Supplemental Online Material to:

"Preventing unintended pregnancy and HIV transmission: The effect of the HIV treatment cascade on contraceptive choice in rural KwaZulu-Natal"

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1. Effects of covariates on contraceptive use in the main sample of HIV-infected women

Understanding predictors of contraceptive use can inform efforts to target populations that are less likely to use dual protective methods of contraception, which prevent both unintended pregnancies and sexually transmitted infections (STI) transmission. In our estimation of the effect of moving along the HIV treatment cascade on contraceptive choice, we included a number of covariates that are plausible determinants of contraception use and choice. The predictors we included in the analysis were age, education, marital and cohabitating status, parity, household wealth quintile, self-reported health status, pregnancy, distance to main and secondary roads, and calendar year. As in the main paper, we refer to condom use alone as "single-method dual protection", to the use of condoms combined with other methods as "dual-method dual protection", and to the use of any other contraceptive method as "single protection". As in the main paper, we present the impact of covariates as the average marginal effects on the contraceptive outcomes of using single protection, single-method dual protection, and dual-method dual protection.

We found that greater age led to greater use of dual protective methods of contraception, with single-method dual protection increasing by 1.4 percentage points (pp, p-value 0.046) per year of age and dual-method dual protection increasing by 1.4 pp (p-value <0.001). Increased age also decreased the likelihood of not contracepting by 3.7 pp (p-value <0.001). With each additional year of educational attainment, the use of dual-method dual protection significantly increased by 0.3 pp (p-value 0.007) and not using any contraception significantly decreased by 0.9 pp (p-value 0.007), while the use of single protection and single-method dual protection were not significantly affected by education. Being married or in a conjugal relationship did not significantly affect contraceptive use. Pregnancy significantly increased not using any contraception (11.0 pp, p-value 0.016) and significantly decreased the use of single protection (-9.8 pp, p-value 0.001) and dual-method dual protection (-3.5 pp, p-value 0.001), while not significantly affecting the use of single-method dual protection. With parity, the use of single protection increased

significantly (1.9 pp, p-value 0.012) and the use of single-method dual protection decreased significantly (-2.5, p-value 0.003). Distance to primary road significantly decreased use of single-method (-0.3 pp, p-value 0.005) and dual-method (-0.1 pp, p-value 0.050) dual protection and increased the probability of not using any contraception (0.2 pp, p-value 0.039). Distance to secondary road, self-perceived health status, and wealth did not have a significant impact on contraceptive use. Later calendar years (after 2009) were associated with large, significant increases in use of dual-method dual protection (ranging between 11 and 13.7 pp) and large, significant decreases in not using any contraception (ranging between 23.2 and 26.5 pp) relative to 2005 (**Table 4**, in the main paper).

Over the observation period of the study, the coding of self-reported health status changed. Respondents initially had five options for self-reported health status: “excellent”, “very good”, “good, fair”, and “poor”. Beginning in 2009, “excellent”, “very good”, or “good” health status was combined into one answer code. In the main analysis, we coded health responses by the five options and coded “excellent, very good, or good” responses from 2009-2012 as very good. To test the robustness of findings to recoding of this variable into three categories over the entire observation period (“excellent, very good, or good”, “fair” and “poor”), we re-estimated our bivariate probit results and marginal effects replacing the initial health status variables with five answer categories with the recoded health status variable with only three answer categories. As presented in **Tables A1** and **A2**, the bivariate probit and marginal effects results with the recoded health status variable are highly consistent with the main results presented in **Table 4** (in the main paper) with the exception of being in “fine” health, which has a statistically significant negative association with single protection in the bivariate results.

Our findings are consistent with prior research, with the exceptions of the positive relationship between age and dual protective methods. While our finding that greater age is associated with greater use of dual protective methods is inconsistent with previous findings that younger age is associated with greater contraceptive use,[1-3] it is possible that older women in this population have more exposure to

contraceptive counseling and HIV prevention messages. Older women may also continue using dual contraceptive methods once they initiate the habit. Our finding that younger HIV-infected women are less likely to use contraception is a concerning indication about HIV among young adults and suggests that efforts to counsel women and provide contraception should focus on younger women.

The large decreases in non-use of contraception of up to 26.5 pp and large increases in use of dual-method dual protection of up to 13.7 pp with later calendar years are encouraging evidence suggesting increased counseling efforts and the integration of HIV care and reproductive healthcare, or relevant cultural background changes. In keeping with prior results,[1, 4] we found that living further from a main road significantly decreased use of dual protective methods; this finding suggests that geographic disparity in access to contraception persists and that efforts to provide counseling and access to contraception should be focused more on women living in remote areas. Also consistent with prior findings,[5, 6] we found that education increased use of dual-method dual protection; efforts to increase dual protective methods through counseling and the provision of free contraception could thus be particularly effective for women with lower educational attainment.

2. Effects of progression through the HIV treatment cascade on contraceptive use among HIV-infected and HIV-uninfected women

We estimated the impact of progression through the HIV treatment cascade on contraceptive use among a population of both HIV-infected and HIV-uninfected women as a robustness check for our main estimation among only HIV-infected women. In keeping with the main paper, we refer to condom use alone as "single-method dual protection", to the use of condoms combined with other methods as "dual-method dual protection", and to the use of any other contraceptive method as "single protection".

We chose to exclude HIV-uninfected women from the main analysis due to the likelihood of reverse causality – we are estimating the impact of progressing along the treatment cascade on contraceptive use, but dual protective methods of contraception affect HIV acquisition; women who use dual protective methods of contraception are less likely to become HIV-infected. This reverse causal relationship could lead to biased estimation of the effects of progression through the HIV treatment cascade on contraceptive use and choice.[7] As in the main analysis, we used Wellcome Trust Africa Centre Health and Demographic Surveillance System data and patient records from the Hlabisa HIV Treatment and Care Programme. We restricted the analysis to the period between 2005 and 2012 and to women aged 15-49 years. We selected the most recent observation in which women reported on their sexual behavior for inclusion in the analysis. We estimated a bivariate probit model to account for the relationship between the choice to use single-method dual protection and the choice to use single protection. We included age, education, marital status, current pregnancy, parity, distance to major road, self-reported health status, and wealth quintiles as covariates.

Of 27,111 women, 19,757 (73%) reported on their sexual behavior in the past year. Among women who reported on their sexual behavior, 13,789 (70%) had been sexually active within the past year. Of these women, 9761 (71%) reported on all of the covariates included in the study. This sample of 9761 are those women included in the analysis.

We found that including HIV-uninfected women in the sample changed the estimates of the impact of progression through the treatment cascade among HIV-infected women very little compared to the analysis restricted to HIV-infected women. **Table A3** describes the characteristics of the women in the sample with both HIV-infected and HIV-uninfected women. **Table A4** describes contraceptive use among women in the sample. **Table A5** presents the results of the bivariate probit analysis, and **Table A6** presents the average marginal effects (AME). Compared to women who were HIV-infected but unaware of their HIV status, being on ART for less than a year increased the probability of a woman using single-method dual protection by 11.0 percentage points (pp, $p<0.001$) and increased the probability of a woman using dual-method dual protection by 4.9 pp ($p=0.002$), relative to estimates of 10.3 ($p=0.003$) and 5.2 pp ($p=0.007$), respectively, in the analysis restricted to HIV-infected women. Women who had been on ART for 4-7 years were 23.1 pp ($p<0.001$) more likely to use single-method dual protection and 10.4 pp ($p<0.001$) more likely to use dual-method dual protection than women who were unaware that they were HIV-infected, compared to estimates of 21.6 ($p<0.001$) pp and 11.2 pp ($p<0.001$) in the analysis restricted to HIV-infected women.

Comparing the analysis among HIV-infected women to the analysis among HIV-infected and HIV-uninfected women, all of the average marginal effects estimates changed by less than 2.8 pp with the exception of three; the estimated impact of unknown awareness of positive HIV status on single protection increased by 6.8 pp, the impact on single-method dual protection decreased by 11.0 pp, and the negative impact of not using any contraception decreased by 5.7 pp. However, none of these effects were significant in either the analysis including both HIV-uninfected and -infected women or in the analysis restricted to HIV-infected women.

Women who were HIV-uninfected were generally less likely to not use any method of contraception and were more likely to use dual-method dual protection and single protection, in order of increasing

magnitude, relative to those who were unaware that they were HIV-infected. The direction of the relationship with single-method dual protection was mixed, with those who were aware of their negative HIV status significantly less likely (-5.2 pp, p=0.001) and those who were unaware of their negative HIV status insignificantly less likely to use single-method dual protection relative to those who were unaware of being HIV-infected; those whose awareness of their positive HIV status was unknown and who had unknown HIV status were insignificantly more likely to use single-method dual protection. Those who knew they were HIV-uninfected were 4.5 pp (p=0.038) less likely not to use any contraception, those whose awareness of their negative HIV status was unknown were 8.4 pp (p=0.019) less likely not to use any contraception, and those who were of unknown HIV status were 6.6 pp (p=0.001) less likely not to use any contraception relative to those who were HIV-infected and unaware of their status. Those who were aware of their HIV-uninfected status were also 8.9 pp (p<0.001) more likely to use single protection and 5.2 pp (p=0.001) less likely to use single-method dual protection relative to those who were unaware of their positive HIV status.

We find that the estimates of the impact of progression through the HIV treatment cascade on contraceptive use among HIV-infected women are robust to the inclusion of HIV-uninfected women in the analysis. In particular, the impact of ART initiation and treatment remains substantial, with women who initiated treatment in the past year 11.0 pp more likely to use single-method dual protection and 4.9 pp more likely to use dual-method dual protection relative to women who were unaware of their positive HIV status. Women on ART for 4-7 years were 23.1 pp more likely to use single-method dual protection and 10.4 pp more likely to use dual-method dual protection.

We find that HIV-uninfected women were less likely not to use any contraception relative to women who were unaware of their positive HIV status. In particular, being aware of negative HIV status, having unknown awareness of negative HIV status, and having unknown HIV status led to statistically significantly lower probability of not using any method of contraception. Being aware of negative HIV

status also led to a statistically significantly greater probability of using single protection and a statistically significantly lower probability of using single-method dual protection, while being of unknown HIV status was associated with statistically significantly greater use of dual-method dual protection.

All of the changes in the estimates of the impact of HIV progression on contraceptive use are less than three percentage points different except for the estimated impact of unknown awareness of positive HIV status on single-method dual protection, single protection, and use of no contraception; the lower estimates of the impact of unknown awareness of positive HIV status on single-method dual protection may reflect underestimation due to reverse causation and use of single-method dual protection lowering the likelihood of exposure to HIV.

We conclude that the estimated impacts of progression through the HIV treatment cascade on contraceptive use among HIV-infected women are robust to the analysis including HIV-infected and HIV-uninfected women. We also find that women who are HIV-uninfected who are aware of their negative HIV status or for whom awareness of their negative HIV status is unknown are significantly less likely not to use any contraception relative to women who are unaware that they are HIV-infected.

3. Multiple imputation results

Among the 4624 women who reported that they were sexually active, 31.5% were missing at least one covariate in the main analysis and were therefore excluded from the main analysis. Excluding these women from the analysis could bias the results.[8] We assume that the missing data is missing at random, that is, missing data may depend on the values of other covariates included in the analysis and but not on any covariates excluded from the analysis. We multiply imputed covariates that were missing among the 4624 women who reported that they were sexually active using five multiple imputations by chained equations.[9] We estimated two probit models in which we controlled for substitute methods of contraception and present the results in **Table A7**. We found that the direction and highly statistically significant impacts of being aware of positive HIV status and of being on ART were consistent with the main results, while being in pre-ART counseling had a statistically significant positive impact on single-method dual protection in the imputed results but not in the complete case analysis. Having unknown awareness of positive HIV status did not have a statistically significant impact on contraceptive use in either the complete case analysis or the multiple imputation analysis. Overall, we conclude that participants excluded due to missing covariates did not introduce major biases into our study results.

4. Tables and Figures

Table A1: Effects of progression through the HIV treatment cascade on contraception: bivariate probit regression coefficients with recoded health variable

	Single protection			Single-method dual protection		
	Coefficient	**95% CI**	**p-value**	**Coefficient**	**95% CI**	**p-value**
Stages in the HIV treatment cascade						
HIV+, unaware of HIV status	Ref			Ref		
HIV+, awareness of HIV status unknown	-0.124	(-0.605 - 0.356)	0.612	0.409	(0.013 - 0.805)	0.043
HIV+, aware of HIV status	0.150	(-0.010 - 0.309)	0.066	0.243	(0.091 - 0.394)	0.002
Pre-ART	0.164	(-0.008 - 0.336)	0.062	0.132	(-0.037 - 0.301)	0.127
0-1 years on ART	0.083	(-0.150 - 0.315)	0.486	0.436	(0.211 - 0.662)	<0.001
1-2 years on ART	0.230	(-0.016 - 0.477)	0.067	0.426	(0.180 - 0.672)	0.001
2-4 years on ART	-0.037	(-0.268 - 0.194)	0.756	0.828	(0.604 - 1.052)	<0.001
4-7 years on ART	0.095	(-0.187 - 0.378)	0.508	0.906	(0.626 - 1.185)	<0.001
Age	0.073	(0.021 - 0.124)	0.006	0.083	(0.033 - 0.134)	0.001
Age squared	-0.001	(-0.002 - -0.000)	0.012	-0.002	(-0.002 - -0.001)	<0.001
Education	0.021	(0.001 - 0.042)	0.043	0.014	(-0.006 - 0.035)	0.158
Marital/conjugal relationship status	0.054	(-0.066 - 0.174)	0.376	-0.024	(-0.143 - 0.094)	0.688
Pregnancy status	-0.483	(-0.783 - -0.182)	0.002	-0.037	(-0.328 - 0.253)	0.801
Parity	0.051	(-0.006 - 0.108)	0.082	-0.084	(-0.146 - -0.022)	0.008
Distance to nearest major road	0.002	(-0.006 - 0.010)	0.001	-0.012	(-0.020 - -0.004)	0.003
Distance to nearest secondary road	0.001	(-0.042 - 0.045)	0.164	0.006	(-0.037 - 0.049)	0.774
Health						
Poor health	Ref			Ref		
Fine health	0.002	(-0.006 - 0.010)	0.643	-0.012	(-0.020 - -0.004)	0.003
Good, very good, or excellent health	0.001	(-0.042 - 0.045)	0.953	0.006	(-0.037 - 0.049)	0.774
Household wealth quintile						
Wealth Quintile 1	Ref			Ref		
Wealth Quintile 2	0.051	(-0.102 - 0.203)	0.515	-0.025	(-0.174 - 0.124)	0.743
Wealth Quintile 3	0.036	(-0.116 - 0.189)	0.641	0.010	(-0.139 - 0.159)	0.897
Wealth Quintile 4	0.050	(-0.105 - 0.204)	0.529	-0.056	(-0.210 - 0.097)	0.472
Wealth Quintile 5	-0.103	(-0.267 - 0.062)	0.222	0.109	(-0.051 - 0.269)	0.181
Calendar year						
2005	Ref			Ref		
2006	-0.164	(-0.684 - 0.357)	0.537	0.494	(0.059 - 0.929)	0.026
2007	-0.182	(-0.711 - 0.347)	0.501	0.629	(0.190 - 1.067)	0.005
2008	-0.587	(-1.244 - 0.070)	0.080	0.935	(0.441 - 1.428)	<0.001
2009	0.759	(0.225 - 1.293)	0.005	0.456	(-0.000 - 0.912)	0.050
2010	0.625	(0.100 - 1.150)	0.020	0.609	(0.166 - 1.052)	0.007
2011	0.604	(0.084 - 1.125)	0.023	0.664	(0.227 - 1.101)	0.003
2012	0.692	(0.170 - 1.213)	0.009	0.436	(-0.005 - 0.876)	0.053
Observations	3169					

ART = antiretroviral treatment, HIV+ = HIV-infected

Table A2: Effects of progression through the HIV treatment cascade on contraception: average marginal effects with recoded health

	No contraception			Single protection			Single-method dual protection			Dual-method dual protection		
	AME (in pp)	**95% CI**	**p-value**	**AME** (in pp)	**95% CI**	**p-value**	**AME** (in pp)	**95% CI**	**p-value**	**AME** (in pp)	**95% CI**	**p-value**
Stages in the HIV treatment cascade												
HIV+, unaware of HIV status	Ref			Ref			Ref			Ref		
HIV+ awareness unknown	-0.080	(-0.207 - 0.046)	0.213	0.119	(-0.006 - 0.243)	0.062	-0.062	(-0.162 - 0.038)	0.225	0.023	(-0.040 - 0.087)	0.473
HIV+, aware of HIV status	-0.094	(-0.140 - -0.047)	<0.001	0.046	(0.004 - 0.088)	0.031	0.012	(-0.028 - 0.052)	0.542	0.035	(0.015 - 0.056)	0.001
Pre-ART	-0.070	(-0.122 - -0.019)	0.008	0.017	(-0.029 - 0.064)	0.460	0.026	(-0.019 - 0.071)	0.253	0.027	(0.004 - 0.049)	0.021
0-1 years on ART	-0.129	(-0.195 - -0.063)	<0.001	0.102	(0.034 - 0.171)	0.004	-0.025	(-0.080 - 0.030)	0.368	0.052	(0.014 - 0.089)	0.007
1-2 years on ART	-0.156	(-0.225 - -0.086)	<0.001	0.080	(0.006 - 0.153)	0.033	0.005	(-0.058 - 0.068)	0.872	0.071	(0.027 - 0.115)	0.002
2-4 years on ART	-0.212	(-0.273 - -0.151)	<0.001	0.223	(0.151 - 0.296)	<0.001	-0.089	(-0.135 - -0.043)	<0.001	0.078	(0.036 - 0.119)	<0.001
4-7 years on ART	-0.249	(-0.318 - -0.180)	<0.001	0.218	(0.128 - 0.308)	<0.001	-0.080	(-0.137 - -0.023)	0.006	0.111	(0.052 - 0.169)	<0.001
Age	-0.037	(-0.052 - -0.021)	<0.001	0.014	(0.000 - 0.027)	0.047	0.009	(-0.004 - 0.022)	0.172	0.014	(0.008 - 0.020)	<0.001
Age squared	0.001	(0.000 - 0.001)	<0.001	-0.000	(-0.001 - -0.000)	0.007	0	(-0.000 - 0.000)	0.367	-0.000	(-0.000 - -0.000)	<0.001
Education	-0.008	(-0.015 - -0.002)	0.009	0.002	(-0.004 - 0.007)	0.555	0.004	(-0.002 - 0.009)	0.185	0.003	(0.001 - 0.006)	0.009
Marital/conjugal relationship status	-0.007	(-0.043 - 0.030)	0.72	-0.011	(-0.042 - 0.021)	0.516	0.015	(-0.016 - 0.046)	0.355	0.003	(-0.011 - 0.016)	0.724
Pregnancy status	0.111	(0.021 - 0.201)	0.015	0.023	(-0.061 - 0.107)	0.595	-0.099	(-0.156 - -0.041)	0.001	-0.035	(-0.056 - -0.014)	0.001
Parity	0.009	(-0.009 - 0.027)	0.338	-0.025	(-0.041 - -0.008)	0.003	0.019	(0.004 - 0.034)	0.012	-0.003	(-0.010 - 0.004)	0.401
Distance to nearest primary road	0.002	(0.000 - 0.005)	0.042	-0.003	(-0.005 - -0.001)	0.005	0.001	(-0.001 - 0.003)	0.149	-0.001	(-0.002 - 0.000)	0.054
Distance to nearest secondary road	-0.002	(-0.015 - 0.011)	0.786	0.001	(-0.010 - 0.013)	0.813	0.000	(-0.011 - 0.011)	0.964	0.001	(-0.004 - 0.006)	0.791
Health												
Poor health	Ref			Ref			Ref			Ref		
Fine health	0.011	(-0.064 - 0.087)	0.766	-0.046	(-0.103 - 0.011)	0.115	0.039	(-0.028 - 0.107)	0.256	-0.005	(-0.031 - 0.022)	0.733
Good, very good, or excellent health	-0.017	(-0.056 - 0.022)	0.396	0.012	(-0.022 - 0.046)	0.490	-0.001	(-0.034 - 0.032)	0.956	0.006	(-0.008 - 0.020)	0.431
Household wealth quintile												
Wealth Quintile 1	Ref			Ref			Ref			Ref		
Wealth Quintile 2	-0.006	(-0.052 - 0.040)	0.809	-0.010	(-0.050 - 0.030)	0.610	0.014	(-0.026 - 0.053)	0.489	0.002	(-0.015 - 0.020)	0.811
Wealth Quintile 3	-0.011	(-0.057 - 0.035)	0.643	-0.001	(-0.041 - 0.040)	0.974	0.008	(-0.032 - 0.047)	0.704	0.004	(-0.014 - 0.022)	0.666
Wealth Quintile 4	0.002	(-0.045 - 0.049)	0.93	-0.018	(-0.058 - 0.023)	0.388	0.016	(-0.024 - 0.057)	0.428	-0.001	(-0.018 - 0.017)	0.949
Wealth Quintile 5	-0.005	(-0.054 - 0.045)	0.855	0.036	(-0.009 - 0.082)	0.117	-0.032	(-0.072 - 0.008)	0.114	0.000	(-0.018 - 0.019)	0.982
Calendar year												
2005	Ref			Ref			Ref			Ref		
2006	-0.096	(-0.232 - 0.040)	0.168	0.146	(0.008 - 0.283)	0.037	-0.076	(-0.180 - 0.027)	0.148	0.026	(-0.045 - 0.097)	0.468
2007	-0.130	(-0.263 - 0.003)	0.056	0.185	(0.044 - 0.326)	0.010	-0.091	(-0.190 - 0.007)	0.070	0.036	(-0.041 - 0.113)	0.359
2008	-0.175	(-0.322 - -0.027)	0.02	0.331	(0.163 - 0.498)	<0.001	-0.163	(-0.236 - -0.090)	<0.001	0.007	(-0.071 - 0.084)	0.868

2009	-0.266	(-0.384 - -0.147)	<0.001	0.005	(-0.120 - 0.129)	0.943	0.106	(-0.033 - 0.245)	0.134	0.155	(0.042 - 0.268)	0.007
2010	-0.272	(-0.389 - -0.155)	<0.001	0.062	(-0.065 - 0.190)	0.336	0.06	(-0.065 - 0.185)	0.350	0.150	(0.046 - 0.255)	0.005
2011	-0.286	(-0.405 - -0.167)	<0.001	0.087	(-0.036 - 0.210)	0.166	0.056	(-0.064 - 0.176)	0.362	0.143	(0.049 - 0.236)	0.003
2012	-0.255	(-0.379 - -0.130)	<0.001	0.024	(-0.096 - 0.143)	0.698	0.106	(-0.024 - 0.235)	0.110	0.126	(0.034 - 0.217)	0.007
Observations	3169											

AME = average marginal effects, pp = percentage points, CI = confidence interval, Ref = reference category, ART = antiretroviral treatment, HIV+ = HIV-infected

Table A3: Sample characteristics

Stages in the HIV treatment cascade	
HIV-, aware	2360 (24)
HIV-, awareness of HIV status unknown	378 (4)
HIV-, unaware of HIV status	878 (9)
HIV status unknown	2976 (30)
HIV+, unaware of HIV status	539 (6)
HIV+, awareness of HIV status unknown	292 (3)
HIV+, aware of HIV status	928 (9)
Pre-ART	708 (7)
0-1 years on ART	201 (2)
1-2 years on ART	163 (2)
2-4 years on ART	220 (2)
4-7 years on ART	118 (1)
Age	30.18 (9.31)
Education (in school grades attained)	10.51 (2.97)
Marital/conjugal relationship status	3304 (33)
Distance to nearest major road (in km)	6.85 (6.63)
Distance to nearest secondary road (in km)	1.45 (1.22)
Pregnancy status	470 (5)
Health	
Poor health	78 (1)
Fine health	1315 (14)
Good health	994 (10)
Very good health	6112 (62)
Excellent health	1262 (13)
Parity	0.28 (0.97)
Household wealth quintile	
Poorest	1932 (20)
2nd	2015 (21)
3rd	1981 (20)
4th	2010 (21)
Richest	1823 (19)
Calendar year	
2005	988 (10)
2006	1210 (12)
2007	1105 (11)
2008	813 (8)
2009	787 (8)
2010	1235 (13)
2011	1903 (20)
2012	1720 (18)
Observations	9761

The numbers are N (%) for categorical variables – stages in the HIV treatment cascade, partner, pregnancy, wealth quintile and calendar year – and mean (standard deviation) for continuous variables – age, school grade attainment and distance to nearest major road.

Table A4: Distribution of contraceptive method

	N (%)
No contraception	**4612 (47)**
Single-method dual protection	**1995 (20)**
Male condom only	1914 (20)
Female condom only	65 (0)
Male condom and female condom	16 (0)
Single protection	**2250 (24)**
Injections	1,585 (16)
Pill	314 (3)
Female sterilization	350 (4)
Male sterilization	24 (0)
Dual-method dual protection	**367 (4)**
Male condom & injections	265 (3)
Male condom & pill	56 (1)
Male condom & female sterilization	31 (0)
Male condom & male sterilization	7 (0)
Female condom & injections	12 (0)
Female condom & pill	5 (0)
Female condom & female sterilization	5 (0)
Female condom & male sterilization	3 (0)
Observations	9761

Table A5: Effects of progression through the HIV treatment cascade on contraception: bivariate probit regression coefficients effects

	Single-method dual protection			Single protection		
	Coefficient	**95% CI**	**p-value**	**Coefficient**	**95% CI**	**p-value**
Stages in the HIV treatment cascade						
HIV-, aware	0.310	(0.169 - 0.452)	<0.001	-0.159	(-0.298 - -0.020)	0.025
HIV-, awareness unknown	0.232	(-0.001 - 0.465)	0.051	0.12	(-0.110 - 0.350)	0.306
HIV-, unaware	0.091	(-0.073 - 0.255)	0.278	-0.075	(-0.235 - 0.086)	0.362
Unknown HIV status	0.177	(0.037 - 0.316)	0.013	0.103	(-0.030 - 0.236)	0.130
HIV+, unaware of HIV status	Ref			Ref		
HIV+, awareness of HIV status unknown	0.032	(-0.223 - 0.287)	0.805	0.056	(-0.179 - 0.291)	0.639
HIV+, aware of HIV status	0.190	(0.035 - 0.344)	0.017	0.256	(0.107 - 0.405)	0.001
Pre-ART	0.216	(0.054 - 0.379)	0.009	0.179	(0.018 - 0.339)	0.029
0-1 years on ART	0.129	(-0.096 - 0.354)	0.261	0.498	(0.279 - 0.716)	<0.001
1-2 years on ART	0.282	(0.045 - 0.520)	0.020	0.458	(0.220 - 0.696)	<0.001
2-4 years on ART	-0.008	(-0.228 - 0.211)	0.941	0.935	(0.722 - 1.148)	<0.001
4-7 years on ART	0.137	(-0.131 - 0.406)	0.316	0.990	(0.724 - 1.256)	<0.001
Age	0.108	(0.082 - 0.134)	<0.001	0.040	(0.013 - 0.067)	0.004
Age squared	-0.002	(-0.002 - -0.001)	<0.001	-0.001	(-0.001 - -0.001)	<0.001
Education	0.019	(0.007 - 0.030)	0.001	0.039	(0.026 - 0.052)	<0.001
Marital/conjugal relationship status	0.063	(-0.007 - 0.133)	0.080	-0.153	(-0.226 - -0.080)	<0.001
Pregnancy status	-0.630	(-0.803 - -0.456)	<0.001	-0.286	(-0.457 - -0.116)	0.001
Parity	0.036	(0.003 - 0.070)	0.035	-0.099	(-0.142 - -0.057)	<0.001
Distance to nearest major road	0.002	(-0.003 - 0.006)	0.455	-0.016	(-0.021 - -0.012)	<0.001
Distance to nearest secondary road	-0.005	(-0.028 - 0.018)	0.678	-0.001	(-0.025 - 0.024)	0.946
Health						
Poor health	Ref			Ref		
Fine health	0.256	(-0.086 - 0.598)	0.142	0.136	(-0.248 - 0.520)	0.489
Good health	0.219	(-0.132 - 0.570)	0.222	0.108	(-0.282 - 0.497)	0.588
Very good health	0.276	(-0.061 - 0.613)	0.109	0.104	(-0.274 - 0.482)	0.589
Excellent health	0.138	(-0.213 - 0.489)	0.440	0.189	(-0.197 - 0.576)	0.337
Household wealth quintile						
Wealth Quintile 1	Ref			Ref		
Wealth Quintile 2	0.013	(-0.076 - 0.102)	0.781	-0.026	(-0.118 - 0.066)	0.584
Wealth Quintile 3	0.033	(-0.057 - 0.122)	0.477	-0.022	(-0.114 - 0.070)	0.642
Wealth Quintile 4	0.001	(-0.090 - 0.092)	0.981	0.045	(-0.048 - 0.137)	0.345
Wealth Quintile 5	-0.035	(-0.130 - 0.059)	0.462	0.091	(-0.005 - 0.187)	0.063
Calendar year						
2005	Ref			Ref		

2006	0.070	(-0.092 - 0.232)	0.396	0.153	(-0.001 - 0.308)	0.052
2007	0.015	(-0.151 - 0.181)	0.857	0.178	(0.021 - 0.334)	0.027
2008	-0.140	(-0.319 - 0.039)	0.125	0.207	(0.043 - 0.371)	0.013
2009	0.815	(0.640 - 0.989)	<0.001	-0.02	(-0.202 - 0.161)	0.825
2010	0.718	(0.549 - 0.886)	<0.001	0.13	(-0.039 - 0.299)	0.133
2011	0.663	(0.499 - 0.827)	<0.001	0.181	(0.020 - 0.342)	0.028
2012	0.659	(0.494 - 0.823)	<0.001	0.117	(-0.045 - 0.278)	0.157
Observations			9761			
ρ=-0.309; χ^2 = 236.015, p-value<0.0001						

Table A6: Effects of progression through the HIV treatment cascade on contraception: average marginal effects

	No contraception			Single protection			Single-method dual protection			Dual-method dual protection		
	AME (in pp)	**95% CI**	**p-value**	**AME** (in pp)	**95% CI**	**p-value**	**AME** (in pp)	**95% CI**	**p-value**	**AME** (in pp)	**95% CI**	**p-value**
Stages in the HIV treatment cascade												
HIV-, aware	-0.045	(-0.088 - -0.002)	0.038	0.089	(0.050 - 0.129)	<0.001	-0.052	(-0.082 - -0.022)	0.001	0.008	(-0.005 - 0.020)	0.217
HIV-, awareness unknown	-0.084	(-0.155 - -0.014)	0.019	0.049	(-0.014 - 0.112)	0.129	0.011	(-0.044 - 0.066)	0.696	0.024	(-0.002 - 0.051)	0.075
HIV-, unaware	-0.006	(-0.056 - 0.043)	0.803	0.027	(-0.016 - 0.071)	0.222	-0.022	(-0.058 - 0.015)	0.243	0.001	(-0.013 - 0.014)	0.925
Unknown HIV status	-0.066	(-0.107 - -0.025)	0.001	0.036	(0.001 - 0.072)	0.046	0.012	(-0.020 - 0.044)	0.449	0.017	(0.004 - 0.030)	0.009
HIV+, unaware of HIV status	Ref			Ref			Ref			Ref		
HIV+ awareness unknown	-0.021	(-0.095 - 0.054)	0.589	0.004	(-0.060 - 0.069)	0.895	0.011	(-0.047 - 0.068)	0.712	0.005	(-0.017 - 0.028)	0.637
HIV+, aware of HIV status	-0.105	(-0.151 - -0.059)	<0.001	0.028	(-0.013 - 0.068)	0.179	0.046	(0.008 - 0.085)	0.019	0.031	(0.014 - 0.049)	0.001
Pre-ART	-0.094	(-0.143 - -0.045)	<0.001	0.041	(-0.003 - 0.085)	0.068	0.026	(-0.014 - 0.066)	0.206	0.027	(0.009 - 0.046)	0.003
0-1 years on ART	-0.150	(-0.215 - -0.086)	<0.001	-0.009	(-0.064 - 0.045)	0.738	0.110	(0.047 - 0.173)	0.001	0.049	(0.018 - 0.081)	0.002
1-2 years on ART	-0.174	(-0.242 - -0.106)	<0.001	0.028	(-0.035 - 0.091)	0.384	0.083	(0.017 - 0.149)	0.013	0.063	(0.026 - 0.099)	0.001
2-4 years on ART	-0.238	(-0.297 - -0.180)	<0.001	-0.077	(-0.121 - -0.034)	<0.001	0.241	(0.174 - 0.308)	<0.001	0.075	(0.040 - 0.110)	<0.001
4-7 years on ART	-0.274	(-0.342 - -0.206)	<0.001	-0.061	(-0.118 - -0.005)	0.033	0.231	(0.149 - 0.314)	<0.001	0.104	(0.054 - 0.154)	<0.001
Age	-0.035	(-0.043 - -0.027)	<0.001	0.023	(0.017 - 0.030)	<0.001	0.002	(-0.004 - 0.008)	0.538	0.009	(0.007 - 0.012)	<0.001
Age squared	0.001	(0.000 - 0.001)	<0.001	-0.000	(-0.000 - -0.000)	<0.001	-0.000	(-0.000 - -0.000)	0.008	-0.000	(-0.000 - -0.000)	<0.001
Education	-0.013	(-0.017 - -0.009)	<0.001	0.002	(-0.001 - 0.005)	0.183	0.007	(0.004 - 0.010)	<0.001	0.004	(0.003 - 0.005)	<0.001
Marital/conjugal relationship status	0.019	(-0.003 - 0.040)	0.088	0.024	(0.006 - 0.043)	0.009	-0.038	(-0.054 - -0.021)	<0.001	-0.005	(-0.011 - 0.000)	0.061
Pregnancy status	0.198	(0.154 - 0.242)	<0.001	-0.124	(-0.153 - -0.094)	<0.001	-0.042	(-0.079 - -0.005)	0.025	-0.032	(-0.038 - -0.027)	<0.001
Parity	0.013	(0.002 - 0.025)	0.024	0.015	(0.006 - 0.024)	0.001	-0.024	(-0.034 - -0.014)	<0.001	-0.004	(-0.007 - -0.001)	0.013
Distance to nearest major road	0.003	(0.002 - 0.005)	<0.001	0.001	(0.000 - 0.003)	0.012	-0.004	(-0.005 - -0.003)	<0.001	-0.001	(-0.001 - -0.001)	<0.001
Distance to nearest secondary road	0.001	(-0.006 - 0.008)	0.709	-0.001	(-0.007 - 0.005)	0.713	0.000	(-0.006 - 0.006)	0.966	0.000	(-0.002 - 0.002)	0.718
Health												
Poor health	Ref			Ref			Ref			Ref		
Fine health	-0.094	(-0.204 - 0.016)	0.094	0.054	(-0.040 - 0.148)	0.258	0.013	(-0.077 - 0.103)	0.774	0.027	(-0.015 - 0.068)	0.205
Good health	-0.078	(-0.189 - 0.033)	0.170	0.046	(-0.048 - 0.141)	0.338	0.009	(-0.081 - 0.100)	0.839	0.022	(-0.019 - 0.064)	0.299
Very good health	-0.091	(-0.199 - 0.018)	0.101	0.061	(-0.023 - 0.146)	0.152	0.009	(-0.080 - 0.098)	0.841	0.02	(-0.006 - 0.047)	0.133
Excellent health	-0.076	(-0.187 - 0.035)	0.177	0.020	(-0.071 - 0.111)	0.663	0.034	(-0.060 - 0.128)	0.481	0.022	(-0.019 - 0.063)	0.286
Household wealth quintile												
Wealth Quintile 1	Ref			Ref			Ref			Ref		
Wealth Quintile 2	0.003	(-0.024 - 0.030)	0.845	0.005	(-0.018 - 0.028)	0.695	-0.007	(-0.028 - 0.015)	0.556	-0.001	(-0.008 - 0.007)	0.834
Wealth Quintile 3	-0.003	(-0.030 - 0.024)	0.826	0.009	(-0.014 - 0.032)	0.434	-0.007	(-0.028 - 0.015)	0.54	0.001	(-0.007 - 0.008)	0.884
Wealth Quintile 4	-0.01	(-0.038 - 0.017)	0.456	-0.002	(-0.026 - 0.021)	0.840	0.01	(-0.012 - 0.033)	0.377	0.003	(-0.005 - 0.011)	0.493
Wealth Quintile 5	-0.012	(-0.041 - 0.016)	0.392	-0.014	(-0.038 - 0.010)	0.248	0.023	(-0.001 - 0.047)	0.057	0.003	(-0.005 - 0.011)	0.422

Calendar year												
2005	Ref			Ref			Ref			Ref		
2006	-0.052	(-0.100 - -0.004)	0.034	0.007	(-0.034 - 0.048)	0.740	0.031	(-0.008 - 0.069)	0.119	0.014	(-0.002 - 0.031)	0.078
2007	-0.045	(-0.094 - 0.004)	0.073	-0.008	(-0.048 - 0.033)	0.710	0.040	(0.000 - 0.080)	0.049	0.012	(-0.004 - 0.028)	0.134
2008	-0.018	(-0.070 - 0.035)	0.509	-0.044	(-0.085 - -0.004)	0.031	0.058	(0.014 - 0.102)	0.009	0.004	(-0.012 - 0.019)	0.645
2009	-0.214	(-0.264 - -0.163)	<0.001	0.219	(0.166 - 0.273)	<0.001	-0.063	(-0.097 - -0.029)	<0.001	0.057	(0.031 - 0.083)	<0.001
2010	-0.212	(-0.260 - -0.164)	<0.001	0.174	(0.125 - 0.223)	<0.001	-0.027	(-0.063 - 0.009)	0.148	0.065	(0.040 - 0.089)	<0.001
2011	-0.207	(-0.254 - -0.160)	<0.001	0.154	(0.108 - 0.199)	<0.001	-0.008	(-0.044 - 0.028)	0.658	0.061	(0.040 - 0.083)	<0.001
2012	-0.193	(-0.241 - -0.146)	<0.001	0.159	(0.113 - 0.206)	<0.001	-0.021	(-0.056 - 0.015)	0.250	0.055	(0.034 - 0.076)	<0.001
Observations	9761											

AME = average marginal effects, pp = percentage points

Table A7: Effects of progression through the HIV treatment cascade on contraception: bivariate probit regression coefficients effects after multiple imputation of missing covariates

	Single protection			Single-method dual protection		
	Coefficient	**95% CI**	**p-value**	**Coefficient**	**95% CI**	**p-value**
Stages in the HIV treatment cascade						
HIV+, unaware of HIV status	Ref			Ref		
HIV+, awareness of HIV status unknown	-0.006	(-0.394 - 0.381)	0.974	0.218	(-0.097 - 0.533)	0.175
HIV+, aware of HIV status	0.191	(0.057 - 0.326)	0.005	0.278	(0.143 - 0.412)	<0.001
Pre-ART	0.210	(0.058 - 0.363)	0.007	0.210	(0.048 - 0.373)	0.012
0-1 years on ART	0.166	(-0.048 - 0.380)	0.127	0.556	(0.357 - 0.755)	<0.001
1-2 years on ART	0.273	(0.024 - 0.522)	0.032	0.485	(0.259 - 0.712)	<0.001
2-4 years on ART	0.155	(-0.062 - 0.380)	0.161	0.860	(0.647 - 1.073)	<0.001
4-7 years on ART	0.223	(-0.051 - 0.496)	0.110	0.908	(0.633 - 1.182)	<0.001
Age	0.108	(0.062 - 0.153)	<0.001	0.104	(0.061 - 0.147)	<0.001
Age squared	-0.002	(-0.002 - - 0.000)	<0.001	-0.002	(-0.003 - -0.001)	<0.001
Education	0.024	(0.006 - 0.041)	0.010	0.033	(0.016 - 0.051)	<0.001
Marital/conjugal relationship status	0.085	(-0.022 - 0.192)	0.120	0.037	(0.066 - 0.140)	0.480
Pregnancy status	-0.514	(0.796 - -0.233)	<0.001	-0.113	(-0.386 - 0.161)	0.417
Parity	0.043	(-0.014 - 0.100)	0.138	-0.090	(-0.146 - 0.034)	0.002
Distance to nearest major road	-0.002	(-0.009 - 0.005)	0.611	-0.011	(-0.019 - -0.003)	0.008
Distance to nearest secondary road	-0.007	(-0.0486 - 0.035)	0.757	0.007	(-0.033 - 0.047)	0.728
Health						
Poor health	Ref			Ref		
Fine health	0.085	(-0.367 - 0.537)	0.713	0.315	(-0.194 - 0.824)	0.223
Good health	0.062	(-0.405 - 0.529)	0.794	0.202	(-0.313 - 0.717)	0.440
Very good health	0.120	(-0.321 - 0.562)	0.594	0.336	(-0.156 - 0.828)	0.180
Excellent health	-0.076	(-0.547 - 0.394)	0.751	0.373	(-0.136 - 0.882)	0.150
Household wealth quintile						
Wealth Quintile 1	Ref			Ref		
Wealth Quintile 2	0.051	(-0.109 - 0.212)	0.522	0.025	(-0.119 - 0.168)	0.732
Wealth Quintile 3	0.023	(-0.112 - 0.157)	0.743	0.041	(-0.100 - 0.182)	0.566
Wealth Quintile 4	0.026	(-0.141 - 0.192)	0.758	-0.016	(-0.156 - 0.123)	0.817
Wealth Quintile 5	-0.080	(-0.234 - 0.075)	0.309	0.103	(-0.053 - 0.259)	0.191
Calendar year						
2005	Ref			Ref		
2006	-0.106	(-0.532 - 0.320)	0.626	0.259	(-0.096 - 0.613)	0.153
2007	-0.077	(-0.510 - 0.356)	0.728	0.376	(0.017 - 0.734)	0.040
2008	-0.320	(-0.758 - 0.117)	0.151	0.432	(0.076 - 0.789)	0.017

2009	0.588	(0.144 - 1.032)	0.009	0.315	(-0.095 - 0.726)	0.131
2010	0.616	(0.175 - 1.058)	0.006	0.438	(0.067 - 0.808)	0.021
2011	0.634	(0.194 - 1.074)	0.005	0.540	(0.168 - 0.912)	0.005
2012	0.695	(0.254 - 1.136)	0.002	0.306	(-0.070 - 0.681)	0.111
Single-method dual protection	-0.487	(-0.586 - -0.388)	<0.001			
Single protection				-0.505	(-0.606 - -0.404)	<0.001
Observations			4624			

We conducted two biprobit analyses controlling for the substitute method of contraception.

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