The Effect of HIV/AIDS on Fertility:

What Role Are Proximate Determinants Playing?

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The global fertility rate has dropped significantly over the past 50 years from 4.92 births per woman in 1950 to an estimated 2.02 in 2010. However, some evidence suggests that these declines have stalled in some countries with the highest fertility (Bongaarts, 2006). A number of factors have been suggested for this stall, including deceleration of use, availability, and demand for contraceptives, leveling off of reproductive preferences, and slowing economic development in these countries. Some researchers have further suggested that HIV could play a role in reversing the path of fertility declines through its interactions with the proximate determinants of fertility.

The relationship between HIV/AIDS and fertility is far from straight forward. The same factors that influence fertility rates, such as age at first marriage and use of condoms, have also been found to affect the spread of HIV/AIDS. In addition, HIV/AIDS serostatus and national prevalence have been linked to changes in the proximate determinants of fertility. These findings, along with several studies indicating that HIV/AIDS can lead to a decrease in fertility for women who are HIV positive, begin to illustrate the complexity and interconnectedness of the on-going HIV/AIDS epidemic and changes in fertility. Examining this relationship becomes even more vital with the evidence that fertility decline might be stalling. The role HIV/AIDS will play in future declines in fertility will undoubtedly grow as the impact of the disease continues to unfold in countries with high HIV prevalence and regions where rate are growing such as eastern Europe. While there is concern that resources from family planning are being diverted to HIV programs in countries with high HIV rates, the key will be to better integrate family planning and HIV programs. The primary objective of this study is to provide policy makers with additional information regarding the intersection of HIV/AIDS and fertility determinants in order to provide overarching programmatic guidance related to the integration of both family planning and HIV prevention programs.

In order to accomplish this, I will examine the multidimensional relationship between HIV/AIDS and current fertility for 31 countries from 6 regions (Eastern Europe, East Asia, Latin America, North Africa South Asia, and Sub-Saharan Africa). Specifically, this study estimates the association and possible interaction between HIV/AIDS and the proximate determinants of fertility (such as age at first marriage, current condom use, and postpartum insusceptibility). All of the countries have low to middle incomes with fertility rates ranging from 1.7 to 7.0, and include those with both low and high HIV rates (ranging from 0 to 13.5 percent). I felt that this was important since in many African countries, rates of HIV are actually decreasing (while still extremely high), and countries in regions outside of Sub-Saharan Africa are seeing increases in HIV prevalence (while still relatively low). Along with HIV prevalence and proximate fertility determinants, specifically age at first marriage and condom use, the model also controls for socioeconomic variables (such as Human Development Index). In order to look at the effects over the course of the epidemic, the study examines these relationships in two time periods meant to represent phases of the epidemic. The first (1993-2002) covers the beginning of the expanding spread of HIV/AIDS around the world, and the second (2003-2010) is a period of global scaling up of HIV/AIDS prevention, treatment and care initiatives.

Mechanisms for Possible Impact of AIDS on Fertility

This section highlights prior research linking fertility and HIV/AIDS as well as mechanisms by which fertility determinants might connect them. Specifically, this research uses the relationships between fertility and its determinants as a basis for examining the effect HIV may have on fertility both directly as well as indirectly through relationships with fertility determinants. This section draws upon these associations. A number of determinants have been found to influence fertility. In this study, the focus is on three in particular: age at first marriage, current condom use, and postpartum insusceptibility. Because of the importance of understanding these relationships with out the additional effect of HIV, the following also provide brief descriptions of the affect these determinants have on fertility rates alone.

It should also be noted that the examples presented here are from studies conducted on countries in Sub-Saharan Africa. Because of the high rates of HIV in this region, research has been primarily focused on these countries. In addition to providing additional insight on the effect of HIV on fertility, this study has the potential to look at this relationship in regions currently not being included in this research. However, the basis for this analysis will draw on only the available research from Africa.

The current literature suggests that HIV/AIDS has the potential to affect fertility through biological and behavioral mechanisms via the proximate determinants of fertility, including marriage, contraception, pregnancy, abortion, breastfeeding, postpartum abstinence, pathological sterility and natural fecundity. Based on a combination of changes in the proximate determinants of fertility and physiological consequences of HIV on women's fertility, HIV/AIDS has been found to contribute to declines in fertility (REFS). One study in Zimbabwe found that HIV/AIDS might be responsible for as much as 24% of the fertility decline observed in recent years in that country. In a 2002 publication, James Ntozi provided an overview of research examining the effect of HIV/AIDS on a number of proximate determinants of fertility in various parts of Sub-Saharan Africa. While many of these studies examine only small populations in Sub-Saharan Africa, they provide some evidence of how HIV/AIDS could lead to large-scale changes in fertility as the HIV/AIDS epidemic continues to grow in scope and influence in countries affected by HIV. The following sections below will summarize previous research related to specific fertility determinants of interest for this study. There are other ways in which HIV/AIDS has been found to affect aspects of fertility, but this study is primarily interested in parsing out the impact of HIV/AIDS and proximate determinants of fertility, namely age at first marriage, postpartum insusceptibility and condom use, on fertility rates. While this study should provide some general information on the extent of non-behavioral effects of HIV/AIDS (as a byproduct of controlling for the shared behavioral determinants of HIV/AIDS and fertility decline), further research is needed to more specifically address how each of the biological effects of HIV/AIDS contributes to fertility change (See Table 1 for a complete list of mechanisms and their possible effects on fertility).

Marriage

Just looking at the relationship between marriage and fertility, a decline in the median age at marriage is expected to increase fertility. There are two reasons for this effect. First, marrying at a younger age increases the number of reproductive years spent within marriage and hence exposure to the risk of pregnancy. Secondly, a change in the timing of marriage is typically associated with changes in timing of births. The timing of births across the life course creates a tempo effect that can cause a temporary inflation or deflation of period fertility. The effect produced by a decline in the age at childbearing concludes when changes in the timing of childbearing end (Bongaarts and Feeney 1998; Bongaarts 1999). So, when a country's median age at first marriage is low, total fertility rates will likely be high regardless of the national HIV prevalence rates. However, since the mechanism leading to low fertility could potentially be different in countries with high and low rates of HIV, there could be some variation in the direction of the effect of HIV on fertility.

Previous research shows that HIV/AIDS' impact on marital behaviors would appear to negatively impact fertility. Related qualitative research seems to indicate that fear of HIV infection is playing a part in the delays in age of sexual onset and age of first marriage. Studies by Asiimwe-Okiror et al (1997), and Kamali et al. (2000), in high HIV prevalence areas of Uganda, found that onset of sexual relations had significantly decreased through the 1990's. Over the 6-year study period Asiimwe-Okiror et al (1997) found the proportions of male and female youth aged 15 - 19 years old, who had never had sexual intercourse had increased from 31% to 56% and 26% to 46% respectively. In addition, they found that the median age at first sex had also increased from below 15 years for both males and females to 17.4 years for males and 16.6 years for females. In a similar longitudinal study of Masaka district, Uganda by Kamali et al. (2000), a delay of median age at first sex was noted for males aged 13 - 19 years old from 17.5 to 18.2 years.

Both the Asiimwe-Okiror et al, and Kamali et al studies also found significant delays in marriage among the respondents. Kamali et al. (2000) reported that the median age at first marriage rose from 18.5 to 19.5 years between 1992/93 and 1996/97. In the study by Asiimwe-Okiror et al. (1997), 84% of males and 62% of females aged 15 - 19 years in 1995 had never married compared to 75% and 46% in 1989.

Focus group discussions in 6 districts of Uganda conducted by Mukiza-Gapere and Ntozi (1995) indicated that fear of HIV infection was a contributing factor to women's reluctance to enter into marital unions. Similarly, in Zimbabwe, Gregson et al. (1998) found that among 1237 women of childbearing age in 2 districts of Manicaland, personal risk perception was associated with non-marriage. Specifically, they found that young women who felt at risk because many of their friends and relatives were dying of AIDS were less likely to enter long-term or cohabiting union.

Based on these and similar findings, HIV/AIDS would be expected to negatively affect fertility through an increase in age at first marriage. Countries with high HIV prevalence would have higher age at first marriage compared to similar countries. Even in countries with persistently low median age at first marriage, the relationship between HIV and fertility can also differ depending on HIV prevalence. Based on a country's HIV prevalence variation in the directional effect of age at first marriage on fertility is possible.

As discussed previously, in countries where the median age at first marriage is low, the duration of exposure to the risk of pregnancy would be longer. This would typically lead to higher fertility. However, in countries with high rates of HIV the effect of age at first marriage on the fertility might be influenced by HIV. For example, an increase in premarital condom use in order to protect against contracting HIV might secondarily lead a decrease in unintended pregnancy and lower fertility. In addition, increases in marital condom use or increased rates of abortion that might signal desires to avoid bearing a HIV infected child or potential orphan. In countries with high HIV prevalence, the high median age at first marriage could be associated with collective concern about contracting HIV by limiting the time of exposure to risk of infection as well as risk of pregnancy.

While most research shows that HIV has a primarily negative relationship with both age at first marriage and fertility rates, it is important to remember that the effect of HIV on fertility or its determinants is not straightforward. Gregson et al suggest that other HIV associated factors could actually drive fertility higher. For example, some research suggest that higher HIV prevalence can actually be associated with an increase in desired number of children to ensure survival of a preferred family size which could actually lead to higher fertility.

Postpartum Insusceptibility

Postpartum amenorrhea (a period without menstruation after child birth, often linked to the duration of breastfeeding) and postpartum abstinence (avoiding sex after a birth) have a significant impact of fertility in many developing countries. Among the regions included in this study, the duration of postpartum amenorrhea ranges from an average of 3.8 months in Eastern Europe to 13 months in Sub-Saharan Africa in the period between 1993-2002. Similarly, the median duration of postpartum abstinence in sub-Saharan Africa ranges from 2 months in Uganda to 22 months in Guinea. Elsewhere, the period typically ranges from 1 month to 3 months. While the majority of countries with long durations of postpartum insusceptibility of any type are in sub-Saharan Africa, high duration of postpartum abstinence has been measured in other regions.

In many countries the effects of postpartum abstinence and amenorrhea combined—postpartum insusceptibility —commonly act as the only mechanism for delayed additional pregnancies. On average, postpartum insusceptibility account for birth spacing for up to 2 years (Haggerty & Rutstein, 1999, Stover, 1998). Breastfeeding practices are the primary determinant of how long women will remain amenorrheic after giving birth (WHO, 1998). Women who fully or nearly fully breastfeed their infants remain amenorrheic longer (92). Traditional beliefs often influence sexual activity after childbirth (Renne, 1997). In Lesotho, for example, mothers are separated from their husbands for as long as the mothers are breastfeeding because they believe that having sex with a lactating woman would spoil her milk (Lesotho MOH & WHO, 1995). The duration of postpartum abstinence varies greatly both within and among countries (190). Couples who do not practice postpartum sexual abstinence tend to have their next child quickly. When the length of such abstinence exceeds the length of postpartum amenorrhea, this practice can help women delay their next pregnancy.

In some ways the effect of postpartum insusceptibility is even more complex than the other two determinants included in this study. In more developed countries where other forms of birth control like the pill are available and accepted, the duration of postpartum insusceptibility can actually mean very little. Because in less developed countries postpartum insusceptibility is still used as a form of birth control, the duration is more closely linked with the duration of pregnancy risk. Thus among less developed countries, when a country's median duration of postpartum insusceptibility is low, the average duration of risk of pregnancy could be expected to be longer. This would lead to higher levels of fertility. In countries with high rates of HIV, this effect could be accentuated. As described above, it is expected that decreasing the duration of breastfeeding and postpartum abstinence can lead to increase fertility. HIV has the potential to significantly influence the duration of these practices. In high HIV prevalence countries, in order to avoid mother-to-child transmission of HIV, women may decide to reduce breastfeeding. In communities practicing long postpartum abstinence, women may reduce the duration to discourage regular partners from engaging in extra marital relationships that may result in infection of HIV of the family. There is also research to suggest that increases in infant mortality due to HIV/AIDS have led women to stop breastfeeding and postpartum practices, attracting early pregnancy and hence higher fertility.

<u>Condom Use</u>

Previous research has shown that an increase in modern contraceptive use is one of the primary proximate determinants of fertility decline (Bongaarts and Potter 1983). In pretransitional societies where fertility is high, deliberate use of contraceptives to limit family size is rare. Whereas in low fertility countries at the end of their fertility transition, a large number of couples practice some form of contraception. There are some variations in the effectiveness of forms of modern contraceptives. For example, the pill is more effective that the use of condoms, but any of these methods is more effective than traditional forms of birth control.

The effects of HIV/AIDS on contraception are mixed to some degree. There is evidence that contraceptive use has increased in HIV positive women and in general condoms have become more socially acceptable as a result of the HIV/AIDS epidemic. However, the switch to condoms from more efficient forms of birth control which could lead to more unintended births.

Glynn et. al. (2000) found that HIV infected women who had given birth once were more likely to have used contraceptives than HIV negative women. The proportion of HIV positive women using modern contraceptives was 34.5% compared to 17.5% among HIV negative women in Yaounde, Cameroon and 20.3% compared to 14.8% respectively in Ndola, Zambia in 1998. These studies also found that the increase in contraceptive use in these populations was related their desire to limit family size. For instance in Zambia, two studies observed that respondents favored reduced family sizes of couples living with HIV/AIDS. Results of 8 focus groups and 23 in-depth studies in Ndola indicated that both women and men were overwhelmingly opposed to continued childbearing by persons with symptoms of AIDS in order to prevent HIV transmission to spouses and children (Rutenberg et. al. 2000).

Prior to the spread of HIV/AIDS, condom use was resisted in Africa primarily due to cultural reasons. Rates of condom use are still relatively low compared to countries outside of the region. However, Demographic and Health Surveys in various African countries have noted increases in condom use for protection against HIV and other STDs. In the Manicaland study in Zimbabwe, 21% of women reported ever using condoms for HIV prevention (Gregson). In addition, Lutalo et al. (2000) observed that 26% of 5185 women in Rakai, Uganda in 1995 had ever used condoms, 86% of whom did it for HIV/STDs prevention. Between 1995 and 1998, condom use in the area increased significantly. For both sexes condom use was greater among respondents who perceived themselves to be at risk of HIV than others.

Some researchers have found that the use of condoms as HIV preventive measure has made some women switch from effective methods of family planning to condom use, which is less efficient. Gregson et. al. (1997) reported that 5% (38) of 752 women in the Manicaland study had changed from other contraceptives to using condoms since hearing of AIDS. The majority (63%) of these women had been using the pill, which is considered more effective at preventing pregnancy than the condom. This switch of methods may result in more pregnancies and hence increase fertility.

These findings suggest that countries with low rates of reported current condom use should tend to have high fertility rates. However, Ntozi points out that HIV could be influencing condom use and leading to wider variation in fertility rates. Countries with high HIV prevalence and high condom use will typically be regions of low development, which are also associated with high fertility. In other words the high percent of population reporting use of condoms could actually reflect the protective measures taken to reduce the risk of HIV in groups that are perceived to be at risk. In these countries women who are at the highest risk of pregnancy might have low levels of condom use and thus the two would not be associated (condoms use and fertility) in this setting. The result could be that countries with high HIV and condoms use will actually be associated with countries with high fertility.

In countries with low condom use fertility rates would be expected to be high. However, high rates of HIV could influence other factors that could play a role in depressing fertility. HIV has been associated with a reduced desired family size due to the fear of mother to child transmission. In order to address these concerns abortion might be the preferred for of contraceptive. Or if a woman doesn't have the power to request the use of a condom, she might simply resort to using another form of birth control to at least prevent the conception of an HIV positive child.

HYPOTHESES

Based on the literature presented above, I expect a number of interactions between HIV/AIDS and fertility determinants, which will together explain a significant portion of total fertility. In other words I expect to find that the effect of HIV on fertility will depend on the three fertility determinants included in the model. Using the hypothesized mechanisms for interactions between HIV/AIDS and the proximate determinants of fertility suggested by Gregson et al. (1997) described above, I expect variations between countries with differing levels of HIV prevalence as well as the proximate determinants of fertility included in this analysis. While Gregson's mechanisms were developed and studied in a Sub-Saharan Africa setting, I am using them here in part to determine if any of the relationships found in the African setting might apply to countries in other regions. It will be important of course to take into account characteristics of countries in different regions both in the discussion of the expected results as well as the analysis. Since countries from different regions and levels of development are being included in this analysis (all countries are middle or low income countries), economic development will undoubtedly influence fertility rates in these countries. Economic development is considered a significant cause of fertility decline over time due to the changes in costs and benefits of having children. Changes in the cost/ benefit ratio along with declines in infant mortality typically lead parents to want fewer children. These changes in fertility preference raise the demand for birth control, and if the birth control is available, lower fertility results. Because of this strong association, I expect that the economic development of a country will have a negative affect on fertility regardless of HIV prevalence. I would expect that countries with higher levels of economic development would have both lower HIV prevalence as well as lower total fertility rates. However, controlling for the fertility determinants could significantly minimize this relationship.

While there are clearly other proximate determinants of fertility that could be influencing these relationships, for this analysis only these three were selected. Age at first marriage, current condom use, and postpartum insusceptibility represent the most influential and relevant fertility determinants. Additional analysis is introduced later which actually breaks down postpartum insusceptibility and looks more closely at how this determinant might condition the effect of HIV rates on fertility. In addition, in the discussion I introduce a number of country characteristics and consider their potential role in expanding an understanding of the relationship between HIV prevalence and total fertility rates is discussed.

Based on the review of literature and the discussion above, I expect that both high rates of HIV prevalence and later age at first marriage will be associated with lower Fertility rates (1). Conversely, younger age at first marriage and higher HIV rates will be associated with higher fertility (2).Countries with high rates of condom use and high rates of HIV have the potential for two very different outcomes. On one hand, if the increase in condom use represents simply an increase in overall contraceptive use then (3) these characteristics should be associated with lower fertility. However, if the high condom use in high HIV countries represents the replacement of more effective contraceptive methods with less effective ones in order to prevent disease, then it is possible to see an increase in fertility, especially in countries with low contraceptive prevalence (4). With regard to postpartum insusceptibility, I expect that shorter durations of postpartum insusceptibility and high HIV prevalence will be associated with higher fertility (5) and longer durations of postpartum insusceptibility and high rates of HIV will be associated with lower fertility (6).Similar results are expected for the two components of insusceptibility (abstinence and amenorrhea).

I also expect these relationships to vary between the two time periods being analyzed. HIV had been spreading quickly in Sub-Saharan Africa and other regions such as the Caribbean prior to 2002. During the first period (1993-2002), few programs were in place to address the prevention, treatment and care of this disease. In the second period, 2003-2010, a significant amount of political and financial support was provided to the fight against HIV. I would expect the relationship between HIV and fertility as it relates to the proximate determinants to less significant during the first period than the second. The HIV/AIDS prevention, treatment and care programs raised awareness about the disease and this information most likely affected the proximate determinants in the second period. However, the direct relationship between HIV and fertility, such as the biological effects of HIV on fertility like sterility, might be stronger in the first period before the effect on the proximate determinants was influential.

DATA & METHODS

Whereas previous research has used a two-tiered methodology to examine these relationships both between and within countries, this analysis focuses only on national-level data. I use a modified version of the methodology used by Bongaarts in his study of late marriage and the HIV epidemic in sub-Saharan Africa (REF). This analysis relies on country-level epidemiological and demographic data from 31 countries from two periods of time 1993-2002 and 2003-2010[1]. These countries were included based on a number of criteria. First, all of these countries had to have DHS data in both time periods. In order to look at the effects over the course of the epidemic, two time periods have been chosen to represent the phases of the epidemic; 1993-2002 as the beginning of the expanding spread of HIV/AIDS around the world and 2003-2010 as a period of global scaling up of HIV/AIDS prevention, treatment and care initiatives. It was important to limit the analysis to countries with the same data for both time periods. The use of the same countries in both periods of analysis allows for some level of control for variations over time for the countries.

In countries with multiple DHS surveys in each period, only data from one available year was used. The DHS used in the analysis was selected based on its distance from the middle of the period. For example if a country had 2 DHS studies in the first period one in 1998 and 2001, the DHS from 1998 was selected because it represented the values closest to the middle of the period. The years being compared for a single country in each of the two periods from the DHS ranges from 1993 to 2002 for the first temporal group and 2003 to 2008 for the second. Since the timing of age at first marriage and other determinants on average has changed little in the time in between the surveys chosen for this analysis within each period, Bongaarts found that the differences in these years are unlikely to be a significant problem. Secondly, a few countries were excluded due to extremely high values on key variables. Zambia and Zimbabwe were excluded since they reported HIV prevalence over 15%. The exclusion of these countries did not influence the analysis much since there were a large number of other countries from the same region.

Estimates of HIV prevalence among women aged 15–49 in 2007 are taken from UNAIDS (2008). Estimates of median ages at first marriage[2], current condom use and postpartum insusceptibility are taken from nationally representative DHS. In a typical DHS study, several thousand women of reproductive age (15–49) are interviewed and information is collected on a wide array of demographic, behavioral, and health topics. The Human Development Index (HDI) will be used as a control for level of development. The index is a composite measure created by the United Nations Development Program that includes proximate measures of health status (life expectancy at birth); education (mean years of school and expected years of schooling) and living standards (GNP

[1] Initially a third period was also to be included (1983-1992). This period would have captured some information from a mostly pre-HIV period. It would have allowed additional understanding of the progression of influence of HIV/AIDS on fertility. However, there were not enough countries which had the needed data for all three time periods so the first period had to be excluded from the analysis.
[2] Following DHS convention, the term "marriage" refers to both formal marriages and consensual unions.

per capita) (UNDP, 2011). In this analysis, with countries from a variety of regions and levels of development, this measure is extremely important and is more useful than simply using an economic measure like GNP alone. Appendix I contains a table with all of the data used in this analysis.

The analysis will consist of the construction and testing of six regression models examining the effect of HIV/AIDS on total fertility rates when controlling for other fertility determinants (see Table 3). In the first model, only HIV will be included in order to determine the bivariate relationship between the Total Fertility Rate as the dependent variable and HIV prevalence as the independent variable. Model 2 adds the HDI measure to model 1. Model 3 includes HIV prevalence, HDI, and all of the proximate determinants of fertility (median age at first marriage, percent currently using condoms, and median duration of postpartum insusceptibility). Model 4 adds three interaction terms (HIV x median age at first marriage, HIV x percent currently using condoms, and HIV x median duration of postpartum insusceptibility). The last two models (models 5 & 6) deconstruct postpartum insusceptibility into its two components abstinence and amenorrhea. Model 5 includes all of the same variables as model 4 except median duration of postpartum and HIV x median duration of postpartum are used in place of the postpartum insusceptibility variables. Again, model 6 includes all of the same variables as model 4 except median duration of postpartum abstinence and HIV x median duration of postpartum abstinence are used in place of the postpartum insusceptibility variables.

In order to interpret the interaction terms, the net effect of HIV conditional on values of each of the proximate determinants was calculated using the minimum and maximum values of each determinant. For each of these calculations, the other determinants were held constant at their means. Table 2 shows that many of the independent variables have seen declines in their mean values between the two time periods. The greatest shifts have been in the current use of condoms and postpartum insusceptibility. It is of interest to this study that the average HIV prevalence has remained exactly the same over time.

RESULTS

In order to test the effect of HIV prevalence on fertility rates and whether there is a significant interaction between HIV/AIDS and the proximate determinants of fertility, I use regression models, which include HIV prevalence, HDI, proximate determinants and interaction terms. Generally, the hypothesis was that while there might be a direct effect of HIV on fertility rates, there should also be an interaction effect with the proximate determinants of fertility. So HIV would affect fertility differently at different values of the proximate determinants. Based on prior research, the relationship between HIV and fertility is complex, given the overlap in determinants of risk of pregnancy and of risk of contracting HIV. This study expects to have mixed results since the models are relatively simple and the sample sizes are small. In order to examine these relationships, six regression models were estimated. The results are presented in Table 3 (models 1-6).

In both time periods Model 1 shows that there is a significant positive relationship between HIV prevalence and fertility rates in a bivariate analysis. Figure 3 illustrates this relationship, showing that in countries in this sample, those with high total fertility rates seem to have high HIV prevalence. The regression analysis shows that this positive relationship is statistically significant at a level of .05 for the first period and .01 for the second period (Table 3). Prior to the addition of any of the other independent or control variables, this result is most likely related to the overlap in the countries with high fertility rates and high HIV prevalence (mostly in Africa). In the second time period (2003-2010) this relationship appears to be stronger. This is interesting since both fertility rates and HIV rates tend to be lower in this time period.

With the inclusion of the Human Development Index (HDI) in model 2, the coefficients for HIV prevalence, while still positive, are no longer statistically significant in either time period, while HDI has a powerful negative effect. Figure 4 shows the negative bivariate relationship between total fertility rate and HDI. Countries with higher HDI tend to have lower total fertility rates.. The regression analysis shows this negative relationship is statistically significant at a level of .001 for both periods (Table 3). It is not at all surprising that the HDI is a significant predictor of fertility since as was discussed earlier economic growth has long been linked with the decreasing mortality and fertility associated with the demographic transition.

In model 3, the proximate determinants of fertility are added to the analysis. Figures 5 through 7 shows the bivariate relationships between total fertility rate and each proximate determinant. Based on these figures, age at first marriage has a negative relationship with fertility rates (Figure 5), postpartum insusceptibility is positively associated with fertility (Figure 6), and condom use seems to have a generally negative relationship (Figure 7), particularly in the earlier period.

However, in the multivariate model, not all of these determinants were significantly associated with fertility. Countries with longer postpartum insusceptibility had higher fertility, although the coefficient was only significant at.1 at the first time point and not at all at the second;

condom use reduced fertility at .05 at the first time period but was not significant at the second, and age at first marriage had no significant effect in either period (Table 3), although the direction of all of these relationships remained the same as those presented in Figures 5 through 7. HIV prevalence, however, gained significance in the first period, at least ($p < .1$), even holding HDI and the proximate determinants constant. In the time period 2003-2010, Model 3 shows that HDI was only weakly associated with lower fertility. In both of these models, as expected, we see that the relationship between HDI and fertility was not as strong (and in the period from 1993-2002 not significant, even at .1) when the proximate determinants of fertility were added, suggesting that much of the effect of HDI on fertility works through the effects of the proximate determinants.

Based on literature reviewed previously, the primary hypotheses of this analysis imply that model 3 is obscuring a more comprehensive understanding of relationships between HIV and fertility because the effect of HIV on fertility is actually moderated by the fertility determinants included in the model. Because of the close relationship between fertility determinants and HIV, I hypothesized that the effect of HIV on fertility would depend on the levels of all three of the fertility determinants (median age at first marriage, percent currently using condoms, and median duration of postpartum insusceptibility). In the full model (Table 3, model 4), three interaction terms were added for HIV and the three fertility determinants. In both time periods, HIV prevalence and HDI are significantly associated with fertility rates at a level of .10 for the period between 1993 and 2002 and .01 for the period between 2003-2010. In addition, interaction terms for HIV and age at first marriage, and HIV and postpartum insusceptibility were both significant (p<..01), suggesting that the effect of HIV on fertility differs depending on both of these proximate determinants. Only condom use appears not to interact with HIV in its effects on fertility. For the period between 1993-2002, the HIV- age at first marriage interaction and the HIV- postpartum insusceptibility interaction were significant at .10 and .05 respectively (Table 3). And for the period between 2003-2010, the interaction of HIV and age at first marriage and that of HIV and postpartum insusceptibility on fertility, were both significant at a level of .01 (Table 3).

In order to interpret the interaction terms, the net effect of HIV on fertility conditional on each of the proximate determinants was calculated for all of the values of each determinant. Table 4 presents the effect of HIV on fertility for the minimum and maximum values of each fertility determinant. For each of these calculations, the other determinants were held constant at their means. For example, for age at first marriage for the period 1993-2002, the effect of HIV was calculated for the minimum and maximum values of age at first marriage (13.8 and 22.1 respectively). The mean number of months of postpartum insusceptibility and the mean percent of current condom use (12.2 and 4.4 respectively) were used in the calculation of the effect of HIV. Table 4 presents these calculations and the following sections describe the results of these calculations in more detail.

HIV & Age at First Marriage

For both periods, controlling for the other independent variables and interaction terms, HIV prevalence was positively related to fertility only when age at first marriage was low, suggesting that high HIV prevalence is associated with higher fertility in the context of very young ages at first marriage (Table 4). Based on the calculation of the effect HIV on fertility among countries with older ages at first marriage, however, HIV was negatively associated with fertility. In other words, high HIV prevalence is associated with lower fertility rates in the context of older ages at first marriage. The effect of HIV on fertility was stronger when age at first marriage was low for both time periods. For the period 1993-2002, the interaction of HIV and age at marriage is marginally significant at a level of 10. For the period 2003-2010, this interaction is significant at a level of .001 (Table 3). These results support the study hypotheses that high rates of HIV prevalence and later age at first marriage would be associated with lower fertility rates and younger age at first marriage and higher HIV rates would be associated with higher fertility.

Figure 8 shows the relationship between the effect of HIV prevalence on fertility rates for different values of age at first marriage for both periods. Based on this figure, we can see that the younger the age of first marriage the stronger and more positive the effect of HIV on fertility. However, after age at first marriage is about 20, the effect becomes negative and as the age at first marriage increases the stronger the negative effect becomes. Based on this figure there appears to be little difference between the two periods. In fact, the mean the effect of HIV on fertility conditional on age at first marriage for the period from 2003-2010 is not significantly different from the mean effect for the period 1993-2002.

HIV & Postpartum Insusceptibility

In both periods, controlling for the other independent variables and interaction terms, HIV prevalence was positively related to fertility only when postpartum insusceptibility was low, suggesting that high HIV prevalence is associated with higher fertility in the context of very short lengths of postpartum insusceptibility (Table 4). Based on the calculation of the effect HIV on fertility among countries with longer postpartum insusceptibility, HIV was negatively associated with fertility. In other words, high HIV prevalence and longer lengths of postpartum insusceptibility were associated with lower fertility. The effect of HIV on fertility was stronger when postpartum insusceptibility was low for both time periods. For the period 1993-2002, this relationship was significant at a level of .05 and for the period 2003-2010 this relationship was significant at a level of .01 (Table 3). These results support the study hypotheses that higher HIV prevalence and shorter durations of postpartum insusceptibility would be associated with higher fertility and longer durations of postpartum insusceptibility and high rates of HIV would be associated with lower fertility.

Figure 9 shows the relationship between the effect of HIV prevalence on fertility rates for different values of postpartum insusceptibility for both periods. Based on this figure, we can see that the shorter the duration postpartum insusceptibility the stronger and more positive the relationship between HIV and fertility. At about 13 months of postpartum insusceptibility, the effect becomes negative and as the duration of postpartum insusceptibility increases the stronger the negative relationship becomes. This figure supports the finding that high HIV prevalence is associated with higher fertility in the context of very short lengths of postpartum insusceptibility and high HIV prevalence and longer lengths of postpartum insusceptibility are associated with lower fertility.

Figures 10 & 11 show the relationship between HIV prevalence and TFR for short and long durations of postpartum insusceptibility. In this figure the postpartum insusceptibility is separated at the directional threshold where the effect changes from positive to negative shown in Figure 9. These figures support the finding that the positive relationship between HIV and TFR is more pronounced at very short lengths of postpartum insusceptibility.

There does not appear to be too much variation between the two periods in terms of the overall direction of this effect. Figures 9-11 seem to show that in general the effect of HIV prevalence on fertility rates has decreased at each value of insusceptibility between the two time periods. However, the mean the effect of HIV on fertility conditional on duration of postpartum insusceptibility for the period from 2003-2010 is not significantly different from the mean effect for the period 1993-2002.

Deconstruction of Postpartum Insusceptibility

In order to deconstruct the effect of postpartum insusceptibility, I analyzed the same model used earlier but I substituted the average durations of postpartum amenorrhea and abstinence for postpartum insusceptibility, which includes both. The interaction term of HIV and insusceptibility was significant in model 4 (Table 3). But insusceptibility includes two different types of insusceptibility (postpartum amenorrhea - a period without menstruation after child birth and postpartum abstinence - avoiding sex after a birth). Because postpartum amenorrhea and abstinence have been found to have a significant impact on fertility in many developing countries and have also been linked to HIV, a further analysis of this interaction.

Models 5 and 6 support these hypotheses (Table 5). In both these models the interaction terms for HIV and postpartum amenorrhea, and HIV and postpartum abstinence were significant, suggesting that the effect of HIV on Fertility differs depending both of these proximate determinants. For both models (5 and 6) in the period 1993-2002, the relationship between HIV and postpartum abstinence was significant at a level of .05. However, the relationship HIV and postpartum amenorrhea, was not significant in either model. In addition, in model 5 HIV prevalence and HDI were not significant either. In model 6, HDI was significant but HIV prevalence remained not significant.

For the period 2003-2010, both the HIV and postpartum amenorrhea (Model 5) and HIV and postpartum abstinence (Model 6) and fertility were significantly associated with fertility. These relationships were significant at a level of .01 (Table 5). Models 5 and 6 also show that HDI and HIV prevalence are significant in both models.

Again, in order to interpret the interaction terms, the net effects of HIV on fertility conditional on each of the two insusceptibility measures were calculated using the minimum and maximum values of each determinant. Just like in the previous section, for each of these calculations, the other determinants were held constant at their means. Table 6 presents these calculations and the following sections describe the results of these calculations in more detail.

HIV & Postpartum Amenorrhea

In both periods, controlling for the other independent variables and interaction terms, HIV prevalence was positively related to fertility only when postpartum amenorrhea was low suggesting that high HIV prevalence is associated with higher fertility in the context of very low postpartum amenorrhea (Table 6). Based on the calculation of the effect HIV on fertility for high postpartum amenorrhea, HIV was negatively associated with fertility. In other words, high HIV prevalence among countries with very long lengths of postpartum amenorrhea was associated with lower fertility. The effect of HIV on fertility was stronger when postpartum amenorrhea was low for both time periods. For the period 1993-2002, this relationship is not statistically significant. For the period 2003-2010, this relationship is significant at a level of .01 (Table 5). These results support the study hypotheses that higher HIV prevalence and shorter durations of postpartum amenorrhea would be associated with higher fertility and longer durations of postpartum amenorrhea and high rates of HIV would be associated with lower fertility.

Figure 12 shows the effect of HIV prevalence on fertility rates for different values of postpartum amenorrhea for both periods. Based on this figure, we can see that the shorter the duration of postpartum amenorrhea the stronger and more positive the relationship between HIV and fertility. However, at about 11 months of postpartum amenorrhea for the period between 1993-2002 and 13 months of postpartum amenorrhea for period between 2003-2010, the effect becomes negative and as the duration of amenorrhea increases the stronger the negative relationship becomes.

Figures 13 & 14 show the relationship between HIV prevalence and TFR for low and high values of postpartum amenorrhea. In this figure the postpartum amenorrhea is separated at directional threshold where the effect changes from positive to negative shown in Figure 12 These figures again support the hypothesis that the effect HIV on TFR is more pronounced at lower lengths of postpartum amenorrhea and that at higher lengths postpartum amenorrhea there is a negative effect.

Based on Figures 12-14, the effect of HIV prevalence on fertility rates appears to be stronger between 2003-2010 compared to the earlier period. For example, between 1993-2002 the effect of HIV on fertility for a duration of amenorrhea around 4 months was .394 and between 2003-2010 the effect for the same age was .685. The difference between these means is in fact statistically significant. Specifically, the mean the effect of HIV on fertility conditional on duration of postpartum amenorrhea for the period from 2003-2010 is significantly greater than mean effect for the period 1993-2002 at a level of .01.

<u>HIV & Postpartum Abstinence</u>

For both periods, controlling for the other independent variables and interaction terms, HIV prevalence was negatively related to fertility only when postpartum abstinence was high, suggesting that high HIV prevalence is associated with lower fertility in the context of very long postpartum abstinence (Table 6). And based on the calculation of the effect HIV on fertility for very short postpartum abstinence, HIV was positively associated with fertility suggesting that high HIV among countries with shorter postpartum abstinence is associated with higher fertility. The effect of HIV on fertility was stronger when postpartum abstinence was longer for both time periods. For the period 1993-2002, this relationship is significant at a level of .05. For the period 2003-2010, this relationship is significant at a level of .01 (Table 5). These results support the study hypotheses that higher HIV prevalence and longer durations of postpartum abstinence would be associated with lower fertility and shorter durations of postpartum abstinence and high rates of HIV would be associated with higher fertility.

Figure 15 shows the relationship between the effect of HIV prevalence on fertility rates for different values of postpartum abstinence for both periods. Based on this figure, we can see that the shorter the duration of postpartum abstinence the stronger and more positive the relationship between HIV and fertility. However, at about 6 months of postpartum abstinence, the effect becomes negative and as the duration of amenorrhea increases the stronger the negative relationship becomes.

Figures 16 & 17 show effect of HIV prevalence on TFR for low and high values of postpartum abstinence. In this figure the postpartum abstinence is separated at directional threshold where the effect changes from positive to negative shown in figure 15. Again these figures support the hypothesis that high HIV prevalence is associated with lower fertility in the context of very long postpartum abstinence and in countries with HIV prevalence shorter postpartum abstinence is associated with higher fertility.

Based on Figures 15-17, it appears that the effect of HIV on Fertility increases between the two periods suggesting that interactions between postpartum abstinence and HIV have increased between the two phases of the epidemic. For example, between 1993-2002 the effect of HIV on fertility for a duration of abstinence around 1.9 months was .117 and between 2003-2010 the effect for the same age was .208. The difference between these means is in fact statistically significant. Specifically, the mean the effect of HIV on fertility conditional on duration of postpartum abstinence for the period from 2003-2010 is significantly greater than mean effect for the period 1993-2002 at a level of .001.

DISCUSSION

This analysis was intended to better our understanding of the multidimensional relationship between HIV/AIDS and fertility. Specifically, we examine the interactions between HIV/AIDS and specific proximate determinants of fertility, age at first marriage, current condom use, and postpartum insusceptibility in particular. A variety of results from this analysis support the hypotheses based on previous evidence of the relationship between HIV and fertility.

Specifically, this analysis found that for this sample of 31 countries, high rates of HIV prevalence and later age at first marriage were significantly associated with lower Fertility rates and younger age at first marriage and higher HIV rates were be associated with higher fertility. In addition, shorter durations of postpartum insusceptibility were significantly associated with higher fertility and longer durations of postpartum insusceptibility and high rates of HIV were associated with lower fertility. Further analysis with the separate components of postpartum insusceptibility (postpartum amenorrhea and abstinence) also found that high HIV is associated with higher fertility in the context of very low postpartum amenorrhea and abstinence, and high HIV prevalence among countries with very long lengths of postpartum amenorrhea and abstinence were associated with lower fertility. The interaction of HIV and condoms use was not significantly associated with fertility rates.

As was suggested by Gregson, Ntozi and others, HIV has the potential to disrupt marital patterns in countries with high rates or in at risk populations. This analysis confirmed an association between the two factors: high rates of HIV prevalence and later age at first marriage were found to be associated with lower Fertility rates and younger age at first marriage and HIV rates was found to be associated with higher fertility.

Countries with age at first marriage lower than the median and the highest fertility and HIV rates are mostly in Sub-Saharan Africa in both periods such as Cameroon, Malawi, Mozambique, and Uganda. In the first period, all of these countries had fertility rates over 4.7, HIV prevalence rates over 6%, and age at first marriage under 18.4. In the second period, all of these countries had fertility rates over 4.5, HIV prevalence rates over 3%, and age at first marriage under 17.9. All of these countries have other characteristics in common as well like low age at first sex and long postpartum insusceptibility. One very interesting finding is that in the second time period (2003-2010), a number of countries outside of Sub-Saharan Africa had age at first marriage lower than the median and some of the highest fertility and HIV rates. Chad in North Africa is one of the countries in another region that is seeing its fertility rates stall around 6.3 children per woman and an increase in HIV prevalence rates (2.3% between 1993-2002 and 3.6% between 2003-2010). In addition, Chad's age at first marriage was below 16 in both time periods. This may suggest that Chad and other countries in North Africa that have low age at first marriage and rising HIV prevalence rates could see HIV playing a bigger role in fertility trends in the future.

While some previous research found that high HIV prevalence had a negative influence on fertility through certain changes in behavior, these findings suggest that these behaviors may not be widespread and as of yet do not show up at the national level. Many of those studies were done in small communities. For example in Uganda, which was one of the countries with the lowest age at first marriage and highest HIV prevalence and fertility rates, research described earlier had found that in extremely high HIV prevalence areas, age at first marriage and sexual onset were increasing.

Asiimwe-Okiror et al (1997), and Kamali et al (2000) found increases in both in a region of Uganda with extremely high rates of HIV. While this study did not find evidence of this relationship, over time these effects might become more apparent and some of the analysis here might support that hypothesis. As more information becomes available through HIV programs a more widespread change in these determinants might occur and a fall in country level fertility rates could be measured.

With regard to postpartum insusceptibility, the analysis bore out the expected hypothesis that shorter durations of postpartum insusceptibility in high HIV prevalence countries is associated with high fertility, and longer durations of postpartum insusceptibility and high rates of HIV would be associated with lower fertility. These results suggest that Gregson et. al. might be correct when assuming that HIV prevalence could be closely associated with higher fertility rates in countries where in postpartum insusceptibility is short.

The analysis done with postpartum amenorrhea and abstinence variables produced similar results to the full measure postpartum insusceptibility analysis indicating that high HIV prevalence and longer postpartum amenorrhea and abstinence are both associated with lower fertility rates and high HIV and shorter postpartum amenorrhea and abstinence are both associated with higher fertility. While these two determinants had the same directional influence on the effect of HIV on fertility, there are a number of countries that have high postpartum abstinence and lower postpartum amenorrhea and vice versa. Countries like Haiti and Cambodia have postpartum abstinence durations above the median of 3 months in the period between 2003-2010. However, the durations of postpartum amenorrhea for these two countries was shorter than the median of 9.4 months. In contrast, Ethiopia and Niger, which had the longest durations of postpartum amenorrhea (above 15.7), have durations of postpartum abstinence below the median (2.5 months).

The differences between durations of postpartum amenorrhea and postpartum abstinence are important for few reasons. First, each of these two forms of insusceptibility function somewhat separately. For example, the period of postpartum abstinence is nearly the same or shorter than the period of amenorrhea, abstinence alone has little effect on birth intervals (Grummer-Strawn, Stupp, and Mei, 1998). If the duration of postpartum abstinence is longer, it plays a larger role in reducing number of births through shortening the duration of risk of pregnancy. Secondly, research suggests that postpartum amenorrhea and postpartum abstinence both interact with HIV and effect fertility through different mechanisms. For example, high HIV prevalence in a country has the potential to shorten postpartum amenorrhea due to fear of transmission from mother to child. Duration of postpartum amenorrhea is primarily related to the duration of breast-feeding. Unfortunately, breastfeeding carries a risk of mother-to-child HIV transmission. Because of the fear of this type of transmission some women prematurely end breast-feeding making them susceptible to repeat pregnancy. HIV prevention programs also have encouraged this behavior and supported women's decisions to switch to formula to avoid this risk. Postpartum abstinence on the other hand is driven more by concerns of HIV transmission through extramarital sex of the husband during the culturally prescribed period of abstinence. In countries with cultural norms related to long postpartum abstinence, women may reduce the duration to discourage regular partners from engaging in extra marital relationships that may result in infection of HIV of the family. Finally, based on this analysis, each these determinants were found to be more influential in different countries. This might have implications as research into the effect of the interaction between HIV/AIDS and fertility determinates on fertility rates continues and expands to include new regions with high HIV prevalence such as North Africa and the Caribbean. The combined indicator of postpartum insusceptibility, which includes both amenorrhea and abstinence, is just not a precise enough measure to capture these differences and runs the risk of over simplifying this complex relationship.

This analysis did not show any statistically significant relationship between the condom use and fertility in the final model (neither directly or through the HIV interaction term). Given the extraordinarily complicated interplay between HIV, condoms, and fertility (some of which was touched on in the background section), it is not that surprising that this analysis could not capture these relationships. The hypotheses tried to cover the possibilities of multiply directions of association. I expected that countries with high rates of condom use and high rates of HIV would either result in low fertility if the increase in condom use represents simply an increase in overall contraceptive use or higher fertility if the high condom use in high HIV countries represents the replacement of more effective contraceptive methods with less effective ones. Both of these could be operating within countries and causing national level data to obscure the relationship. Given the literature strongly linking condoms with HIV and fertility, it is extremely unlikely that there is no interaction. I expect that this broad study design was just not able to detect it.

Finally, for some of the interaction terms (specifically the effects conditioned on postpartum amenorrhea and abstinence) there were significant different in the strength of the relationship between the two periods. For postpartum amenorrhea and abstinence, the effects of HIV were stronger both in the positive and negative directions for the later period (2003-2010). Based on the interaction term for postpartum amenorrhea, the mean the effect of HIV on fertility for the period 2003-2010 was significantly greater than mean effect for the period 1993-2002. Similarly, based on the interaction term for postpartum abstinence, the mean the effect of HIV on fertility for the period from 2003-2010 is significantly greater than mean effect for the period 1993-2002. This would mean that shorter durations of postpartum amenorrhea or postpartum abstinence in high HIV prevalence countries is more strongly associated with high fertility in the second period, and longer durations of postpartum insusceptibility and high rates of HIV are also more strongly associated with lower fertility. This might indicate that HIV/AIDS prevention, treatment and care programs have raised awareness about the disease and information regarding intersection of HIV and behaviors related to certain proximate determinants of fertility are changing. It might also highlight differences among countries with high HIV rates related to how HIV is influencing pre-epidemic behaviors related to postpartum amenorrhea, and postpartum abstinence. Whatever is causing an increase in the interacted effect of HIV and proximate fertility determinants of fertility rates, further research is need to test whether HIV programs or something else is actually influencing these types of related behaviors and what mechanisms, policies, and behavior changes might be influencing this shift.

This study has a number of important limitations. First, the number of countries being used is very small (31). Since the sample was limited to countries with DHS in both time periods, a small subsection of the total number of countries with DHS during each was used. Secondly, by using DHS as the source of the majority of the data, more Sub-Saharan African countries are included compared to other regions. The DHS have been collecting data in this region for the past few decades and there are a larger number of surveys from this region than any other. As a result, Sub-Saharan African countries make up 45% of the sample in both time periods. Finally, because the analysis uses country level data, any variation with in regions or subgroups is lost. In addition, the results have to be interpreted by country and we cannot make inferences about individuals.

CONCLUSION

The analysis of changes in fertility rates continues to get more complex as more simplistic and traditional explanations become inadequate to account for the wide variety of factors influencing fertility behaviors. In some regions, HIV/AIDS and its close ties to proximate determinants of fertility are affecting fertility. This paper looked at this relationship in 31 countries from 6 regions of the world including Eastern Europe, East Asia, Latin America, North Africa South Asia, and Sub-Saharan Africa. The primary objective was to provide policy makers with additional information regarding the intersection of HIV/AIDS and fertility determinants in order to provide overarching programmatic guidance related to the integration of both family planning and HIV prevention programs. There are concerns that resources from family planning are being diverted to HIV programs in countries with high HIV rate, but research has shown that in individuals in countries with high HIV prevalence tend to use both family planning and HIV prevention programs to address both of these issues together (Askew & Maggwa, 2002; Maharaj, 2006). Based on the finding presented in this paper, the effect of HIV and some proximate determinants on fertility has increased as the epidemic has evolved. If these relationships continue to be important in explaining changes in fertility in high HIV prevalence countries, it will become more important for both fertility decline and spread of HIV/AIDS that both of these programmatic areas begin to more consciously address this overlap in utilization. It is my hope that the findings from this analysis will provide policy makers with additional information on the interaction of these two demographic factors and lead to some guidance with regard to implementation of integrated family planning/HIV prevention programs, which will appropriately address the needs of populations.

Tables & Figures

Table 1: Mechanisms for Possible Impacts of HIV/AIDS on Fertility in Sub- Saharan Africa

Proximate Determinants of Fertility	Mechanism for Impact of HIV/AIDS	Possible Effect on Fertility
Marriage		
	Delayed onset of sexual relations	Negative
	Reduction in premarital sexual relations	Negative
	Delayed marriage or non-marriage	Negative
	Reduced polygyny	Positive
	Increased divorce	Negative
	Increased widowhood	Negative
	Reduced remarriage	Negative
Contraception		
	Reduced desired family size	Negative
	Increased desired family size	Positive
	Increased condom use	Negative
	Switching from other family planning methods to Condoms	Positive
Pregnancy and Abortion		
	Reduced pregnancy rate	Negative
	Increased induced abortion	Negative
	Increased spontaneous abortion	Negative
Breastfeeding and Postpartum Abstinence		
	Reduction in breastfeeding to avoid mother- to-child HIV transmission Positive	Positive
	Reduction in postpartum abstinence Positive	Positive
	Reduction in breastfeeding and postpartum abstinence due to increased infant mortality	Positive
Pathological sterility		
	HIV induced sterility	Negative
	Reduction in STD prevalence	Positive
Natural Fecundity		
	Increased fetal mortality	Negative
Source: Ntozi, 2002		

Table 2. Summary Statistics

	1993-2002		2003-2010	
	Mean	sd	Mean	sd
N	31		31	
Total Fertility Rate	4.69	1.33	4.35	1.48
HIV Prevalence	2.38	3.49	2.38	3.26
Human Development Index	0.417	0.127	0.469	0.131
Age at First Marriage (Median)	18.26	2	18.7	2.02
Percent Currently Using Condoms	1.67	1.19	3.03	2.19
Months of Postpartum Insusceptibility (Median)	12.2	5.3	10.75	5.05
Months of Postpartum Amenorrhea (Median)	10.16	4.14	9.03	4
Months of Postpartum Abstinence (Median)	5.18	5.33	4.3	4.19
Region (Percent)*				
East Asia & the Pacific	9.68%			
Eastern Europe & Central Asia	3.23%			
Latin America & the Caribbean	12.90%			
North Africa & the Middle East	19.35%			
South Asia	9.68%			
Sub-Saharan Africa	45.16%			

*The same countries are used in both time periods so the percent in each region is the same.

Figure 3. Bivariate Relationship Between Total Fertility & HIV Prevalence for Periods 1993-2002 & 2003-2010

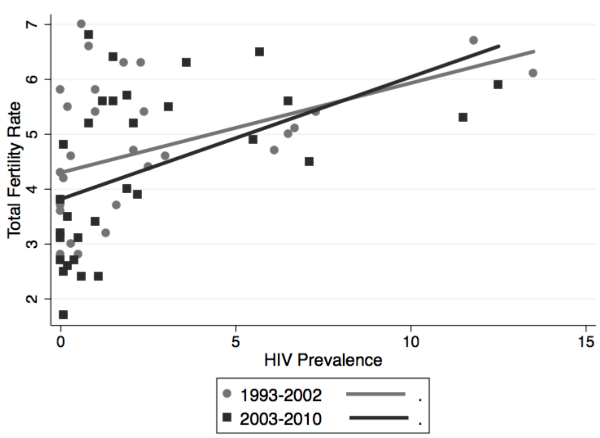


Table 3. Regression Results for Total Fertility Rate Models 1-6 1993-2002 & 2003-2010

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	1993-2002	**2003-2010**	**1993-2002**	**2003-2010**	**1993-2002**	**2003-2010**	**1993-2002**	**2003-2010**	**1993-2002**	**2003-2010**	**1993-2002**	**2003-2010**
Constant	4.3	3.82	7.63	8.19	4.35	4.26	2.46	1.23	2.14	0.047	5.28	3.67
	-0.267	-0.291	-0.606	-0.675	-1.82	-2.13	-2.1	-2.02	-2.36	-2.16	-1.83	-1.74
HIV Prevalence	.163*	.223**	0.068	0.07	.083~	0.064	3.15~	3.53**	1.96	4.15**	1.28	2.55**
	-0.064	-0.073	-0.047	-0.051	-0.045	-0.053	-1.56	-1.1	-1.86	-1.4	-1.11	-0.895
Human Development Index			-7.44***	-8.54	-3.73	-6.06~	-5.42~	-7.12*	-2.25	-5.99~	-7.44**	-9.92***
			-1.29	-1.27	-3.01	-3.09	-2.93	-2.71	-3.44	-3.01	-2.39	-2.05
Age at First Marriage					0.061	0.101	0.188	.266*	0.111	.271*	0.149	.259*
					-0.123	-0.119	-0.137	-0.117	-0.143	-120	-0.134	-0.118
Percent Currently Using Condoms					-.314*	-0.073	-.334~	-0.072	-0.394	-0.047	-0.373	-0.045
					-0.139	-0.078	-0.165	-0.096	(.169)*	-0.094	-0.171	-0.099
Months of Postpartum Insusceptibility (Median)					0.091	0.103~	0.131*	0.142*				
					-0.047	-0.061	-0.049	-0.054				
Months of Postpartum Amenorrhea (Median)									.193*	.221**		
									-0.077	-0.075		
Months of Postpartum Abstinence (Median)											.064~	.088~
											-0.036	-0.046
HIV Prevalence*Age at First Marriage							-.124~	-.151**	-0.082	-.166*	-.068*	-.123*
							-0.071	-0.052	-0.081	-0.061	-0.062	-0.047
HIV Prevalence*Current Condom Use							0.069	0.014	0.054	-0.011	.080~	0.015
							-0.042	-0.024	-0.047	-0.024	-0.044	-0.025
HIV Prevalence*Postpartum Insusceptibility							-.071*	-.057**				
							-0.033	-0.016				
HIV Prevalence*Postpartum Amenorrhea									-0.044	-.091**		
									-0.043	-0.03		
HIV Prevalence*Postpartum Abstinence											-.029*	-.046**
											-0.013	-0.013
R2	0.184	0.242	0.627	0.71	0.741	0.752	0.805	0.844	0.792	0.847	0.78	0.829
Adjusted R2	0.156	0.216	0.6	0.689	0.689	0.702	0.734	0.788	0.7167	0.791	0.701	0.767
N	31	31	31	31	31	31	31	31	31	31	31	31

S.E are in parenthesis. Significance Notation: ~.1, *.05, ** .01, ***.000

Figure 4. Bivariate Relationship Between Total Fertility & Human Development Index for Periods 1993-2002 & 2003-2010

Figure 5. Bivariate Relationship Between Total Fertility & Age at First Marriage for Periods 1993-2002 & 2003-2010

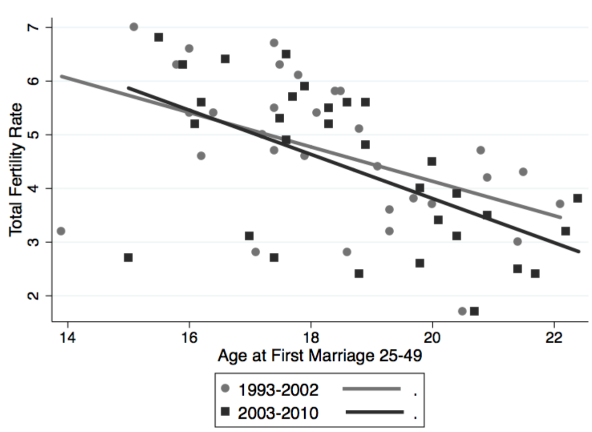


Figure 6. Bivariate Relationship Between Total Fertility & Postpartum Insusceptibility for Periods 1993-2002 & 2003-2010

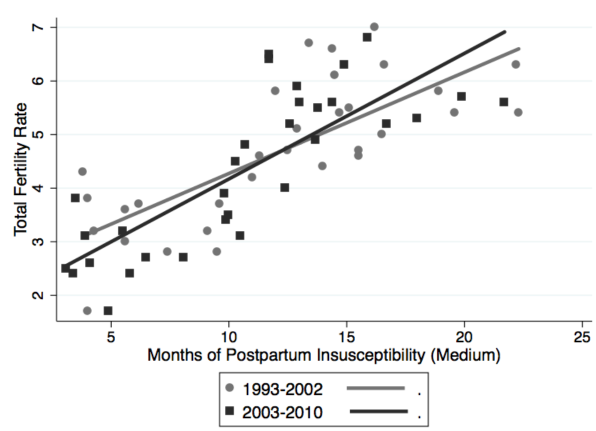


Figure 7. Bivariate Relationship Between Total Fertility & Current Condom Use for Periods 1993-2002 & 2003-2010

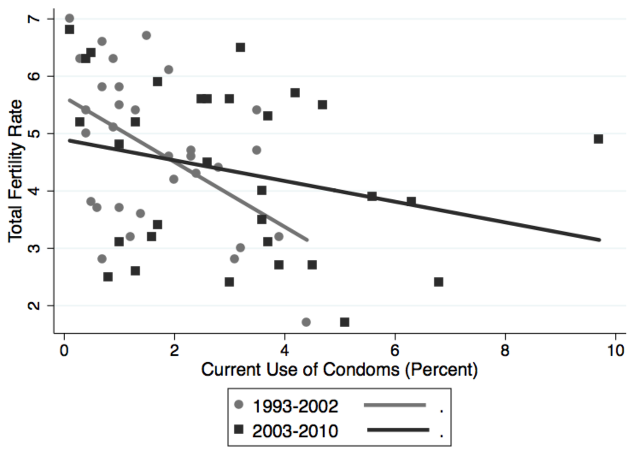


Table 4. Conditional Effect of HIV on TFR (holding the values of the other variables and interaction terms at their means)*

	1993-2002		2003-2010	
	Low	High	Low	High
Age at First Marriage (Low: 13.9, 15; High: 22.1, 22.4)	0.675	-0.341	0.705	-0.412
Postpartum Insusceptibility (Low: 3.8, 3.1; High: 22.3, 21.7)	.731	-0.582	0.572	-0.488
Percent Currently Using Condoms (Low: .1, .1; High: 4.4, 9.7)	0.026	0.323	0.105	0.24

* The net effect of HIV on fertility conditional on each of the proximate determinants was calculated for all of the values of each determinant using the high and low values of each determinant (identified in the table). All of the variables were held at their means except for the variables in the interaction term of interest.

Figure 8. Calculated Effect of HIV Prevalence on Fertility by Age at First Marriage for Periods 1993-2002 & 2003-2010

Figure 9. Calculated Effect of HIV Prevalence on Fertility by Postpartum Insusceptibility for Periods 1993-2002 & 2003-2010

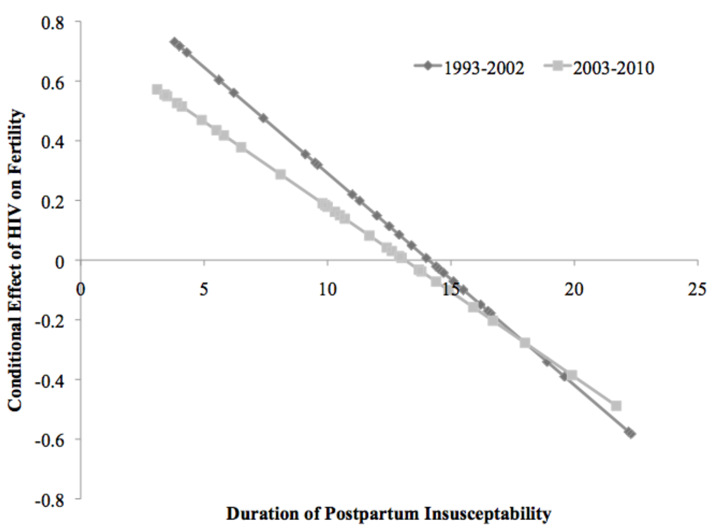


Figure 10. Total Fertility & HIV Prevalence with Postpartum Insusceptibility Interaction Effect (1993-2002)

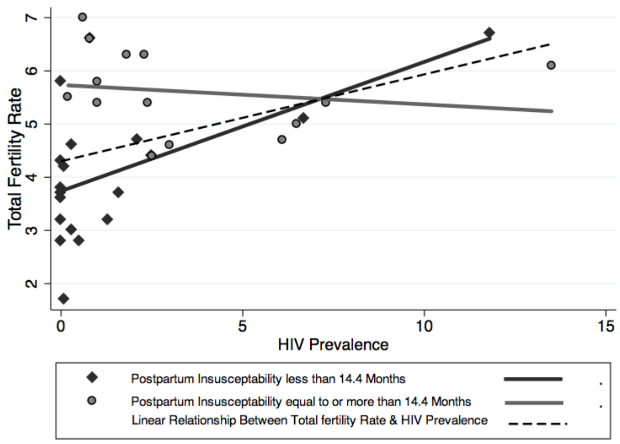


Figure 11. Total Fertility & HIV Prevalence with Postpartum Insusceptibility Interaction Effect (2003-2010)

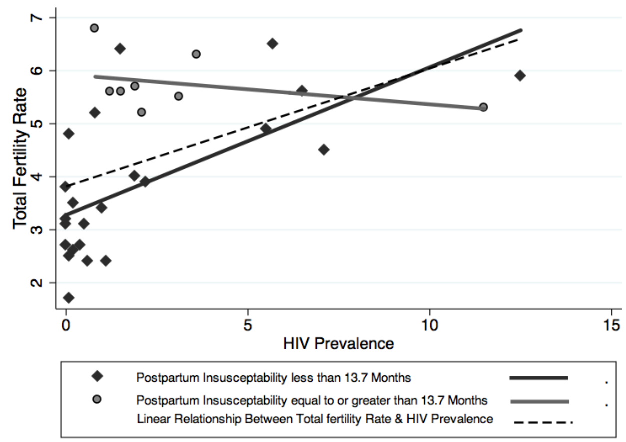


Table 5. Effect of HIV on TFR holding values of the other variables (and interaction terms) at their means

	1993-2002		2003-2010	
	Shorter	Longer	Shorter	Longer
Duration of Postpartum Amenorrhea (Low: 3.5, 2.5; High: 19.0, 15.8)	0.399	-0.283	0.785	-0.337
Duration of Postpartum Abstinence (Low: 1.4, 1.8; High: 22.1, 21.3)	0.131	-0.469	0.246	-0.651

* The net effect of HIV on fertility conditional on each of the proximate determinants was calculated for all of the values of each determinant using the high and low values of each determinant (identified in the table). All of the variables were held at their means except for the variables in the interaction term of interest.

Figure 12. Calculated Effect of HIV Prevalence on Fertility by Postpartum Amenorrhea for Periods 1993-2002 & 2003-2010

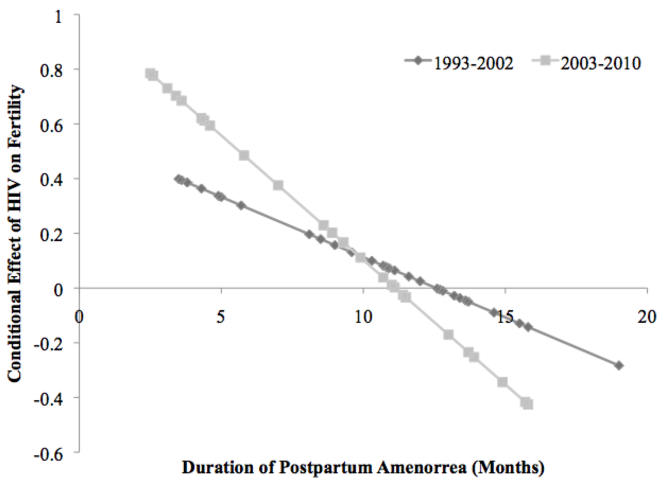


Figure 13. Total Fertility & HIV Prevalence with Postpartum Amenorrhea Interaction Effect (1993-2002)

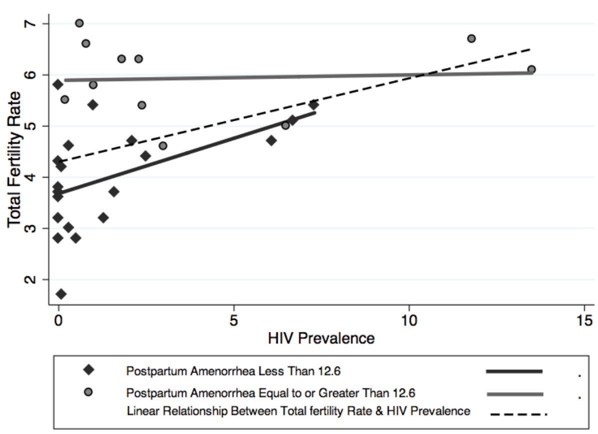


Figure 14. Total Fertility & HIV Prevalence with Postpartum Amenorrhea Interaction Effect (2003-2010)

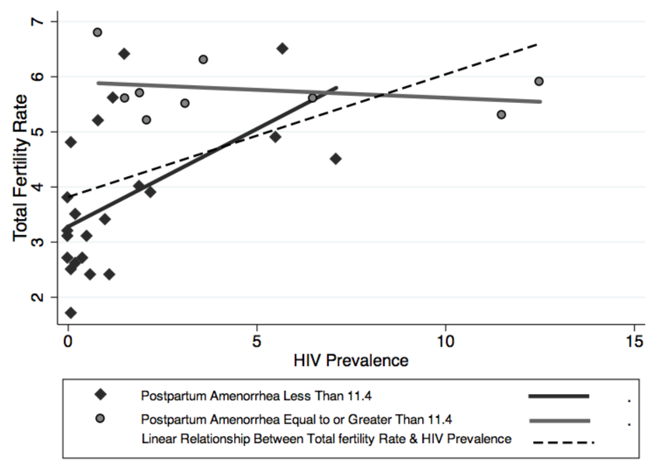


Figure 15. Calculated Effect of HIV Prevalence on Fertility by Postpartum Abstinence for Periods 1993-2002 & 2003-2010

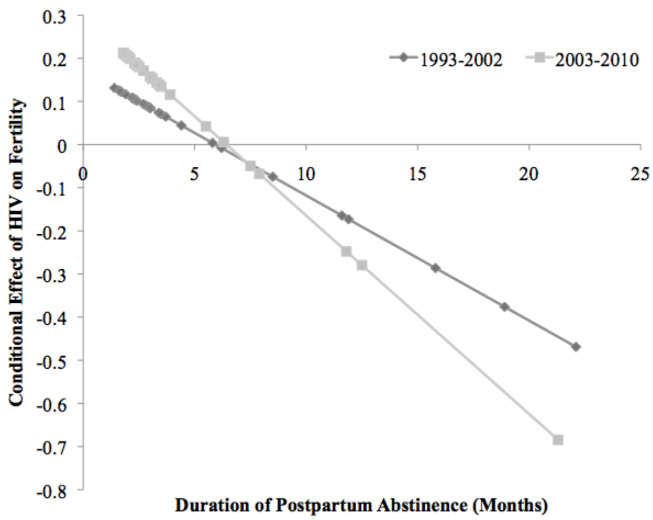


Figure 16. Total Fertility & HIV Prevalence with Postpartum Abstinence Interaction Effect (1993-2002)

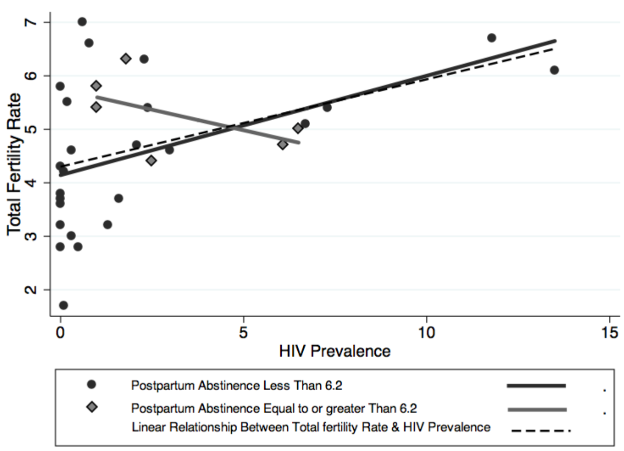
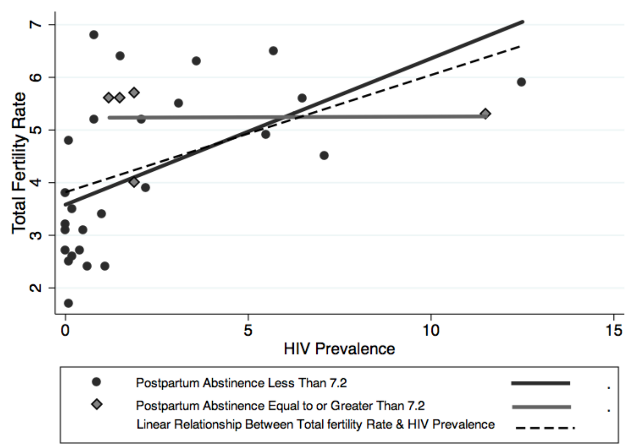


Figure 17. Total Fertility & HIV Prevalence with Postpartum Abstinence Interaction Effect (2003-2010)



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