software is used for all the regression analysis.

The biological characteristic in this analysis is circumcision. As mentioned previously, studies (Gray *et al*., 2000; Agot *et al*., 2004; Auvert *et al*., 2005) have shown a strong negative association between HIV infection and circumcision. It is predicted that this analysis will yield similar results.

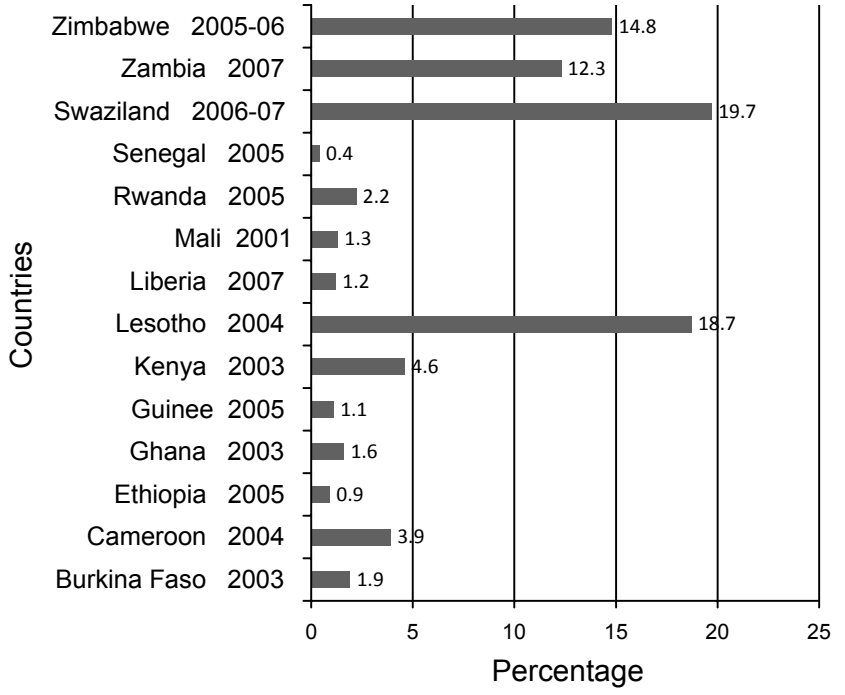

Fig 1. HIV prevalence estimates among sub-Saharan African men. Source: HIV prevalence data from Measure DHS, Macro International Inc.

Behavioural factors selected for this model are condom use during sex, alcohol use during sex and number of lifetime sexual partners. The variable for condom use has two categories: 1=the respondent used a condom during each sexual intercourse with their last sexual partner and 0=otherwise. Many HIV prevention programmes have promoted condom use as an effective strategy in preventing HIV infection. It is predicted that condom use is negatively associated with HIV infection. However, the variable used in this study is not a direct test of the effectiveness of condoms. It only serves as an indicator of safer-sex tendencies and, to some extent, the availability of condoms to the respondent. Alcohol use during sex is a binary variable: 1=both sexual partners were drunk during the last three times the respondent had sexual intercourse and 0=otherwise. Since information related to last three sexual intercourses is used, this variable reflects the general behavioural pattern related to alcohol consumption. It is predicted that alcohol use during sex is positively associated with HIV infection, as it not only alters sexual behaviour but also the ability to remember and to correctly use a condom. Furthermore, the use of alcohol has been previously associated with increased risk behaviours through disinhibiting effects (Zablotska *et al.*, 2006). Number of lifetime sexual partners (two or fewer versus more than two) is also analysed. It is expected that individuals who have had multiple sexual partners in the past are more likely to have HIV.

Table 1. Sample distribution of sexually experienced Zambian men aged 15–59 based on selected background characteristics, Zambia DHS 2007

Characteristic	Percentage
HIV positive	13.5
Age group	
<20	11.9
20–29	33.4
30–39	30.0
40–59	15.6
Region of residence	
Central	10.0
Copperbelt	16.0
Eastern	15.3
Luapula	6.9
Lusaka	17.0
Northern	13.1
North-Western	5.4
Southern	10.2
Western	6.2
Education	
No education	4.9
Primary	46.6
Secondary	40.1
Higher	8.4
Wealth index	
Poor	20.5
Poorer	16.0
Middle	18.9
Richer	22.3
Richest	22.4
Ever married	
No	29.2
Yes	70.8
First sexual intercourse before age 15	
No	84.3
Yes	15.7
Self-perceived risk of HIV contraction	
No risk	37.2
Low risk	35.6
Medium risk	13.5
High risk	13.7
Circumcised	
No	86.9
Yes	13.1
Used a condom every time had sex with last sex partner	
No	8.0
Yes	92.0
Both partners were drunk during last three times had sexual intercourse	
No	97.4
Yes	2.6
More than two lifetime sexual partners	
No	30.9
Yes	69.1

Note: Statistics are reported for population of men (aged 15–59) who have ever had sex.

Table 2. Logistic regression results: likelihood of HIV infection among sexually experienced Zambian men aged 15–59, Zambia DHS 2007

	OR	95% CI	AOR	95% CI
Circumcised				
No[a]				
Yes	0.61**	0.47–0.79	0.56**	0.43–0.74
Used condom every time had sex with last sex partner				
No[a]				
Yes	1.62**	1.22–2.14	1.45**	1.09–1.93
Both partners were drunk during last three times had sexual intercourse				
No[a]				
Yes	2.42**	1.57–3.75	1.98**	1.27–3.08
More than two lifetime sexual partners				
No[a]				
Yes	3.02**	2.37–3.85	3.03**	2.37–3.86

[a]Reference group for comparison.
**significant at 1%.

The demographic characteristics are current age and region of residence. The age variable is divided into four age groups: under 20, 20–29, 30–39 and 40–59 years. Region has nine categories for each Zambian province: Central, Copperbelt, Eastern, Luapula, Lusaka, Northern, North-Western, Southern and Western.

The social factors included are education, wealth, marital status, age at first sex, years since first sex and self-perceived risk of contracting HIV. Education is divided into no education, primary, secondary and higher than secondary. One may hypothesize that more educated individuals possess a greater knowledge of HIV prevention methods, which should lower their risk of infection. Wealth is divided into five quintiles based on the Measure DHS wealth index: poorest, poorer, middle, richer and richest. Wealthier individuals may have greater access to health care and safer-sex methods. Marital status has two categories: never married and ever married. Respondents in the ever-married group were, at the time of the survey, currently married, living together, widowed, divorced or not living together. Age at first sexual intercourse is divided into two categories: before age 15 and age 15 and over. Years since first sexual intercourse has five categories: fewer than 5, 5–14, 15–24, 25–34 and 35 and above. Finally, self-perceived risk of HIV contraction is classified into no, low, medium and high risk. Tested against HIV prevalence, this may reveal how well informed Zambian men are concerning their HIV risk status.

Results

Table 2 reports the crude association between likelihood of HIV infection and behavioural and biological characteristics. Logistic regressions are used to calculate the crude odds ratios (OR), adjusted odds ratios (AOR) and 95% confidence intervals (CI). Independently, all the behavioural characteristics are found to be significantly

Table 3. Logistic regression results: likelihood of HIV infection among sexually experienced Zambian men aged 15–59 based on selected characteristics, Zambia DHS 2007

	Model 1		Model 2		Model 3		Model 4		Model 5	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Biological characteristics										
Circumcised										
No[a]										
Yes	0.68*	0.50–0.91	0.64**	0.47–0.87	0.64**	0.47–0.87	0.63**	0.46–0.86	0.64**	0.47–0.88
Behavioural characteristics										
Used condom every time had sex with last sex partner										
No[a]										
Yes	1.38*	1.04–1.84	1.55**	1.15–2.09	1.53**	1.13–2.06	1.54**	1.14–2.08	1.49*	1.10–2.02
Both partners were drunk during last three times had sexual intercourse										
No[a]										
Yes	1.71*	1.09–2.69	1.76*	1.11–2.80	1.76*	1.10–2.80	1.70*	1.07–2.71	1.60*	1.00–2.56
More than two lifetime sexual partners										
No[a]										
Yes	2.90**	2.27–3.71	2.24**	1.73–2.89	2.19**	1.70–2.83	2.18**	1.69–2.82	1.89**	1.45–2.46
Demographic characteristics										
Region										
Central[a]										
Copperbelt	1.08	0.73–1.59	1.09	0.73–1.62	1.02	0.68–1.53	0.88	0.59–1.33	1.00	0.66–1.51
Eastern	0.79	0.54–1.15	0.71†	0.48–1.04	0.77	0.52–1.13	0.87	0.59–1.28	0.91	0.61–1.35
Luapula	1.31	0.89–1.92	1.17	0.79–1.73	1.21	0.81–1.79	1.23	0.83–1.84	1.34	0.89–2.01
Lusaka	1.52*	1.08–2.15	1.60**	1.13–2.29	1.56*	1.09–2.23	1.25	0.86–1.80	1.37†	0.94–2.00
Northern	0.69	0.45–1.08	0.61*	0.39–0.96	0.62*	0.40–0.98	0.65†	0.41–1.02	0.70	0.44–1.11
North-Western	0.52*	0.32–0.87	0.56*	0.33–0.94	0.56*	0.33–0.93	0.60†	0.35–1.00	0.60†	0.35–1.01
Southern	1.11	0.77–1.61	1.14	0.78–1.66	1.11	0.76–1.63	1.08	0.73–1.58	1.18	0.80–1.75
Western	1.24	0.85–1.83	1.32	0.89–1.96	1.35	0.91–2.01	1.55*	1.03–2.32	1.36	0.90–2.05
Age										
<20[a]										
20–29			1.20	0.86–1.66	1.20	0.87–1.67	1.19	0.86–1.66	1.41	0.87–2.29
30–39			2.36**	1.72–3.23	2.35**	1.71–3.21	2.40**	1.75–3.29	2.39**	1.48–3.84
40–59			2.72**	1.94–3.81	2.74**	1.96–3.85	2.77**	1.97–3.90	2.76**	1.76–4.32

Table 3. *Continued*

	Model 1		Model 2		Model 3		Model 4		Model 5	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Social characteristics										
First sexual intercourse before age 15										
No[a]										
Yes			0.93	0.72–1.21	0.95	0.73–1.23	0.95	0.73–1.23	0.86	0.65–1.12
Marital status										
Never married[a]										
Ever married			2.53**	1.86–3.43	2.73**	2.01–3.72	2.88**	2.11–3.93	2.45**	1.74–3.45
Education										
No education[a]										
Primary					1.40	0.86–2.30	1.26	0.77–2.08	1.27	0.77–2.09
Secondary					2.16**	1.32–3.55	1.57†	0.94–2.61	1.55†	0.93–2.58
Higher					2.13**	1.23–3.70	1.30	0.72–2.35	1.18	0.65–2.14
Wealth index										
Poorest[a]										
Poorer							1.42†	0.99–2.05	1.46*	1.01–2.10
Middle							1.81**	1.29–2.53	1.75**	1.25–2.47
Richer							2.73**	1.96–3.79	2.58**	1.85–3.60
Richest							2.69**	1.83–3.95	2.53**	1.72–3.72
Years since first sexual intercourse										
<5[a]										
5–14									1.39	0.88–2.20
15–24									1.78*	1.07–2.96
25–34									1.64†	0.93–2.89
35+									2.21*	1.16–4.22
Self-perceived risk of HIV contraction										
No risk[a]										
Low risk									1.52**	1.19–1.94
Medium risk									1.84**	1.38–2.46
High risk									2.62**	1.97–3.48

[a]Reference group for comparison.
†Significant at 10%; *significant at 5%; **significant at 1%.

associated with HIV infection. Furthermore, even after adjusting for all the behavioural characteristics, the associations remain significant. The most significant correlate among behavioural characteristics was having more than two lifetime sexual partners (OR 3.02 and AOR 3.03).

To further account for socio-demographic variables of interest and those earlier found to be determinants of HIV status, these are sequentially entered into the multinomial logistic regressions. Table 3 reports results for five multivariate logistic regressions as other covariates are sequentially added to the models. The covariate are entered in the following sequence: Model I adds eight region dummy variables to biological and behavioural characteristics (the regression from Table 1); Model II adds demographic characteristics age, marital status and first sexual intercourse before age 15 to Model I; Model III adds education; Model IV adds wealth; Model V adds years since first sexual intercourse and self-perceived risk of HIV contraction.

Models I to III highlight regional differences: at a 5% level, residents of Lusaka are more likely to be HIV positive compared with residents of Central region. Conversely, respondents in North-Western are less likely to have HIV. In Model II the demographic variable age shows a statistically significant positive association with HIV prevalence. Compared with respondents under age 20, individuals aged 20–29 are more than 2 times as likely to be HIV positive, while respondents aged 40–59 are more than 2½ times as likely to be infected. Compared with respondents who were never married, those who were ever married are between 2 and 3 times as likely to have HIV. In Model III, education is found to be significantly associated with HIV infection. In Model IV, a positive relationship between wealth and HIV prevalence is observed. Respondents in the richest wealth quintile are more than 2½ times as likely to be HIV positive compared with those in the poorest category.

However, as the wealth covariate is added to the multinomial logistic regression, there is a significant change in the results of other covariates. Comparing Model III and Model IV the region-wise difference in HIV prevalence disappears as wealth is controlled for. Also, education is no longer a significant determinant of HIV status, as was observed in Model III.

In Model V, both years since first sexual intercourse and self-perceived risk of HIV contraction show a strong positive association with HIV prevalence. Respondents who see themselves as high risk for HIV infection are the most likely to be infected. Adding these two covariates, however, does not change any of the signs of the other covariates from Model IV.

The biological factor, circumcision, reveals statistical significance at a 5% level in all models. Respondents who are circumcised have an approximately 40% reduced risk of being HIV positive. All behavioural characteristics are statistically significant in all the models. Condom use provides a protective effect against HIV infection. Individuals who did not use a condom every time they had sex with their last sexual partner are more likely to be HIV positive. Respondents who, along with their sexual partner, were drunk during the last three times they had sexual intercourse are more likely to be HIV positive: this is significant even after adjusting for other sexual behaviour. This makes a strong case for the role of alcohol in the spread of HIV. Having had more than two lifetime sexual partners increases a given individual's likelihood of infection by two-fold.

Discussion

In an attempt to improve current knowledge of the HIV/AIDS crisis in Zambia, this paper has tested key variables that may be associated with HIV seroprevalence among Zambian men. A discussion of these factors follows.

Older age was positively associated with HIV prevalence, with individuals in the oldest age group (40–59) having the greatest likelihood of HIV infection. Older men are likely to have the longest duration of sexual activity, which may increase their probability of contracting the disease through sexual means. This finding is in contrast to that of Johnson & Way (2006), in their analysis of Kenya, who found that an inverted U-shaped relationship existed between age and HIV prevalence, with the risk of infection peaking for men in the 35–39 age group. With regards to region of residence in this study of Zambia, Lusaka residents were most likely to be infected, while North-Westerners were least likely to be HIV positive. However, the significance of this result decreases as wealth is controlled for. At the region level there are large differences in proportion of circumcisions (Lukobo & Bailey, 2007); North-Western region has a higher proportion of circumcisions. In the above analysis circumcision is included as a covariate and accounts for such differences. Nevertheless, there still exist some regional differences in HIV status. One of the explanations for regional differences may be the population density levels of the two regions. Lusaka is the most densely populated province in Zambia, while North-Western has the lowest population density in the country. A higher population density may facilitate sexual transmission between individuals.

Education was not a statistically significant factor after controlling for wealth in the last two models. This lack of a relationship with HIV seroprevalence has been observed for men in other sub-Saharan African nations (Hong *et al*., 2004; Akwara *et al*., 2005; Johnson & Way, 2006). Wealth status, however, had a strong positive relationship to HIV prevalence. Mishra *et al*. (2007) also found a positive association between wealth and HIV prevalence for numerous sub-Saharan African nations. Thus, further support is shown for the claim that HIV, unlike many other diseases, disproportionately affects the wealthy members of the population.

Survey respondents in the 'married at some time' group were more likely to be HIV positive compared with those who were never married. Several explanations may be offered for this. Clark (2004) found that early marriage was associated with HIV risk factors, such as decreased condom use and increased frequency of sex. In addition, divorced men may have separated from their wives because of HIV infection, while widowed men may have infected their wives, who have since died of AIDS.

HIV infection peaked among the men who had their first sexual intercourse 15–24 years prior to the time of survey (2007). This period would coincide with 1983–1992, when the HIV prevalence rates in Zambia increased rapidly, and subsequently stabilized (Fylkesnes *et al*., 1997, 1998).

Self-perceived risk had a strong positive association with HIV prevalence. A comparable finding was observed for Kenyans (Johnson & Way, 2006), who thought they had a small risk for HIV contraction, but were more likely to be infected than those who had no perceived risk. This may be explained by individuals who see

themselves as having a higher risk also being more likely to engage in risky sexual behaviour. Akwara *et al*. (2003) found a strong positive association between perceived risk of contracting HIV and risky sexual behaviour, including having multiple sexual partners, lack of condom use during last casual sex, and occurrence of an STD.

As expected, circumcision is negatively associated with HIV infection. This finding merely adds to an already large pool of research that indicates the protective effect of circumcision.

Respondents who did not use a condom every time they had sex with their last sexual partner were more likely to be HIV positive compared with men who did use a condom. This suggests that the consistent use of condoms during sexual intercourse protects against HIV infection. Respondents who, along with their sexual partner, were drunk during the last three times they had sexual intercourse were more likely to be HIV positive. This may be explained by the fact that excessive drinking impairs judgement, leading to improper or negligent use of safer-sex methods. Also, individuals who are drunk may be more likely to engage in promiscuous behaviour. The number of lifetime sexual partners had a strong positive relationship to HIV prevalence, which is not surprising, since sexual transmission continues to be the primary mode of HIV spread in sub-Saharan Africa (Schmid *et al*., 2004).

In conclusion, this analysis reveals that the HIV epidemic in Zambia is multifaceted. A diverse collection of demographic, social, biological and behavioural characteristics are associated with the likelihood of HIV infection among Zambian men. Above all, the findings emphasize the importance of sexual behaviour. Zambian men who do not use condoms during sex, are drunk during sex or have had multiple lifetime sexual partners have a greatly increased likelihood of HIV infection. HIV prevention programmes in Zambia should focus on education around these risk factors with the intention of reducing such behaviour.

References

Agot, K. E., Ndinya-Achola, J. O., Kreiss, J. K. & Weiss, N. S. (2004) Risk of HIV-1 in rural Kenya: a comparison of circumcised and uncircumcised men. *Epidemiology* **15**, 157–163.

Akwara, P. A., Fosu, G. B., Govindasamy, P., Alayón, S. & Hyslop, A. (2005) *An In-Depth Analysis of HIV Prevalence in Ghana: Further Analysis of Demographic Health Surveys Data*. ORC Macro, Calverton, MD, USA.

Akwara, P. A., Nyovani, J. M. & Hinde, A. (2003) Perception of risk of HIV/AIDS and sexual behaviour in Kenya. *Journal of Biosocial Science* **35**, 385–411.

Auvert, B., Taljaard, D., Lagarde, E., Sobngwi-Tambekou, J., Sitta, R. & Puren, A. (2005) Randomized controlled intervention trial of male circumcision for reduction of HIV infection risk: the ANRS 1265 Trial. *PLoS Med* **2**, e298

Central Statistical Office (CSO), Ministry of Health (MOH), Tropical Diseases Research Centre (TDRC), University of Zambia & Macro International Inc. (2009) *Zambia Demographic and Health Survey 2007*. CSO and Macro International Inc., Calverton, MD, USA.

Clark, S. (2004) Early marriage and HIV risks in sub-Saharan Africa. *Studies in Family Planning* **35**, 149–160.

Fortson, J. (2008) The gradient in sub-Saharan Africa: socioeconomic status and HIV/AIDS. *Demography* **45**, 303–322.

Fylkesnes, K., Musonda, R. M., Kasumba, K., Ndhlovu, Z., Mluanda, F., Kaetano, L. *et al.* (1997) The HIV epidemic in Zambia: socio-demographic prevalence patterns and indications of trends among childbearing women. *AIDS* **11**, 339–345.

Fylkesnes, K., Musonda, R. M., Sichone, M., Ndhlovu, Z., Tembo, F. & Monze, M. (2001) Declining HIV prevalence and risk behaviours in Zambia: evidence from surveillance and population-based surveys. *AIDS* **15**, 907–916.

Fylkesnes, K., Ndhlovu, Z., Kasumba, K., Mubanga Musonda, R. & Sichone, M. (1998) Studying dynamics of the HIV epidemic: population-based data compared with sentinel surveillance in Zambia. *AIDS* **12**, 1227–1234.

Glynn, J. R., Caraël, M., Buvé, A., Anagonou, S., Zekeng, L., Kahindo, M. *et al.* (2004) Does increased general schooling protect against HIV infection? A study in four African cities. *Tropical Medicine and International Health* **9**, 4–14.

Gray, R. H., Kiwanuka, N., Quinn, T. C., Sewankambo, N. K., Serwadda, D., Mangen, F. W. *et al.* (2000) Male circumcision and HIV acquisition and transmission: cohort studies in Rakai, Uganda. *AIDS* **14**, 2371–2381.

Hong, R., Mishra, V. & Govindasamy, P. (2004) *Factors Associated with Prevalent HIV Infections among Ethiopian Adults: Further Analysis of the 2005 Ethiopia Demographic and Health Survey*. ORC Macro, Calverton, MD, USA.

ICF Macro (2009) *HIV Prevalence Remains High in Zambia: Knowledge of Prevention and HIV Testing Lagging*. ICF Macro, Calverton, MD, USA. URL: http://www.measuredhs.com/pr1/post.cfm?id=47E889C3-5056-9F36-DC59B0184A0BDDBA (accessed November 2009).

Lukobo, M. D. & Bailey, R. C. (2007) Acceptability of male circumcision for prevention of HIV infection in Zambia. *AIDS Care* **19**, 471–477.

Johnson, K. & Way, A. (2006) Risk factors for HIV infection in a national adult population: evidence from the 2003 Kenya Demographic and Health Survey. *Journal of Acquired Immune Deficiency Syndrome* **42**, 627–636.

Michelo, C., Sandøy, I. F., Dzekedzeke, K., Siziya, S. & Fylkesnes, K. (2006) Steep HIV prevalence declines among young people in selected Zambian communities: population-based observations (1995–2003). *BMC Public Health* **6**, 279.

Mishra, V., Bignami, S., Greener, R., Vaessen, M., Hong, R., Ghys, P. *et al.* (2007) A study of the association of HIV infection with wealth in sub-Saharan Africa. *AIDS* **21**(7), S17–28.

Nunn, A. J., Kenyega-Kayonodo, J. F., Malamba, S. S., Seeley, J. A. & Mulder, D. W. (1994) Risk factors for HIV-1 infection in adults in a rural Ugandan community: a population study. *AIDS* **8**, 81–86.

Schmid, G. P., Buvé, A., Mugyenyi, P., Garnett, G. P., Hayes, R. J. & Williams, B. G. (2004) Transmission of HIV-1 infection in sub-Saharan Africa and effect of elimination of unsafe injections. *AIDS* **363**, 482–488.

UNAIDS (2008) *Report on the Global AIDS epidemic*. UNAIDS, Geneva.

Zablotskam, I. B., Gray, R. H., Serwaddab, D., Nalugodab, F., Kigozib, G., Sewankambob, N. *et al.* (2006) Alcohol use before sex and HIV acquisition: a longitudinal study in Rakai, Uganda. *AIDS* **20**, 1191–1196.