# Maternal Healthcare and the Spread of AIDS in Burkina Faso and Cameroon

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**Abstract**
This paper analyzes whether exposure to maternal healthcare is associated with a higher risk of HIV infection. Using data provided by Demographic and Health Surveys in Burkina Faso and Cameroon, the paper finds that women are 26% to 78% more likely to be HIV positive if they received tetanus toxoid injections during their last pregnancy. The analysis does not provide empirical evidence for the hypotheses that this association might be due to reverse causality, omitted variables or self-selection.

## 1. Introduction

At the end of 2005, an estimated 38.6 million people were infected with the Human Immunodeficiency Virus (HIV). More than 60% are living in sub-Saharan Africa, where 2.7 million people became newly infected and 2.0 million died from the acquired immune deficiency syndrome in 2005 (AIDS; see UNAIDS 2006).

HIV transmission occurs through direct contact with contaminated body fluids (blood, semen, vaginal fluid or breast milk). The transmission modes are unprotected sexual contacts, vertical transmission from mother to child, punctures with contaminated needles and sharp instruments (such as tattoo needles and injection equipment) and blood transfusions.

The relevance of different transmission modes is the subject of a controversial debate. It is widely asserted that in sub-Saharan Africa, HIV is predominantly transmitted heterosexually, and that this transmission mode accounts for more than 95% of all HIV infections (Schmid et al. 2004;

Garnett et al. 2006). Varying HIV prevalence rates are explained by differences in sexual behaviours (Philipson and Posner 1995; Caldwell 2000; Shelton et al. 2005), sexual network patterns (Morris and Kretzschmar 1997) and differences in transmission efficiencies through different levels of male circumcision (Auvert et al. 2001) or untreated sexually transmitted diseases (Oster 2005).

In contrast, Gisselquist and colleagues (2002) argue that unsafe medical care, particularly the re-use of syringes and needles, contributes to the spread of HIV/AIDS in sub-Saharan Africa and accounts for 20% to 40% of HIV infections. This hypothesis rests on the observation that rapid growth in the HIV/AIDS epidemic occurred in countries with wide access to medical care (Brewer et al. 2003). Increased risk of HIV seropositivity is associated with medical injections (Bloom et al. 2002; Pepin et al. 2006; Quigley et al. 1997, 2000; St Lawrence et al. 2006), blood transfusion (Adejuyigbe et al. 2003; Iliyasu et al. 2004) and exposure to maternal healthcare (Chao et al. 1994; Deuchert and Brody 2006). It was argued, however, that reverse causality hampers the interpretation of these studies. The positive association between exposure to healthcare and HIV seropositivity could be explained by HIV positives receiving treatment for HIV-related illnesses. Thus, a positive association between exposure to healthcare and HIV seropositivity is not necessarily an indicator for iatrogenic HIV transmission (Schmid et al. 2004).

The extent to which unsafe healthcare contributes to the spread of HIV in sub-Saharan Africa remains unclear. Having knowledge of the relevance of different transmission modes is, however, of special importance for the design of efficient HIV prevention strategies. If unsafe healthcare is an important factor driving sub-Saharan Africa's HIV/AIDS epidemic, more attention and resources need to be devoted to the prevention of iatrogenic HIV transmission. To provide further insight on the risk of HIV transmission within the formal healthcare sector, this paper empirically analyzes the determinants of HIV seropositivity (including exposure to healthcare). The study contributes to the existing literature because it empirically tests whether the positive association between healthcare exposure and HIV seropositivity is explained by data limitations such as confounding, reverse causality, omitted variables and self-selection.

The paper uses data from Demographic and Health Surveys (DHS) conducted in Burkina Faso and Cameroon. It analyzes data for a subsample of women who gave birth in the past 5 years and examines whether exposure to maternal healthcare (measured by receiving tetanus toxoid injections) is associated with HIV seropositivity. Because tetanus injections are not therapeutic injections but are given during pregnancy to prevent neonatal tetanus, this proxy for healthcare exposure largely reduces the bias caused by reverse causality. It is shown that receiving tetanus toxoid injections is powerfully and robustly associated with HIV seropositivity in Burkina Faso and Cameroon. The probability of HIV seropositivity increases by 26% in Burkina Faso and by 78% in Cameroon if the woman received any tetanus injections during last pregnancy. The analysis does not provide empirical evidence for the hypotheses that the association between tetanus injections and HIV seropositivity is explained by reverse causality, omitted variables or self-selection.

The remaining sections of the paper are organized as follows. Section 2 provides information on access to and quality of the formal healthcare sector in Western Africa. Section 3 presents the data used for this analysis and discusses the hypotheses tested in the paper. Section 4 portrays the methodology and presents the results. Section 5 discusses the results and provides a conclusion.

## 2. Challenges for Healthcare Services in Western Africa

The Human Development Report (UNDP 2005) reveals several severe health problems in Western Africa. Life expectancy at birth is lower than the African average, the burden of malaria is very high, and tuberculosis and HIV/AIDS are major health problems but less common than in Eastern or Southern Africa.

A particular problem is the high level of maternal and infant mortality. In Western Africa, the infant mortality rate is around 100 per 1000 live births; the maternal death rate is 430 to 1800 per 100,000 live births (UNDP 2005).[1] High levels of maternal and child mortality are associated with low access to maternal healthcare (Ronsmans et al. 2003). In Western Africa, less than 50% of births are attended by skilled health personnel (WHO 2005). Additionally, it is argued that the quality of maternal healthcare services is poor, resulting in severe maternal morbidity (Prual et al. 2000). This is confirmed by maternal health facility surveys conducted in Burkina Faso and Cameroon, which discovered major shortages of basic equipment, supplies and essential drugs. Many maternal health facilities had no electricity or source of clean water, and did not employ any skilled birth attendants or were understaffed. Most providers needed training in essential obstetric care functions (Family Care International 2005; Averting Maternal Death and Disability Program [AMDD] 2002).

A critical component of healthcare quality is injection and blood safety, because contaminated injection equipment and blood products carry a high risk of transmitting blood-borne pathogens such as HIV and hepatitis B and C. The WHO Regional Office for Africa carried out injection safety surveys that included several countries in Western Africa[2] (Dicko et al. 2000). Re-use of injection materials without sterilization, accidental needle-stick injuries among healthcare workers and injection-related abscesses were common in all considered countries.[3] Shortage of injection equipment, improper disposal leading to recycling and re-sale after use, and the lack of awareness about the risk of blood-borne–pathogen transmission explain this pattern (Dicko et al. 2000; Musa 2005). A similar picture can also be drawn for blood safety: In 2002, more than 25% of all units of blood transfused in sub-Saharan Africa had not been tested for HIV (WHO 2002). In Cameroon, HIV screening for blood transfusions was not available until the mid-1990s (Langman et al. 2006). Thus, at least until the late-1990s, administering unscreened blood products was very common in Western Africa.

## 3. Data and Hypotheses

This paper assesses the role of unsafe healthcare in spreading HIV/AIDS in Western Africa using data from Burkina Faso and Cameroon. The countries were chosen because they have recently conducted Demographic and Health Surveys (DHS) that allow a link to be made between individual HIV test results and information about receiving healthcare and sexual behaviour. They are nationally representative surveys designed to provide information on fertility; family planning; antenatal-, delivery- and postpartum-care; AIDS and other sexually transmitted infections.

In Cameroon, the DHS covered more than 10,000 households. All women attending the household (and men in 50% of households[4]) were interviewed. In households chosen for the male interviews, HIV tests were offered to all adults. In total, 10,565 women and 5280 men were interviewed; 5277 women and 5125 men were tested for HIV. The consenting rates for HIV testing were 92% for women and 90% for men. In Burkina Faso, the DHS covered more than 9000 households. Twelve thousand women and 3605 men were interviewed; 4223 women and 3418 men were tested for HIV. The participation rates for HIV testing were similar to those found in Cameroon (92.3% for women and 85.8% for men). National HIV prevalence rates based on DHS data are 1.8% for women and 1.9% for men in Burkina Faso, and 6.8% for women and 4.1% for men in Cameroon.[5]

Table 1 shows that HIV prevalence rates are higher for women who have been in contact with the formal healthcare system. HIV prevalence rates are considerably higher in Cameroon; however, the relative risk ratios (RR) are similar in Burkina Faso and Cameroon, indicating that HIV prevalence rates are 34% to 125% higher for women who were in contact with the formal healthcare sector.

It has been argued that the association between recent exposure to formal healthcare (i.e., visiting a healthcare provider in the past 12 months, injections in the past 3 months) and HIV seropositivity are constrained by reverse causality. HIV-positive women visit healthcare facilities or receive injections because they are ill with AIDS-related symptoms, including opportunistic infections (Schmid et al. 2004).

This argument is, however, less relevant for receiving blood transfusions, because blood transfusion is not a common treatment for opportunistic infections or other AIDS-defining conditions. The HIV transmission efficiency of blood transfusion is more than 90% (Piot and Bartos 2002), and it has been argued that contaminated blood transfusions may have played an important role in spreading HIV in sub-Saharan Africa (Schneider and Drucker 2006). However, only 10% of

HIV-positive women in the Cameroon DHS sample received blood transfusions, suggesting that the association of increasing HIV prevalence with other variables measuring exposure to healthcare may not exclusively be explained by transmission through contaminated blood transfusion.

**Table 1. HIV prevalence rates for women, by exposure to formal healthcare**

| | Burkina Faso | | | | Cameroon | | | |
|---|---|---|---|---|---|---|---|---|
| | No | Yes | | RR | No | Yes | | RR |
| **All women** | | | | | | | | |
| Visited health facility | 1.80% | 2.42% | | 1.34 | 5.47% | 7.95% | *** | 1.45 |
| Injection in past 3 months | n/a | n/a | | n/a | 6.16% | 9.15% | *** | 1.49 |
| Blood transfusion | n/a | n/a | | n/a | 6.43% | 12.21% | *** | 1.90 |
| **Women who gave birth in past 5 years** | | | | | | | | |
| Any tetanus injections | 1.34% | 2.00% | | 1.49 | 3.72% | 7.68% | *** | 2.06 |
| Skilled prenatal healthcare | 0.96% | 2.15% | * | 2.25 | 4.26% | 7.15% | ** | 1.68 |
| Skilled birth assistance | 1.59% | 2.20% | | 1.38 | 4.40% | 8.02% | *** | 1.82 |
| Delivery in health facility | 1.54% | 2.25% | | 1.46 | 4.13% | 8.18% | *** | 1.98 |

Note. Information about injections in the past 3 months and blood transfusions is not available for Burkina Faso.
RR = relative risk ratio; n/a = not available.
Significance levels based on Pearson chi2 test of independence: *** 1%, ** 5%, * 10%.

The positive association between receiving antenatal healthcare (tetanus injections,[6] skilled prenatal healthcare and birth assistance, delivery in health facilities) and HIV seropositivity is less constrained by reverse causality. The primary reason for receiving maternal healthcare is because women are pregnant, not because they are sick. Thus, this paper analyzes the association between receiving maternal healthcare and HIV prevalence using data from the subsample of women who gave birth in the past 5 years. [7]

This subsample is not representative because it concentrates on sexually active women of reproductive age who are exposed to both risk factors (unsafe sex and potentially unsafe healthcare). Of all women in the subsample, 67% in Burkina Faso and 75% in Cameroon received any tetanus injections during the last birth; 76% and 81% received skilled prenatal care; 42% and 62% received skilled birth assistance; and 43% and 63% delivered in a health facility in Burkina Faso and Cameroon, respectively. Detailed information about medical treatments other than receiving a tetanus vaccination is not available. Thus, receiving antenatal healthcare serves only as proxy for receiving (potentially) unsafe healthcare.

Unconditional risk ratios provided in Table 1 show that HIV prevalence rates for women who received any kind of maternal healthcare are 38% to 125% higher than for women who did not receive maternal healthcare during last pregnancy. However, DHS data is non-experimental. In principle it could be true that the observed association between maternal healthcare exposure and HIV serostatus does not portray a causal relationship but is driven by data limitations. To verify that the observed association between receiving maternal healthcare and HIV serostatus is not driven by data limitations, this paper tests the following hypotheses:

*Hypothesis 1:* Exposure to maternal healthcare is not independent from other risk factors (see

Appendix A.3). For example, promiscuous behaviour or concurrent partnerships may be correlated with wealth and, thus, increase HIV infection rates for wealthy people (Shelton et al. 2005). Wealth, however, increases access to maternal healthcare. Thus, the pattern can be explained by *confounders.*

*Hypothesis 2:* Higher HIV prevalence rates among women who receive maternal healthcare may be driven by the behaviours of their partners. Household wealth, for example, is an important determinant of male risk-taking sexual behaviours (Kongnyuy et al. 2006). As a consequence, wealthier men may be at higher risk of sexual HIV transmission, and this risk may be carried over to their partners (who have better access to maternal healthcare). Thus, the positive association between maternal healthcare and HIV seropositivity may be explained by *unobserved variables.*

*Hypothesis 3:* Exposure to maternal healthcare may not be independent from HIV serostatus. The positive relation between HIV seropositivity and exposure to maternal healthcare could be explained by HIV-infected women being more likely to receive maternal healthcare. This could be the case if antiretroviral treatment is available to reduce HIV transmission from mother to child, which increases the incentive to search for prenatal healthcare. Another possibility is that HIV-infected women are more likely to be sick and, thus, search for treatment. Once women are in contact with the healthcare system, the probability of accessing maternal healthcare services increases. Thus, the pattern may be explained by *reverse causality.*

*Hypothesis 4:* Respondents voluntarily decide on HIV testing. HIV tests results are not provided automatically, but respondents can get them from a nearby Voluntary Counselling and Testing (VCT) provider. However, women with limited access to healthcare providers may also have limited access to VCT providers and, thus, are less likely to consent to HIV testing. Thus, women who received maternal healthcare may be over-represented in the subsample, and the observed pattern between HIV prevalence and maternal healthcare may be driven by a *self-selection bias.*

## 4. Methodology and Results

To test Hypothesis 1, regression analyses are used to control for confounders. Since the outcome variable is a binary variable indicating that a woman tests HIV positive, the paper uses a Probit model[8] to estimate the probability of a positive HIV test.

The central explanatory variable proxies access to healthcare. A binary variable indicates that the respondent received any tetanus toxoid injection during last pregnancy. A second set of regressions is estimated, including the number of tetanus toxoid injections.

The analysis controls for factors that may be associated with sexual HIV transmission. The model includes the number of sexual partners in the previous 12 months and variables on sexual history: the years of sexual activity and the number of lifetime partners. The latter variable is available for Cameroon only. To allow for nonlinear effects, square terms of these variables are included. Consistent condom use can reduce the risk of sexual HIV transmission and, thus, a variable indicating that condoms are used as a contraception device is included.[9] The risk of HIV infection depends on HIV prevalence in the contact group. Risk profiles are not available and, thus, regional HIV prevalence rates are used as a proxy. Socio-economic variables (wealth and education), marital status, rural residence, employment and religious confession may be risk factors (e.g., they may capture unobserved differences in sexual behaviours or sexual networks) and, thus, are included into the regression.

The regression coefficients are presented in Table 2. Receiving tetanus injections is significantly associated with HIV seropositivity. In Burkina Faso, the number of injections is significantly associated with HIV seropositivity; in Cameroon, the binary variable that indicates the respondent received any tetanus injections is significantly associated with HIV seropositivity. Conditional relative risk ratios (evaluated at mean values of covariates) reveal that receiving any tetanus injections increases the probability of a positive HIV test by 78% in Cameroon and 26% in Burkina Faso.

Sexual history is positively associated with HIV serostatus. Years of sexual activity increases the probability of HIV infection. The effect is nonlinear, peaking at 17 years in Burkina Faso and 15 years in Cameroon. It could be the case that women who started their sexual activity before the epidemic took off may be less likely to have acquired the virus. Another possibility is that women who acquired the disease at their sexual debut have already died of causes related to HIV/AIDS. In Cameroon, the number of lifetime partners increases the risk of HIV; the effect is nonlinear, peaking at 15 partners. Because more than 98% of women report less than 15 lifetime partners, the peak is a statistical effect rather than indicating that having more than 15 partners decreases the probability of HIV seropositivity. Recent sexual behaviour measured by the number of partners in the past 12 months and condom use is not significantly associated with HIV. Surprisingly, women who reported sexual activity in the past 4 weeks are less likely to be HIV positive (significant for Cameroon only). One possible explanation is that recent sexual activity is constrained by reverse causality. HIV-positive women may be more likely to be sick and, as a consequence, abstain from sexual activity.

**Table 2. Regression results (Probit model)**

| | Burkina Faso | | | | | | Cameroon | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | coef. | | t | coef. | | T | coef. | | t | coef. | | t |
| Number of tetanus injections | 0.11 | * | 1.72 | | | | 0.05 | | 1.50 | | | |
| Any tetanus injections | | | | 0.09 | | 0.61 | | | | 0.26 | ** | 2.39 |
| Number of partners (12 months) | 0.00 | | -0.02 | -0.01 | | -0.07 | 0.10 | | 1.62 | 0.10 | | 1.59 |
| Number of partners (lifetime) | | | | | | | 0.09 | *** | 2.96 | 0.09 | *** | 2.96 |
| Number of partners (lifetime), squ. | | | | | | | 0.00 | ** | -1.99 | 0.00 | ** | -1.99 |
| Condom use (contraception) | | | | | | | -0.10 | | -0.62 | -0.09 | | -0.56 |
| Sexual active in past 4 weeks | -0.09 | | -0.59 | -0.09 | | -0.55 | -0.21 | ** | -2.34 | -0.21 | ** | -2.33 |
| Years of sexual activity | 0.07 | * | 1.89 | 0.07 | * | 1.85 | 0.11 | *** | 4.28 | 0.11 | *** | 4.27 |
| Years of sexual activity, squared | 0.00 | | -1.63 | 0.00 | | -1.61 | 0.00 | *** | -4.02 | 0.00 | *** | -4.01 |
| HIV prevalence | 0.12 | * | 1.93 | 0.12 | * | 1.91 | 0.12 | *** | 5.77 | 0.12 | *** | 5.74 |
| Rural resident | -0.30 | | -1.38 | -0.30 | | -1.37 | -0.17 | * | -1.78 | -0.17 | * | -1.76 |
| Wealth: poorest quintile | -0.07 | | -0.33 | -0.07 | | -0.33 | -0.01 | | -0.08 | 0.00 | | 0.01 |
| Wealth: richest quintile | 0.13 | | 0.57 | 0.14 | | 0.64 | 0.04 | | 0.33 | 0.05 | | 0.37 |
| Education: primary | 0.07 | | 0.36 | 0.07 | | 0.33 | -0.15 | | -1.00 | -0.17 | | -1.15 |
| Education: secondary, higher | -0.19 | | -0.57 | -0.17 | | -0.53 | -0.12 | | -0.72 | -0.15 | | -0.89 |
| Working | 0.09 | | 0.38 | 0.06 | | 0.26 | -0.04 | | -0.39 | -0.03 | | -0.33 |
| Married | -0.45 | *** | -2.91 | -0.44 | *** | -2.86 | -0.43 | *** | -4.48 | -0.43 | *** | -4.49 |
| Muslim | 0.04 | | 0.28 | 0.04 | | 0.28 | 0.11 | | 0.77 | 0.12 | | 0.85 |
| _cons | -2.16 | *** | -3.75 | -2.05 | *** | -3.55 | -2.59 | *** | -8.70 | -2.70 | *** | -8.85 |
| Pseudo R2 | | | 0.08 | | | 0.07 | | | 0.12 | | | 0.12 |
| *N* | | | 2412 | | | 2412 | | | 2571 | | | 2572 |

Significance levels: *** 1%, ** 5%, * 10%; data is from the subsample of women who gave birth in the past 5 years.

In both countries, married women are less likely to be infected. Women are more likely to be infected when living in a region with higher HIV prevalence rate and less likely to be infected if they are residents of rural areas (in Cameroon only). In contrast to other DHS studies (Shelton et al. 2005), socio-economic factors (education and wealth) are not significantly associated with HIV prevalence. Education and wealth are jointly insignificant in regressions excluding tetanus injections and also insignificant in regression including only wealth or education.[10]

Hypothesis 2 states that the higher risk for women receiving tetanus injections is driven by the partners' behaviour. Information about partners is available for married women. Eighty-six percent of women in Burkina Faso and 68% in Cameroon in the considered subsample are married. Figure 1 shows that the increased risk of wives who received tetanus injections is unlikely to be explained by the higher risk of their husbands. In Burkina Faso, husbands of women who received tetanus injections have lower HIV prevalence than husbands of women who did not receive them. In Cameroon, HIV prevalence is higher for husbands if their wives received tetanus injections. However, the increase in risk is far less than their wives' risk increase, which makes it unlikely that the association between female HIV prevalence and receiving tetanus injections is explained by husbands infecting their wives. This result is in line with the study from Rakai, Uganda, that shows the higher risk of HIV infection during pregnancy is not explained by women's or men's sexual behaviour, because pregnant women and their partners reported significantly fewer external sexual partners (Gray et al. 2005). However, this result holds only for married couples. Information about extramarital partners and non-married couples is not available. To statistically test if the association between tetanus injection and HIV prevalence is explained by omitted variables (i.e., risk profiles of the partners), instrumental variables with Probit estimation (IV Probit) is applied (Wooldbridge 2002).

Instruments can be also used to test Hypothesis 3. This hypothesis refers to reverse causality, which arises if women who are HIV positive are more likely to received tetanus injections.

Access to (maternal) healthcare is determined by demand- and supply-side factors (Ensor and Cooper 2004). Because DHS did not conduct a detailed community questionnaire in Burkina Faso and Cameroon, supply-side determinants for healthcare are not available. Therefore, the paper uses as instruments self-reported demand barriers that prevent women from getting medical advice or treatment.

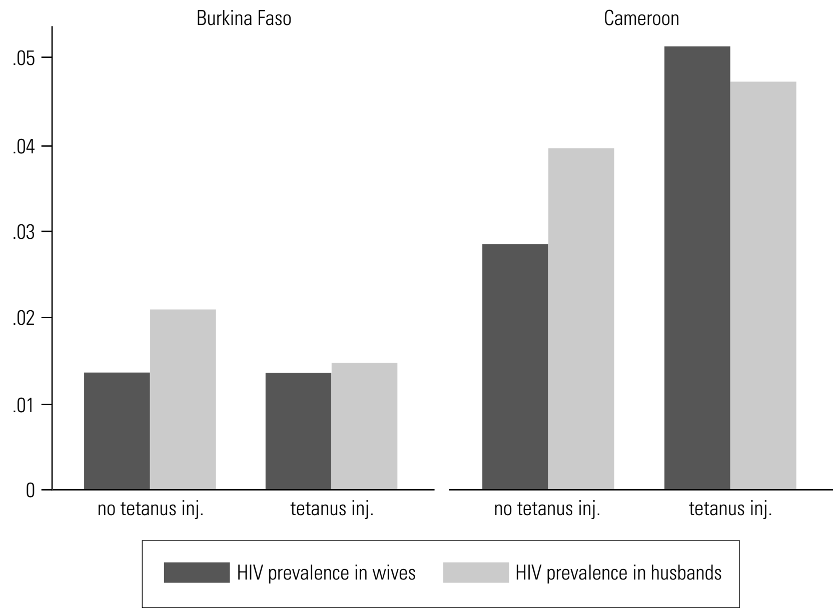
The self-reported barriers are (i) difficulties in reaching a health facility, (ii) intra-household allocation and (iii) cultural factors. Difficulties in reaching a health facility are measured by lack of knowledge about where the next health facility is, long distance and having to take transportation. The factor measuring intra-household allocation is whether the woman needs permission to get treatment. Cultural barriers are defined by the concern that there may not be a female health provider. For each of these variables, women responded whether the factor was a "big problem" or a "small problem" (reference value).

The results from the reduced form specification of the instrumented variable can be found in the Appendix (Table A.4). The F-test rejects the null hypothesis that the coefficients of all instruments are jointly zero on a 1% significance level. With exception from the regression model using the number of injections in Burkina Faso, all F-statistics are greater than 10, which provides reasonable insurance against a weak instrument bias (Bound et al. 1995).

The over-identifying restriction is tested after the two-step estimation of the IV Probit model.[11] The corresponding test statistics are between 2.6 and 3.1 and do not provide sufficient empirical evidence that the instruments are correlated with the error term of the second-stage equation. Thus, the instruments appear to be valid.

The results for the IV Probit are presented in the Appendix (Table A.5). The coefficients for tetanus injections are positive in all regressions. The results confirm those from the standard Probit model. For Cameroon, the coefficient for receiving any tetanus injections is significant on the 5% significance level; for Burkina Faso, the coefficient for number of tetanus injections is significant on the 11% significance level. All other coefficients are similar in size and significance to the coefficients from the standard Probit regression. However, exogeneity of the instrumented variable cannot be rejected in any model. Thus, the estimates from the regular Probit appear to be consistent but have smaller standard errors than those from the IV Probit (Wooldridge 2002). This may explain why the coefficient for the number of tetanus injections in the Burkina Faso model loses significance.

**Figure 1. HIV prevalence in marital couples (by wives receiving tetanus injections)**




Note. Only couples in which the wife gave birth in the past 5 years are included.

One may argue that self-reported difficulties in reaching a health facility may not be strictly exogenous, because difficulties in reaching a health facility are more common in rural settings, where people have less opportunity for risk-taking sexual behaviours. Therefore, this paper uses an alternative specification and excludes self-reported difficulties in reaching a health facility from the list of instruments (Table A.6). In both countries, the coefficients for receiving tetanus injections are larger than in the standard Probit model and are significant on the 1% significance level.[12]

Hypothesis 4 refers to the methodology of how the sample is collected. Because women voluntarily decided on HIV testing, the sample is self-selected. The association between HIV prevalence and tetanus injection may be a result of a sample selection bias if women receiving tetanus injections are more likely to consent to HIV testing. To account for a possible selection bias, a Heckman Selection Probit[13] model is employed; it separately models the probability of consenting to HIV testing (selection model) and the probability of HIV infection (outcome model).

Women did not receive test results automatically, but obtained them from a nearby VCT provider. VCT is often provided by health facilities and, thus, barriers that prevent women from accessing medical advice or treatment are also barriers to HIV testing. Thus, access barriers are used as additional instruments to model the selection stage. Results are presented in the Appendix (Tables A.7 and A.8). Receiving tetanus injections is not related to testing (selection stage). The coefficients for tetanus injections are significant in the outcome equation (probability of HIV seropositivity), confirming the positive association between tetanus injections and HIV serostatus. Again, all other coefficients are similar in size and significance, as are the coefficients from the standard Probit regression.

To test if the error terms of the selection and outcome models are dependent, a likelihood-ratio test is employed. Dependence can be rejected for all models, suggesting that the outcomes from the Probit model and the outcomes from the Heckman Selection Probit model are not significantly different. Thus, results from the standard Probit model appear to be unbiased.

## 5. Discussion and Conclusion

This study analyzes the association between healthcare exposure and HIV serostatus. Within standard Probit models that control for socio-economic variables and sexual behaviour and history, HIV seropositivity is significantly associated with tetanus injections received during last pregnancy. The paper does not find empirical evidence consistent with the hypotheses that this pattern is explained by confounding, reverse causality, omitted variables or self-selection. Thus, the positive association between receiving tetanus injections and HIV seropositivity could be an indicator for the hypothesis that unsafe healthcare contributes to the spread of HIV in Burkina Faso and Cameroon.

A low quality of healthcare has been documented for Burkina Faso and Cameroon. The results from this analysis raise the fear that further distributing low-quality healthcare services may accelerate the spread of HIV in these countries. Thus, public health interventions may need to concentrate on providing safe medical equipment (such as surgical instruments, syringes and safe blood products) and on training health workers to adequately use this equipment. In addition, patients may need to be informed about the risk of HIV transmission by iatrogenic procedures. Informed patients can protect themselves when seeking medical care by, for example, insisting on unused injection equipment or bringing their own equipment.

Several factors may hamper the interpretation of the results presented in this paper. DHS data relies on self-reported sexual behaviour and it is not known if results are skewed by misreporting, in particular, by under-reporting the number of partners. However, women receiving tetanus injections are not known to under-report the number of partners more than other people. Thus, the results from the study are unlikely to be biased by under-reporting by women receiving tetanus injections. Furthermore, relevant information is missing, such as the number of lifetime partners (Burkina Faso) and sexual practices. Moreover, it is not known when the infection occurred and which treatment women received (i.e., how many injections the respondent received in total and whether or not these injections were unsafe). Therefore, it is not possible to quantify the relative importance of sexual transmission versus transmission by unsafe medical care. Since knowledge about the relevance of different transmission modes is essential for efficiently designed public health interventions, further research is needed.

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## Notes

1 In high-income countries, the infant mortality rate is 5 per 1000 births; the maternal death rate is 8 per 100,000 live births (UNDP 2005).

2 The considered countries in Western Africa are Burkina Faso, Cameroon, Chad, Guinea-Bissau and Senegal.

3 In Burkina Faso, the survey found that only 11% of rural health centres, 60% of provincial dispensaries, and 80% of urban health centres used new syringes and needles for each injection. A substantial amount of injections were given by untrained labourers. A later study observed 116 injections in 52 health facilities and found that almost all were given with new single-use syringes and needles (Fitzner et al. 2004). However, this may have been a demonstration effect and does not provide compelling evidence for injection safety in Burkina Faso.

4 Households were randomly selected for the male survey.

5 The term HIV refers to HIV-1 and HIV-2 infections. In Burkina Faso, 0.3% of women and 0.4% of men were infected with HIV-2; 1.5 % of men and women were infected with HIV-1. In Cameroon, almost all respondents were infected with HIV-1. A detailed description of the surveys can be found in INS (2004) and INSD (2004).

6 Tetanus toxoid injections are given to mothers to protect their infants against neonate tetanus, a frequent cause of death in many developing countries.

7 Descriptive statistics for this subsample is presented in Appendix Tables A.1 and A.2.

8 Unlike the Logit model, which assumes errors follow the standard logistic distribution, the Probit model assumes the standard normal distribution. The linear transformation on the dependent variable is fairly similar for Logit and Probit models (details can be found in Greene 2000). The Probit model is chosen over the Logit model because subsequent analyses are based on the normal assumption. Re-estimating the models from Table 2 using the Logit model shows that the outcome was not affected by the distributional assumption. The results are not reported but are available from the author upon request.

9 In Burkina Faso, too few women use condoms as contraception method. This variable predicts the failure perfectly and, therefore, this information is not included in the Burkina Faso model.

10 To test for multicollinearity, Variance Inflation Factors (VIF) based on a linear probability model (OLS) are estimated. Apart from variables that are included as polynomials, all remaining VIFs are less than three, suggesting that multicollinearity is not a problem. Results are not reported but are available from the author upon request.

11 The results are not reported but are available from the author upon request.

12 This indicates that HIV positive women are less likely to get tetanus injections; this may be explained by the supply and the demand side of healthcare. If the maternal health provider knows (or at least guesses) the serostatus of the patient, the provider may be less willing to administer injections because she tries to avoid acquiring a known infection by accidental needle-stick injuries, or because syringes and needles are not available and she does not want to contaminate scarce equipment. Supply-side discrimination has been reported (Sadob et al. 2006). Viewed from the demand side, women who adopt a healthy lifestyle (including the avoidance of high-risk sexual behaviours) may also be more likely to vaccinate their unborn babies.

13 Details on the Heckman Selection Probit can be found in Greene (2000).

## References

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## Appendix

**Table A.1. Descriptive statistics (Burkina Faso)**

| Variable | *N* | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| HIV serostatus | 2448 | 0.02 | 0.13 | 0 | 1 |
| Any tetanus injections | 7290 | 0.67 | 0.47 | 0 | 1 |
| Number of tetanus injections | 7290 | 1.20 | 1.02 | 0 | 6 |
| Barrier: where to go | 7367 | 0.83 | 0.37 | 0 | 1 |
| Barrier: permission | 7366 | 0.84 | 0.37 | 0 | 1 |
| Barrier: distance | 7366 | 0.52 | 0.50 | 0 | 1 |
| Barrier: transport | 7366 | 0.60 | 0.49 | 0 | 1 |
| Barrier: no female provider | 7366 | 0.86 | 0.35 | 0 | 1 |
| Number of partners (12 months) | 7359 | 0.70 | 0.46 | 0 | 2 |
| Sexual active in past 4 weeks | 7359 | 0.40 | 0.49 | 0 | 1 |
| Years of sexual activity | 7344 | 12.80 | 7.54 | 0 | 36 |
| HIV prevalence | 7367 | 1.69 | 1.05 | 0.1 | 4.2 |
| Rural resident | 7367 | 0.82 | 0.38 | 0 | 1 |
| Wealth: poorest quintile | 7367 | 0.18 | 0.38 | 0 | 1 |
| Wealth: richest quintile | 7367 | 0.18 | 0.38 | 0 | 1 |
| Education: primary | 7367 | 0.10 | 0.29 | 0 | 1 |
| Education: secondary, higher | 7367 | 0.04 | 0.21 | 0 | 1 |
| Working | 7367 | 0.92 | 0.27 | 0 | 1 |
| Married | 7367 | 0.84 | 0.36 | 0 | 1 |
| Muslim | 7365 | 0.57 | 0.50 | 0 | 1 |

**Table A.2. Descriptive statistics (Cameroon)**

| | *N* | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| HIV serostatus | 2646 | 0.07 | 0.25 | 0 | 1 |
| Any tetanus injections | 5224 | 0.75 | 0.43 | 0 | 1 |

**Table A.2. Continued**

| | | | | | |
|---|---|---|---|---|---|
| Number of tetanus injections | 5222 | 1.55 | 1.18 | 0 | 6 |
| Barrier: where to go | 5315 | 0.17 | 0.38 | 0 | 1 |
| Barrier: permission | 5313 | 0.13 | 0.33 | 0 | 1 |
| Barrier: distance | 5313 | 0.41 | 0.49 | 0 | 1 |
| Barrier: transport | 5312 | 0.39 | 0.49 | 0 | 1 |
| Barrier: no female provider | 5297 | 0.13 | 0.34 | 0 | 1 |
| Number of partners (12 months) | 5300 | 0.91 | 0.59 | 0 | 20 |
| Number of partners (lifetime) | 5302 | 3.08 | 4.55 | 1 | 95 |
| Condom use (contraception) | 5321 | 0.07 | 0.26 | 0 | 1 |
| Sexual active in past 4 weeks | 5301 | 0.56 | 0.50 | 0 | 1 |
| Years of sexual activity | 5307 | 11.93 | 7.23 | 0 | 36 |
| HIV prevalence | 5321 | 5.47 | 2.44 | 1.7 | 8.7 |
| Rural resident | 5321 | 0.59 | 0.49 | 0 | 1 |
| Wealth: poorest quintile | 5321 | 0.22 | 0.42 | 0 | 1 |
| Wealth: richest quintile | 5321 | 0.16 | 0.37 | 0 | 1 |
| Education: primary | 5321 | 0.44 | 0.50 | 0 | 1 |
| Education: secondary, higher | 5321 | 0.32 | 0.47 | 0 | 1 |
| Working | 5321 | 0.70 | 0.46 | 0 | 1 |
| Married | 5321 | 0.67 | 0.47 | 0 | 1 |
| Muslim | 5313 | 0.19 | 0.39 | 0 | 1 |

**Table A.3. Average values (confounders) by receiving tetanus injections**

| | Burkina Faso | | | Cameroon | | |
|---|---|---|---|---|---|---|
| | Received any tetanus injections | | | Received any tetanus injections | | |
| | No | Yes | | No | Yes | |
| Number of partners (12 months)[§] | 0.70 | 0.70 | | 0.91 | 0.91 | |
| Number of partners (lifetime)[§] | | | | 2.70 | 3.22 | *** |
| Condom use (contraception) | 0.01 | 0.03 | *** | 0.04 | 0.08 | *** |
| Sexual active in past 4 weeks | 0.40 | 0.40 | | 0.59 | 0.54 | *** |
| Years of sexual activity[§] | 13.73 | 12.34 | *** | 12.46 | 11.74 | *** |
| Rural resident | 0.92 | 0.81 | *** | 0.69 | 0.57 | *** |
| Wealth: poorest quintile | 0.24 | 0.15 | | 0.33 | 0.18 | *** |

**Table A.3. Continued**

| | | | | | | |
|---|---|---|---|---|---|---|
| Wealth: richest quintile | 0.08 | 0.22 | *** | 0.11 | 0.17 | *** |
| Education: primary | 0.05 | 0.12 | *** | 0.36 | 0.47 | *** |
| Education: secondary, higher | 0.02 | 0.06 | *** | 0.20 | 0.35 | *** |
| Not working | 0.94 | 0.91 | *** | 0.72 | 0.70 | |
| Married | 0.86 | 0.83 | *** | 0.74 | 0.65 | *** |
| Muslim | 0.55 | 0.58 | ** | 0.29 | 0.16 | *** |

Note. Variables marked with § are tested on equality of mean; remaining (dummy) variables are tested on independence (Pearson chi$^2$ test).
*** 1%, ** 5%, * 10%; data is from the subsample of women who gave birth in the past 5 years.

**Table A.4. Reduced form specification of tetanus injections (OLS)**

| | Burkina Faso | | | | | | Cameroon | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Any tetanus injections | | | Number of tetanus injections | | | Any tetanus injections | | | Number of tetanus injections | | |
| | coef. | | t | coef. | | t | coef. | | T | coef. | | t |
| Barrier: where to go | 0.02 | | 0.79 | 0.06 | | 1.01 | -0.07 | *** | -2.61 | -0.10 | | -1.47 |
| Barrier: permission | -0.10 | *** | -3.40 | -0.11 | * | -1.65 | -0.05 | * | -1.77 | -0.07 | | -0.95 |
| Barrier: distance | -0.09 | *** | -3.79 | -0.12 | ** | -2.32 | -0.04 | | -1.41 | -0.08 | | -1.00 |
| Barrier: transport | -0.02 | *** | -0.80 | -0.03 | | -0.57 | -0.08 | *** | -2.78 | -0.21 | *** | -2.72 |
| Barrier: no female provider | -0.03 | *** | -1.22 | -0.14 | ** | -2.28 | -0.09 | *** | -3.28 | -0.27 | *** | -3.64 |
| _cons | 0.73 | | 53.41 | 1.28 | *** | 42.75 | 0.81 | *** | 71.58 | 1.68 | *** | 55.00 |
| F(5) | | | 11.29 | | | 4.96 | | | 19.79 | | | 14.48 |

*** 1%, ** 5%, * 10%; data is from the subsample of women who gave birth in the past 5 years and who consented to HIV testing.

**Table A.5. Regression coefficients (IV Probit), full specification**

| | Burkina Faso | | | | | | Cameroon | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | coef. | | t | coef. | | t | coef. | | t | coef. | | t |
| Number of tetanus injections | 0.73 | | 1.60 | | | | 0.47 | ** | 1.99 | | | |
| Any tetanus injections | | | | 0.04 | | 0.03 | | | | 1.10 | * | 1.72 |
| Number of partners (12 months) | 0.04 | | 0.34 | -0.01 | | -0.07 | 0.11 | * | 1.82 | 0.10 | * | 1.65 |
| Number of partners (lifetime) | | | | | | | 0.08 | *** | 2.82 | 0.08 | *** | 2.74 |
| Number of partners (lifetime), squ. | | | | | | | 0.00 | * | -1.88 | 0.00 | * | -1.88 |
| Condom use (contraception) | | | | | | | -0.14 | | -0.93 | -0.11 | | -0.71 |

**Table A.5. Continued**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sexual active in past 4 weeks | -0.08 | | -0.61 | -0.09 | | -0.56 | -0.20 | ** | -2.31 | -0.20 | ** | -2.15 |
| Years of sexual activity | 0.06 | | 1.46 | 0.07 | * | 1.8 | 0.10 | *** | 3.83 | 0.11 | *** | 3.95 |
| Years of sexual activity, squared | 0.00 | | -1.14 | 0.00 | | -1.59 | 0.00 | *** | -3.67 | 0.00 | *** | -3.79 |
| HIV prevalence | 0.10 | | 1.39 | 0.12 | * | 1.9 | 0.11 | *** | 4.13 | 0.11 | *** | 4.07 |
| Rural resident | -0.18 | | -0.76 | -0.30 | | -1.35 | -0.12 | | -1.19 | -0.13 | | -1.28 |
| Wealth: poorest quintile | -0.02 | | -0.14 | -0.07 | | -0.33 | 0.06 | | 0.47 | 0.06 | | 0.46 |
| Wealth: richest quintile | -0.06 | | -0.23 | 0.15 | | 0.51 | 0.03 | | 0.29 | 0.07 | | 0.60 |
| Education: primary | -0.07 | | -0.33 | 0.08 | | 0.28 | -0.32 | ** | -2.05 | -0.33 | * | -1.87 |
| Education: secondary, higher | -0.23 | | -0.87 | -0.17 | | -0.5 | -0.33 | * | -1.76 | -0.34 | | -1.61 |
| Working | 0.14 | | 0.76 | 0.06 | | 0.26 | -0.04 | | -0.48 | -0.02 | | -0.27 |
| Married | -0.37 | * | -1.75 | -0.44 | *** | -2.85 | -0.35 | *** | -2.81 | -0.41 | *** | -3.93 |
| Muslim | 0.05 | | 0.42 | 0.04 | | 0.28 | 0.10 | | 0.78 | 0.15 | | 1.07 |
| _cons | -2.61 | *** | -5.27 | -2.01 | | -1.64 | -2.89 | *** | -10.67 | -3.07 | *** | -9.59 |
| *N* | | | 2411 | | | 2411 | | | 2557 | | | 2558 |
| Wald test of exogeneity ($chi^2$) | | | 0.78 | | | 0.00 | | | 2.14 | | | 1.41 |
| Amemiya-Lee-Newey (Two step) | | | 2.60 | | | 3.07 | | | 2.63 | | | 2.94 |
| Instruments | Barriers to get medical treatment: knows where to go, permission to get treatment, distance to next facility, transport, no female health worker | | | | | | | | | | | |

*** 1%, ** 5%, * 10%; data is from the subsample of women who gave birth in the past 5 years.

**Table A.6. Regression coefficients (IV Probit), restricted specification**

| | Burkina Faso | | | | | | Cameroon | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | coef. | | t | coef. | | t | coef. | | t | coef. | | t |
| Number of tetanus injections | 0.83 | *** | 2.73 | | | | 0.66 | *** | 3.38 | | | |
| Any tetanus injections | | | | 0.80 | | 0.55 | | | | 1.83 | *** | 3.53 |
| Number of partners (12 months) | 0.05 | | 0.48 | 0.01 | | 0.09 | 0.10 | * | 1.80 | 0.09 | | 1.50 |
| Number of partners (lifetime) | | | | | | | 0.07 | ** | 2.46 | 0.06 | ** | 2.13 |
| Number of partners (lifetime), squ. | | | | | | | 0.00 | * | -1.77 | 0.00 | * | -1.67 |
| Condom use (contraception) | | | | | | | -0.12 | | -0.90 | -0.07 | | -0.50 |
| Sexual active in past 4 weeks | -0.07 | | -0.62 | -0.08 | | -0.51 | -0.17 | ** | -2.08 | -0.15 | * | -1.70 |
| Years of sexual activity | 0.05 | | 1.35 | 0.07 | * | 1.89 | 0.09 | *** | 2.88 | 0.08 | *** | 2.63 |
| Years of sexual activity, squared | 0.00 | | -1.04 | 0.00 | | -1.58 | 0.00 | *** | -2.83 | 0.00 | *** | -2.62 |

**Table A.6. Continued**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HIV prevalence | 0.08 | | 1.28 | 0.12 | * | 1.83 | 0.09 | *** | 2.78 | 0.08 | ** | 2.19 |
| Rural resident | -0.14 | | -0.62 | -0.25 | | -1.03 | -0.07 | | -0.72 | -0.06 | | -0.59 |
| Wealth: poorest quintile | -0.01 | | -0.08 | -0.04 | | -0.19 | 0.09 | | 0.81 | 0.10 | | 0.96 |
| Wealth: richest quintile | -0.10 | | -0.48 | 0.03 | | 0.09 | 0.02 | | 0.24 | 0.09 | | 0.85 |
| Education: primary | -0.10 | | -0.58 | -0.03 | | -0.11 | -0.39 | *** | -3.06 | -0.44 | *** | -3.33 |
| Education: secondary, higher | -0.22 | | -0.96 | -0.21 | | -0.66 | -0.42 | *** | -2.72 | -0.51 | *** | -3.03 |
| Working | 0.14 | | 0.89 | 0.06 | | 0.27 | -0.04 | | -0.47 | -0.01 | | -0.07 |
| Married | -0.32 | | -1.54 | -0.42 | ** | -2.32 | -0.26 | * | -1.81 | -0.31 | ** | -2.43 |
| Muslim | 0.05 | | 0.47 | 0.03 | | 0.23 | 0.09 | | 0.81 | 0.16 | | 1.41 |
| _cons | -2.52 | *** | -4.46 | -2.50 | *** | -2.87 | -2.78 | *** | -7.70 | -3.03 | *** | -8.94 |
| *N* | | | 2412 | | | 2412 | | | 2561 | | | 2562 |
| Wald test of exogeneity (chi$^2$) | | | 1.37 | | | 0.20 | | | 3.62 | | | 3.37 |
| Amemiya-Lee-Newey (Two step) | | | 0.35 | | | 1.12 | | | 0.00 | | | 0.05 |
| Instruments | Barriers to get medical treatment: permission to get treatment, no female health worker | | | | | | | | | | | |

*** 1%, ** 5%, * 10%; data is from the subsample of women who gave birth in the past 5 years.

**Table A.7. Regression coefficients for Burkina Faso (Heckman Selection Probit)**

| | Selection | | | Outcome | | | Selection | | | Outcome | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barrier: where to go | -0.23 | | -1.30 | | | | -0.24 | * | -1.69 | | | |
| Barrier: permission | 0.08 | | 0.54 | | | | 0.08 | | 0.55 | | | |
| Barrier: distance | -0.05 | | -0.35 | | | | -0.06 | | -0.44 | | | |
| Barrier: transport | 0.08 | | 0.61 | | | | 0.07 | | 0.55 | | | |
| Barrier: no female provider | -0.23 | | -1.50 | | | | -0.22 | * | -1.67 | | | |
| Number of tetanus injections | 0.02 | | 0.14 | 0.08 | | 0.49 | | | | | | |
| Any tetanus injections | | | | | | | -0.02 | | -0.36 | 0.10 | * | 1.72 |
| Number of partners (12 months) | -0.09 | | -0.72 | 0.01 | | 0.04 | -0.11 | | -0.83 | -0.01 | | -0.04 |
| Sexual active in past 4 weeks | 0.03 | | 0.26 | -0.09 | | -0.61 | 0.04 | | 0.32 | -0.09 | | -0.56 |
| Years of sexual activity | 0.04 | | 1.50 | 0.06 | | 0.78 | 0.04 | | 1.49 | 0.07 | * | 1.94 |
| Years of sexual activity, squared | 0.00 | | -1.06 | 0.00 | | -0.82 | 0.00 | | -1.03 | 0.00 | * | -1.66 |
| HIV prevalence | 0.03 | | 0.60 | 0.11 | | 0.98 | 0.03 | | 0.56 | 0.12 | * | 1.94 |
| Rural resident | 0.45 | *** | 2.84 | -0.37 | | -1.04 | 0.45 | *** | 2.82 | -0.27 | | -1.26 |
| Wealth: poorest quintile | -0.07 | | -0.42 | -0.05 | | -0.25 | -0.06 | | -0.39 | -0.07 | | -0.35 |

**Table A.7. Continued**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wealth: richest quintile | -0.35 | ** | -2.23 | 0.20 | | 0.64 | -0.35 | ** | -2.21 | 0.11 | | 0.47 |
| Education: primary | -0.06 | | -0.42 | 0.07 | | 0.36 | -0.06 | | -0.37 | 0.07 | | 0.34 |
| Education: secondary, higher | -0.33 | * | -1.76 | -0.07 | | -0.14 | -0.34 | * | -1.80 | -0.21 | | -0.67 |
| Working | 0.06 | | 0.39 | 0.05 | | 0.24 | 0.02 | | 0.17 | 0.10 | | 0.44 |
| Married | 0.02 | | 0.14 | -0.42 | * | -1.76 | 0.02 | | 0.16 | -0.45 | *** | -2.91 |
| Muslim | -0.19 | * | -1.79 | 0.07 | | 0.34 | -0.20 | * | -1.83 | 0.03 | | 0.21 |
| _cons | 0.60 | | 1.46 | -1.74 | | -1.01 | 0.66 | | 1.62 | -2.24 | *** | -3.91 |
| *N* | | | | | | 2521 | | | | | | 2411 |
| LR test of independent equations | | | | | | 0.03 | | | | | | 0.10 |

*** 1%, ** 5%, * 10%; data is from the subsample of women who gave birth in the past 5 years.

**Table A.8. Regression coefficients for Cameroon (Heckman Selection Probit)**

| | Selection | | | Outcome | | | Selection | | | Outcome | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barrier: where to go | 0.23 | | 1.39 | | | | 0.23 | | 1.39 | | | |
| Barrier: permission | -0.43 | *** | -2.81 | | | | -0.43 | *** | -2.79 | | | |
| Barrier: distance | -0.04 | | -0.23 | | | | -0.05 | | -0.27 | | | |
| Barrier: transport | -0.19 | | -1.12 | | | | -0.20 | | -1.15 | | | |
| Barrier: no female provider | 0.59 | *** | 2.62 | | | | 0.57 | ** | 2.50 | | | |
| Number of tetanus injections | | | | | | | -0.07 | | -1.52 | 0.06 | | 1.57 |
| Any tetanus injections | -0.07 | | -0.53 | 0.26 | ** | 2.35 | | | | | | |
| Number of partners (12 months) | 0.01 | | 0.09 | 0.11 | | 1.62 | 0.00 | | 0.00 | 0.11 | | 1.64 |
| Number of partners (lifetime) | 0.04 | | 1.59 | 0.09 | *** | 2.95 | 0.04 | | 1.63 | 0.09 | *** | 2.89 |
| Number of partners (lifetime), squ. | 0.00 | * | -1.81 | 0.00 | ** | -2.01 | 0.00 | * | -1.86 | 0.00 | ** | -1.99 |
| Condom use (contraception) | -0.21 | | -1.33 | -0.13 | | -0.81 | -0.21 | | -1.35 | -0.14 | | -0.84 |
| Sexual active in past 4 weeks | 0.03 | | 0.26 | -0.22 | ** | -2.35 | 0.04 | | 0.31 | -0.22 | ** | -2.36 |
| Years of sexual activity | -0.03 | | -0.85 | 0.11 | *** | 4.33 | -0.03 | | -0.92 | 0.11 | *** | 4.36 |
| Years of sexual activity, squared | 0.00 | | 1.27 | 0.00 | *** | -4.04 | 0.00 | | 1.30 | 0.00 | *** | -4.08 |
| HIV prevalence | -0.03 | | -1.32 | 0.12 | *** | 5.71 | -0.03 | | -1.34 | 0.12 | *** | 5.77 |
| Rural resident | 0.50 | *** | 3.92 | -0.18 | * | -1.74 | 0.50 | *** | 3.96 | -0.19 | * | -1.81 |
| Wealth: poorest quintile | 0.00 | | -0.01 | 0.01 | | 0.10 | -0.02 | | -0.10 | 0.00 | | 0.02 |
| Wealth: richest quintile | -0.43 | *** | -3.24 | 0.05 | | 0.39 | -0.42 | *** | -3.20 | 0.06 | | 0.43 |
| Education: primary | -0.12 | | -0.71 | -0.17 | | -1.17 | -0.11 | | -0.68 | -0.15 | | -1.01 |

**Table A.8. Regression coefficients for Cameroon (Heckman Selection Probit)**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Education: secondary, higher | -0.01 | | -0.05 | -0.14 | | -0.85 | -0.01 | | -0.03 | -0.11 | | -0.69 |
| Working | -0.03 | | -0.31 | -0.04 | | -0.40 | -0.04 | | -0.33 | -0.04 | | -0.45 |
| Married | 0.03 | | 0.24 | -0.44 | *** | -4.51 | 0.03 | | 0.23 | -0.44 | *** | -4.49 |
| Muslim | -0.12 | | -0.79 | 0.12 | | 0.84 | -0.11 | | -0.76 | 0.11 | | 0.77 |
| _cons | 1.49 | *** | 4.22 | -2.69 | *** | -8.37 | 1.56 | *** | 4.49 | -2.56 | *** | -7.97 |
| *N* | | | | | | 2655 | | | | | | 2654 |
| LR test of independent equations | | | | | | 0.01 | | | | | | 0.07 |

*** 1%, ** 5%, * 10%; data is from the sub-sample of women who gave birth in the past 5 years.