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Supplementary webappendix

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Supplement to: Tanser F, Bärnighausen T, Hund L, Garnett GP, McGrath N, Newell M-L. Effect of concurrent sexual partnerships on rate of new HIV infections in a high-prevalence, rural South African population: a cohort study. *Lancet* 2011; **378:** 247–55.

Supplementary Information

Statistical Analysis

In our analyses, we account for the fact that the observation of HIV seroconversion is interval-censored. Interval-censored survival analyses are an improvement over standard methodologies that assign a fixed seroconversion date based when only information on time interval of serconversion is available. The HIV seroconversion incidence rate is modeled using a parametric hazard model,[1] controlling for known confounders (age, gender, marital status, wealth tertile, years of education, and urban environment) as well as individual level sexual behaviour (reported number of partners in the last 12 months) and community-level variables (HIV prevalence, concurrency prevalence, and mean number of lifetime partners). (We also sequentially added polynomial terms for the community-level variables in the model to allow for the possibility of a non-linear relationship to hazard of infection; but none of these terms approached statistical significance). All parametric and semiparametric survival analyses were done using the user-written stpm package in Stata 11.[2]

We assume that time to HIV seroconversion follows a Weibull survival distribution, $S(t) = \exp(-\exp(\mu+\mathbf{X\beta})t^{1/\sigma})$, where $\mathbf{X}$ is a matrix of known covariates and μ, σ, $\boldsymbol{\beta}$ are model parameters to be estimated using maximum likelihood. Our model for the hazard function is:

$$\lambda(t) = 1\backslash(\sigma t)\exp[-t^{1/\sigma}(\mu+\beta_C C + \alpha_1 z_1+...+ \alpha_p z_p)/\sigma]$$

where z are the p covariates included in the model to control for confounding with corresponding log-hazard ratios $\{\alpha_i\}$; μ and σ are the shape and scale parameters for the Weibull distribution; and C is the community-level covariate of interest with corresponding log-hazard ratio β_C. We test the null hypothesis that $\beta_C=0$ (there is no association between the community-level covariates and incidence of HIV) using a Wald test statistic.

Estimates from parametric survival models are often sensitive to choice of the form of the baseline survival function. We fit several alternative and more flexible models to assess sensitivity to this assumption and found that our results, specifically the hazard ratio point estimates and standard errors, are not sensitive to the choice of baseline hazard. (Alternative models we considered include midpoint-imputed Cox proportional hazard model and a flexible interval-censored model, which models the baseline hazard function using a restricted cubic spline in log time.[1])

Table S1: Full output from parametric hazard regression model showing the influence of community level mean lifetime partners and prevalence of concurrent partnerships (male and female) on an individual's hazard of acquiring HIV infection (N= 11,861).

Model	Mean lifetime partners*		Concurrency*		Both†	
Covariate	HR (95% CI)	p-value	HR (95% CI)	p-value	HR (95% CI)	p-value
Unadjusted Models						
Mean lifetime partners	1.181 (1.07, 1.30)	0.001	-	-		
Concurrency (10% increase)	-	-	0.96 (0.87, 1.07)	0.455		
Adjusted Models						
Mean lifetime partners	1.14 (1.02, 1.26)	0.016	-	-	1.14 (1.02, 1.28)	0.024
Concurrency (10% increase)	-	-	1.05 (0.94, 1.17)	0.410	0.99 (0.88, 1.12)	0.879
Prevalence (10% increase)	1.44 (1.19, 1.75)	<0.001	1.53 (1.26, 1.85)	<0.001	1.44 (1.18, 1.75)	<0.001
Partners in last 12 months (vs. 0)						
1	3.26 (1.90, 5.61)	<0.001	3.26 (1.90, 5.61)	<0.001	3.26 (1.90, 5.61)	<0.001
> 1	5.46 (2.97, 10.04)	<0.001	5.50 (2.99, 10.09)	<0.001	5.45 (2.97, 10.03)	<0.001
Marriage (vs. single)						
Monogamous	0.53 (0.39, 0.71)	<0.001	0.53 (0.39, 0.71)	<0.001	0.53 (0.39, 0.71)	<0.001
Polygamous	0.73 (0.39, 1.35)	0.311	0.74 (0.40, 1.37)	0.331	0.73 (0.39, 1.35)	0.310
Urban (vs. Rural)						
Peri-urban	1.01 (0.81, 1.25)	0.955	0.98 (0.79, 1.21)	0.848	1.01 (0.81, 1.25)	0.949
Urban	0.44 (0.20, 0.95)	0.037	0.42 (0.20, 0.92)	0.030	0.44 (0.20, 0.95)	0.038
Wealth Category (vs. Well-off)						
Moderately poor	0.95 (0.79, 1.14)	0.555	0.95 (0.79, 1.14)	0.546	0.95 (0.79, 1.14)	0.558
Very poor	0.91 (0.75, 1.10)	0.325	0.91 (0.75, 1.11)	0.346	0.91 (0.75, 1.10)	0.325
Years of Education	0.96 (0.94, 0.98)	<0.001	0.96 (0.94, 0.98)	<0.001	0.96 (0.94, 0.98)	<0.001
Males - Age (vs. age 15-19)						
Age 20-24	3.56 (2.45, 5.17)	<0.001	3.54 (2.44, 5.14)	<0.001	1.52 (1.25, 1.84)	<0.001
Age 25-29	4.78 (3.05, 7.48)	<0.001	4.76 (3.04, 7.45)	<0.001	1.12 (0.83, 1.50)	0.457
Age 30-34	4.61 (2.69, 7.89)	<0.001	4.60 (2.69, 7.88)	<0.001	0.75 (0.53, 1.07)	0.109
Age 35-39	2.57 (1.39, 4.75)	0.003	2.57 (1.39, 4.75)	0.003	0.58 (0.41, 0.82)	0.002
Age 40-44	2.38 (1.25, 4.53)	0.008	2.39 (1.26, 4.55)	0.008	0.31 (0.21, 0.47)	<0.001
Age 45 & up	1.74 (1.05, 2.91)	0.033	1.75 (1.05, 2.92)	0.031	0.21 (0.14, 0.31)	<0.001
Females - Age (vs. age 15-19)						
Age 20-24	1.52 (1.25, 1.84)	<0.001	1.51 (1.25, 1.83)	<0.001	3.56 (2.45, 5.17)	<0.001
Age 25-29	1.12 (0.83, 1.50)	0.457	1.11 (0.83, 1.49)	0.486	4.78 (3.05, 7.48)	<0.001
Age 30-34	0.75 (0.53, 1.07)	0.109	0.74 (0.52, 1.05)	0.096	4.61 (2.69, 7.89)	<0.001
Age 35-39	0.58 (0.41, 0.82)	0.002	0.57 (0.41, 0.81)	0.002	2.56 (1.39, 4.74)	0.003
Age 40-44	0.31 (0.21, 0.47)	<0.001	0.31 (0.21, 0.46)	<0.001	2.38 (1.25, 4.52)	0.008
Age 45 & up	0.21 (0.14, 0.31)	<0.001	0.20 (0.14, 0.31)	<0.001	1.74 (1.04, 2.90)	0.033

* Derived using a 3km standard Gaussian kernel.

† Includes both the male community level mean lifetime partners and prevalence of concurrent partnerships covariate.

The median number of lifetime partners in women in the sexual behaviour survey was 2 (IQR = 1-3); 1.8% (95% CI =1.4 - 2.1) of sexually-active women reported being in a concurrent sexual relationship (1.4% of all women in the survey). The overall point-prevalence of partnership concurrency in men and women combined in the general adult population was 12.3% and the corresponding value in the sexually-active population was 15.3%.

References

1. Royston P, Parmar MKB. Flexible parametric proportional hazards and proportional odds models for censored survival data, with application to prognostic modelling and estimation of treatment effects. *Statistics in medicine*. 2002; **21**: 2175-97.

2. Royston P. Flexible parametric alternatives to the Cox model, and more. *Stata Journal*. 2001; **1**: 1-28.