Circumcision and the Labor Market Consequences of HIV in Developing Countries

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Abstract

Measuring the effect of HIV on economic outcomes is vital if we wish to understand the full impact of HIV on well-being in developing countries. This paper uses household level data spanning thirteen countries and exploits the recent finding that circumcision reduces the probability of contracting HIV to identify random variation in HIV prevalence and pin down the impact of HIV on employment. Using empirical methods that allow for the possibility that circumcision is correlated with omitted variables, we find that, for men living with the disease, HIV is associated with a reduction in employment of approximately 13 percent.

1 Introduction

The HIV/AIDS epidemic has had a devastating impact on global health. The United Nations estimates that there are 33.4 million individuals living with HIV worldwide, and 2 million annual AIDS-related deaths. Sub-Saharan Africa has been the hardest hit; with an adult prevalence rate of 5.2 percent, it contains only an eighth of the world population but accounts for two-thirds of those living with HIV (PRB, 2008; UNAIDS, 2009). In addition to reduced life expectancy, those suffering from HIV experience symptoms that increase in severity as the disease progresses, including fevers, headaches, chronic diarrhea, weight loss, shortness of breath, and fatigue.

While the impact of HIV on health and mortality has been well documented, there has been less progress in understanding the effects of the epidemic outside of the domains of health and population demographics. In particular, while there has been speculation that high HIV prevalence in Africa could explain the relatively slow economic growth observed in that region over the past twenty-five years (see, for example, Clive Bell, Shantayanan Devarajan and Hans Gersbach (2003)), there has been little progress identifying the economic effects of HIV infection. Indeed, while it seems quite likely that the world has paid a severe price in terms of lost productivity, it has proven difficult to generate estimates of the causal impact of HIV on economic outcomes. Kathleen Beegle and Joachim De Weerdt (2008) conducts a methodological overview of the existing literature, noting that "when stringent methodological requirements are applied to existing studies, few survive scrutiny."

The primary obstacle to identifying the economic consequences of HIV has been that HIV infection is not randomly assigned, raising the possibility that those with HIV may be systematically different than those without. As a result, any observed differences between the HIV positive and negative populations may be due to HIV, or may be due to pre-existing unobserved differences. In order to make headway, it is necessary to find variation in HIV prevalence that is uncorrelated with omitted characteristics which influence employment.

This paper builds on a recent finding from the medical literature, namely that circumcision is protective against HIV infection. While this possibility was suggested as early as 1986 (Aaron J. Fink, 1986), observational data generated mixed evidence, and the link remained speculative. The hypothesis was finally confirmed by three randomized controlled trials conducted in South Africa, Uganda, and Kenya. All three studies conclude that circumcision greatly reduces the risk of contracting HIV, by 48 percent in Uganda, 53 percent in Kenya, and 60 percent in South Africa (Ronald H. Gray, Godfrey Kigozi, David Serwadda, Frederick Makumbi, Stephen Watya, Fred Nalugoda, Noah Kiwanuka, Lawrence H. Moulton, Mohammad A. Chaudhary, Michael Z. Chen, Nelson K. Sewankambo, Fred Wabwire-Mangen, Melanie C. Bacon, Carolyn F.M. Williams, Pius Opendi, Steven J. Reynolds, Oliver Laeyendecker, Thomas C. Quinn and Maria J. Wawer, 2007; Robert C Bailey, Stephen Moses, Corette B Parker, Kawango Agot, Ian Maclean, John N Krieger, Carolyn FM Williams, Richard T Campbell and Jeckoniah O Ndinya-Achola, 2007; Bertran Auvert, Dirk Taljaard, Emmanuel Lagarde, Joëlle Sobngwi-Tambekou, Rémi Sitta and Adrian Puren, 2005). Indeed, the Kenyan and Ugandan trails were sufficiently safe and effective that the studies were halted early so that treatment could be offered to those randomly assigned to the control arms (HHS, 2006). This paper leverages the finding that circumcision is protective against HIV to identify exogenous HIV variation, and uses this variation to determine the impact of HIV on employment. The analysis is conducted using individual level data spanning thirteen countries: Burkina Faso, Cameroon, Côte d'Ivoire, Ethiopia, Ghana, Guinea, Haiti, Kenya, Lesotho, Malawi, Rwanda, Senegal, and Tanzania.

We begin by examining the impact of circumcision on labor market outcomes. Since those who are circumcised are less susceptible to HIV, the strategy is to compare the labor market behavior of those who are circumcised with those who are uncircumcised, interpreting any difference as being a consequence of their increased likelihood of HIV infection. The identifying assumption is that circumcision is protective against HIV, but does not have any direct impact on employment, and is also uncorrelated with omitted factors that do influence employment.

Since circumcision often occurs as a rite of passage in adolescence, one concern with this identification strategy is that higher status men are potentially more likely to become circumcised, and that these men may also be more successful on the labor market. In order to mitigate these concerns, we use characteristics of the HIV virus to further refine our identification strategy. In particular, since circumcision is only protective against HIV obtained during sexual intercourse, one would not expect HIV to cause circumcised and uncircumcised men to differ amongst those who have never had a sexual encounter. Moreover, one would expect that the health consequences of HIV will cause the employment patterns of the circumcised and uncircumcised populations to diverge with the length of time since the onset of sexually activity. This is true for two reasons. First, it is extremely unlikely that an individual will contract HIV during their first sexual encounter, but this probability increases over time if the individual remains sexually active. Second, since the health of an HIV positive individual is virtually unimpacted initially, but deteriorates sharply once HIV progresses to AIDS, it becomes increasingly likely that HIV will impact employment as the time since initial exposure increases. For these reasons, this paper attempts to pin down the economic consequences of HIV by focusing on the interaction between a man's circumcision status and the length of time since his first sexual encounter.

Amrita Ahuja, Brian Wendell and Eric Werker (2006) has taken a similar approach, using circumcision to estimate the economic effects of HIV, but has done so using a cross-country growth model approach. Given that circumcision data does not exist for many countries, they use tribal circumcision data to estimate circumcision prevalence for each African country. Using this proxy for circumcision, they find that HIV has not had a significant impact on economic growth. This is a surprising finding, given that studies using micro-level data have documented labor market effects of HIV (Matthew P. Fox, Sydney Rosen, William B. MacLeod, Monique Wasunna, Margaret Bii, Ginamarie Foglia and Jonathon L. Simon, 2004; Harsha Thirumurthy, Joshua Graff Zivin and Markus Goldstein, 2008). As a result, it is unclear from existing studies whether HIV has had substantial economic consequences. While Ahuja, Wendell and Werker (2006) is representative of all African countries, their conclusions are invalid if countries with higher circumcision prevalence are unobservably different from countries with low circumcision prevalence. On the other hand, Fox et al. (2004) and Thirumurthy, Zivin and Goldstein (2008) use longitudinal data to ensure that their results are not due to unobservable differences between those with HIV and those without, but these studies both examine rural Kenya, and it is thus difficult to rule out the possibility that HIV has larger economic consequences in this particular setting.

In this study, we bridge the gap between these two literatures, exploiting micro level data to ensure that our results are not biased by omitted variables correlated with circumcision, and using data that is nationally representative of men in thirteen countries to ensure that our results are generalizable. We find that circumcision is protective against HIV and, consistent with prior micro-level evidence, we find that this has important labor market consequences. More specifically, we find that HIV status is associated with about a 13 percent decline in employment, and we argue that this is likely to be a downward biased estimate of the true employment effect.

The paper proceeds as follows. We discuss our data in Section 2. In Section 3, we review our empirical methodology. We provide preliminary evidence on whether circumcision is a valid instrument for HIV status in Section 4, and we present our results in Section 5. Finally, we review the implications of this research in Section 6.

2 Data

The Demographic and Health Survey (DHS) and AIDS Indicator Survey (AIS) are nationally-representative household surveys administrated by ICF Macro. These surveys have a key advantage for the question at hand, which is that they are among the few data sources that both collect circumcision information and conduct HIV testing. Another advantage is that similar instruments have been fielded in 85 countries, allowing this study to gain statistical power by pooling observations across DHS/AIS surveys conducted in multiple countries.

Using the DHS/AIS, however, also implies certain limitations. The most important of these is that neither survey collects income, expenditure, or wealth data. As a result, it is impossible for us to determine the impact of HIV on any direct measures of financial well-being. However, the surveys do collect information on each respondent's work status, including whether the respondent is currently working and whether they have worked in the past year. As a result, we will be able to draw inferences regarding the impact of HIV on employment.

Our analysis includes DHS/AIS surveys that: (a) asked about male circumcision status, (b) conducted HIV testing, and (c) was completed by October 2005. We implement this time cutoff because the results of the first randomized trial linking circumcision with reduced risk of HIV (Auvert et al., 2005) was published in October 2005. Since the data in our analysis were collected before this date (and the individuals included in our sample were typically circumcised many years before that), it is highly unlikely that men in our sample chose to become circumcised with the intention of reducing their probability of acquiring HIV. As a result, this time cutoff helps to ensure that HIV risk is not driving the decision to become circumcised. Thirteen DHS and AIS surveys met these criteria: Burkina Faso, Cameroon, Côte d'Ivoire, Ethiopia, Ghana, Guinea, Haiti, Kenya, Lesotho, Malawi, Rwanda, Senegal, and Tanzania. Because DHS and AIS didn't begin conducting HIV tests until 2003, all of these surveys were fielded between 2003 and 2005.

Across these thirteen surveys, 62,200 men were eligible for the male questionnaire, and DHS/AIS successfully interviewed 56,444 of these men. We eliminate an additional 186 men due to missing circumcision status, 120 men due to missing work status, and 6,683 due to missing HIV tests, resulting in a final sample of 49,455 men aged 15 to 59 in 36,140 households.[1]

[1]Since circumcision and HIV status are likely to be correlated within household, standard errors are clustered at the household level.

3 Methodology

We are interested in the relationship between employment and HIV status:

$$E(l_i|\text{HIV}_i, Z_i) = \alpha_0 + \alpha_1\text{HIV}_i + \alpha_2 Z_i$$

where l_i is employment status, HIV_i is a dummy variable indicating whether the individual is HIV positive, and Z_i is a vector of controls. Control variables include an urban/rural indicator, an indicator for whether the individual has any formal schooling, a years of education spline (with knots at primary and secondary school completion), age (with a separate indicator for each year), religion indicators, and geographic region indicators.[2]

Ultimately our goal is to estimate the impact of HIV on employment (α_1) – but estimating this parameter is problematic. On one hand, employment generates greater financial resources, which may lead to increased opportunity for sexual activity, increasing HIV risk, and generating a positive correlation between HIV status and employment. On the other hand, greater resources may result in better access to information about safe sex practices, reducing HIV risk, and generating a negative correlation between HIV status and employment. In either case, one may estimate a significant α_1, even if there is no causal impact of HIV on employment. As a result, we will ultimately estimate α_1 using an instrumental variable strategy, where circumcision status is used to identify exogenous variation in HIV. With this approach we hope to generate estimates of the impact of HIV on employment that are robust to omitted variable bias and reverse causality.

With this goal in mind, we begin our analysis by focusing on the relationship between HIV and circumcision, also known as the *first stage*:

$$E(\text{HIV}_i|\text{CIRCUM}_i, Z_i) = \beta_0 + \beta_1\text{CIRCUM}_i + \beta_2 Z_i$$

[2]Regions within each country are defined by DHS/AIS, and range from as few as three regions (in Malawi) to as many as fourteen regions (in Burkina Faso).

where CIRCUM_i is a dummy variable indicating whether the individual is circumcised. Our intention here is to determine whether circumcision is predictive of HIV in our sample, which is an important requirement if we intend to use it as an instrument. We estimate this relationship with a linear probability model, regressing HIV status on circumcision:

$$\text{HIV}_i = \beta_0 + \beta_1 \text{CIRCUM}_i + \beta_2 Z_i + \epsilon_{\beta i}$$

Unlike recent clinical trials, circumcision is not randomly assigned in this data, and could thus be correlated with other factors that influence HIV risk. To address this concern, we utilize the fact that the protective effect of circumcision should increase with an individual's exposure to the virus. Ideally, exposure would be measured using the number of sexual encounters that an individual has had, along with the characteristics of each encounter (e.g., condom use and HIV status of the partner). Such data, however, is unavailable. Even if it were available, it is possible that true exposure could itself be influenced by an individual's HIV status, raising the possibility of reverse causality. To address this, we instead proxy for exposure using the length of time since sexual debut. We estimate the first stage using the following linear probability model:

$$\text{HIV}_i = \delta_0 + \delta_1 \text{CIRCUM}_i + \delta_2 \text{EXPOSURE}_i + \delta_3 \text{CIRCUM}_i * \text{EXPOSURE}_i + \delta_4 Z_i + \epsilon_{\delta i}$$

where EXPOSURE_i is the length of time since sexual debut. Our estimate of the protective effect of circumcision with increased exposure is δ_3, and it is this interaction between circumcision and time since sexual debut that we will use to instrument for HIV status when we estimate the impact of HIV on employment. The appeal of this specification is that it allows for the possibility that circumcision status is correlated with unobserved factors that influence HIV risk, since any such effects will be absorbed by δ_1. Similarly, it allows for the possibility that length of time since sexual debut (controlling for age) is correlated with HIV risk, since any such effects will be absorbed by δ_2. The key assumption here is that there are no omitted variables that are correlated with both circumcision and the length of time since sexual debut.

Using similar linear probability models, we also estimate relationship between employment status and circumcision, also known as the *reduced form*:

$$l_i = \gamma_0 + \gamma_1 \text{CIRCUM}_i + \gamma_2 Z_i + \epsilon_{\gamma i}$$

This model estimates the impact of circumcision on employment. Note that γ_1 is simply the mean employment of the circumcised population minus the mean employment of the uncircumcised population, so we refer to this as the *difference* estimator of the reduced form impact of circumcision on employment. This model begins to shed light on the core question of this paper, whether HIV status has an impact on employment, since $\gamma_1 = \alpha_1 \beta_1$. If we find in our reduced form regressions that circumcision has an impact on employment ($\gamma_1 \neq 0$), then this implies that HIV does influence labor market outcomes ($\alpha_1 \neq 0$). Furthermore, given the strong evidence that circumcision reduces the risk of HIV infection ($\beta_1 < 0$), it seems reasonable to suppose that a negative γ_1 implies a positive α_1. In other words, in a reduced form regression of employment on circumcision, we will interpret a *positive* circumcision coefficient as evidence that HIV has a *negative* impact on employment.

Once again, this difference estimator will produce biased results if circumcision is correlated with unobserved factors that also influence the outcome variable – for example if high status men are more likely to be circumcised and also do better on the labor market. We implement the same solution here as we did in the first stage, interacting circumcision with the length of time since sexual debut, our proxy for HIV exposure:

$$l_i = \theta_0 + \theta_1 \text{CIRCUM}_i + \theta_2 \text{EXPOSURE}_i + \theta_3 \text{CIRCUM}_i * \text{EXPOSURE}_i + \theta_4 Z_i + \epsilon_{\theta i}$$

This specification leverages the fact that the protective effect of circumcision increases with exposure to the virus, and the protective effect of circumcision on employment with increased exposure is now θ_3. As long as the interaction between circumcision and length of time since sexual debut is uncorrelated with unobserved factors that influence employment, this will produce unbiased estimates of the impact of circumcision on employment.

One characteristic of HIV is that, aside from flu like symptoms that manifest immediately after infection, individuals typically remain asymptomatic for years after contracting the virus. While there is a great deal of heterogeneity in the length of this latent period, the best available evidence suggests that median latency in societies without widespread use of antiretroviral therapy ranges from 8 to 11 years, depending on age at seroconversion (Collaborative Group on AIDS Incubation and HIV Survival, 2000). As a result, it is unlikely that HIV infection would substantively alter health, and thus employment, within the first eight years after sexual debut. Taking this characteristics of the virus to our empirical model, we implement a final specification for the reduced form:

$$l_i = \mu_0 + \mu_1 \text{CIRCUM}_i + \mu_2[\text{EXP}_i > 8] + \mu_3 \text{CIRCUM}_i * [\text{EXP}_i > 8] + \mu_4 Z_i + \epsilon_{\mu i}$$

where $[\text{EXP}_i > 8]$ is a dummy variable that is equal to one if the individual first had sexual intercourse over 8 years ago, and the protective effect of circumcision is now captured by μ_3. Rather that assuming that the employment gap between circumcised and uncircumcised men will steadily increase with the length of time since sexual debut, this specification makes use of the fact that any HIV induced gap between circumcised and uncircumcised men should not arise until after a minimum of eight years of sexual activity. Since μ_3 is the mean employment of the circumcised population minus the mean employment of the uncircumcised population for those who have been sexually active for eight years, minus the same difference for those who have not been sexually active for eight years, we refer to this as the *difference-in-difference* estimator of the reduced form impact of circumcision on employment.

When instrumenting for HIV to measure the impact of HIV on employment, we implement a bivariate probit model where HIV is treated as an endogenous regressor. We do this, rather than continuing with a linear model, because Jay Bhattacharya, Dana Goldman and Daniel McCaffrey (2006) has shown via Monte Carlo analysis that when both the outcome and the treatment is binary, bivariate probit produces performs better than two-stage least squares (2SLS), particularly when the underlying data-generating process is non-normal or the dependent variable is close to 0 or 1, and Joseph V. Terza, W. David Bradford and Clara E. Dismuke (2008) shows that this performance gap increases with sample size. Moreover, in this application, we have found that 2SLS often produces predicted probabilities that fall outside the unit interval.

4 Background

HIV prevalence rates vary dramatically from country to country, and this fact is borne out in our sample of 15-59 year old men. The first column of Table 1 shows HIV prevalence rates for our sample in each country. Prevalence ranges from less than 1 percent in Senegal, to nearly 19 percent in Lesotho. The prevalence of male circumcision also varies widely across countries. The second column of Table 1 shows that circumcision prevalence ranges from just over 5 percent in Haiti, to nearly 99 percent in Guinea. The fact that circumcision is rare in some countries but nearly universal in others reflects the variability in social norms with respect to circumcision. These social norms often have their roots in traditional ethnic, tribal, or religious practices. In some cultures, nearly all boys are circumcised in infancy. In other cultures, male circumcision is a rite of passage into adulthood. Whether circumcision is done in infancy or in puberty, however, the practice is nearly always completed before age 15, which is the age cutoff for inclusion in our sample.

In order to assess the validity of using circumcised men as a comparison group when measuring the impact of HIV on employment, it is important to know what observable factors are correlated with circumcision. Throughout our analysis, we control for country, region, religion, and age. As a result, rather than focusing on the cultural factors that explain circumcision prevalence across societies, we are more interested in understanding why some boys are circumcised, while other boys in the same country, region, religion, and cohort are not. We are particularly concerned about the possibility that circumcised men may be of lower or higher status. Indeed, Peter Aggleton (2007) argues that circumcision is often a marker of social standing, and the author notes that he was told in Kenya that it would be unthinkable for that country to have an uncircumcised president. To investigate this concern, we begin by examining whether circumcision is indeed correlated with social status and cultural practices in our data.

4.1 Pre-HIV outcomes

This paper will exploit the fact that circumcision is protective against HIV to identify the impact of HIV on employment. Circumcision is not randomly assigned, however, and could itself be correlated with unobserved factors that influence HIV risk. If this is the case, then we have simply traded one statistically endogenous variable for another, and the correlation between circumcision and HIV could reflect these other risk factors, rather than the protective effect of circumcision. To address this concern, we begin our analysis by investigating the relationship between circumcision and behaviors that influence HIV risk: in particular extra-marital sex and condom use.

Finding a correlation between circumcision and current sexual practices, however, would not necessarily be evidence of a problem, since sexual practices are themselves choices, which could be influenced by one's HIV status. For example, if we find that uncircumcised men are less likely to engage in extra-marital sex, we cannot rule out the possibility that this is precisely because they are more likely to be HIV positive. The DHS/AIS surveys provide us with an opportunity to side-step this concern, since it asks 15-24 year old respondents who have engaged in sexual intercourse whether they used a condom *at sexual debut*, and it asks men of all ages whether they were married *at sexual debut*. Since these questions ask about sexual practices at a time when the respondent is highly unlikely to have been HIV positive, we can be sure that we are not picking up the impact of one's own HIV status on sexual practices.

A related concern is that higher status men may be more likely to be circumcised, in which case a correlation between circumcision and employment may arise because circumcision is a proxy for status, rather than a result of the fact that circumcised men are healthier due to their lower propensity to contract HIV. We investigate this concern by looking at the correlation between circumcision and graduation from primary school, since primary school is generally completed well before one is at risk for sexually transmitted HIV.

In Panel A of Table 2, we regress these pre-HIV outcomes on circumcision, and we find that circumcision is indeed correlated with sexual practices. Circumcised men aged 15-24 were more likely to use a condom, and circumcised men of all ages were more likely to be unmarried at sexual debut. Moreover, they were also more likely to complete primary school, suggesting that circumcised men are higher status, on average.

As discussed in the methodology section, we address the fact that circumcised men have different cultural practices and are of higher status than their uncircumcised peers by interacting circumcision with a proxy for HIV exposure – namely the length of time since sexual debut. While both circumcision and exposure may be correlated with unobserved factors, the critical assumption for this specification is that the interaction between circumcision and exposure is uncorrelated with omitted factors that influence employment. In Panel B of Table 2, we regress pre-HIV risk factors on circumcision, years since sexual debut, and the interaction of these two variables. While circumcision and years since sexual debut are strongly correlated with sexual practices and graduation from primary school, the interaction is statistically insignificant for all three pre-HIV outcomes.

Throughout our analysis, we will also employ a specification that makes use of the fact that, since HIV is typically asymptomatic for years after seroconversion, the health of circumcised and uncircumcised men should be similar in the eight years after sexual debut, but should diverge afterward, since uncircumcised men are more likely to be HIV positive and will begin to experience a decline in health associated with AIDS. In Panel C of Table 3, we regress pre-HIV risk factors on circumcision, an indicator for whether sexual debut occurred over eight years ago, and the interaction between these two variables. Once again, the interaction is not statistically significant for the risk factors at sexual debut. The interaction is significant, however, for finishing primary school, raising the possibility that men who are circumcised and began having sex at a younger age are particularly likely to have better educational outcomes. For this reason, throughout the rest of our analysis, we flexibly control for years of education using a years of education spline, with knots at primary and secondary school completion. This ensures that the circumcision-exposure interaction will not be biased due to its correlation with education.

5 Results

We now turn to our main results for the impact of circumcision on HIV status (the first stage) and on employment (the reduced form). In Panel A of Table 3, we regress HIV and employment on circumcision status. Surprisingly, we find no statistically significant relationship between circumcision and HIV. Given the strong evidence from randomized clinical trials that circumcision is protective against HIV, we take this as compelling evidence that circumcision is indeed correlated with unobserved factors that influence HIV risk. For example, in the previous section, we showed that circumcised men were more likely to be unmarried at sexual debut, suggesting that they may have engaged in more risky sexual practices. Given that circumcision is not associated with increased HIV prevalence in this sample, it makes sense that we find no association between circumcision and work status.

The central idea of this paper is that, while circumcision may be correlated with unobserved factors, if circumcision is protective against HIV, then we would expect HIV rates to rise more quickly with HIV exposure for uncircumcised men. In Panel B, we proxy for HIV exposure using the number of years since sexual debut. As expected, HIV prevalence increases with exposure for uncircumcised men (at a rate of 0.2 percentage points per year after sexual debut), but increases at just half this rate for circumcised men. The magnitude of this effect is consistent with the degree of protection found in randomized controlled trials (where point estimates of the protective effect of HIV range between 48 and 60 percent). The interaction is also strongly predictive of employment status. While current employment increases by 0.4 percentage points per year since sexual debut for uncircumcised men, it increases by 0.6 percentage points per year for circumcised men. The magnitude of the employment effect is similar when looking at the probability of working at any point over the past year.

In Panel C, we exploit the fact that HIV is typically asymptomatic for eight to eleven years after seroconversion, since this suggests that we should not expect employment patterns for circumcised and uncircumcised men to diverge in the first eight years following sexual debut. We use a difference-in-difference estimator to assess whether employment rates increase more after eight years of exposure for circumcised men than they do for uncircumcised men. We find that they do, with a fraction currently working that is 4.8 percentage points higher for circumcised men after eight years of exposure. Similarly, we find that the fraction working this year is 3.4 percentage points higher for circumcised men after eight years of exposure.

5.1 Robustness Check: Different cutoffs for years since debut

While median time from seroconversion to AIDS is eight to eleven years, there is considerable heterogeneity at the individual level, so some individuals will progress to AIDS much earlier than 8 years, and others will progress much later. Moreover, most individuals who obtain HIV will not do so in their first sexual encounter, meaning that many individuals will not progress from HIV to AIDS until well after eight years after sexual debut. In Appendix Table 1, we demonstrate that our results are not sensitive to the number of years of exposure used to construct the difference-in-difference estimator in Panel C of Table 3. Of course, regardless of the number of years of exposure used to construct the difference-in-difference estimator, some HIV positive individuals will have progressed to AIDS prior to the cutoff, and other HIV positive individuals will not have progressed after the cutoff. As a result, it is likely that the difference-in-difference estimator represents an underestimate of the true impact of circumcision on employment.

In addition to the fact that we don't observe when individuals progress from HIV to AIDS, it is important to recognize that many individuals died from HIV prior to the fielding of these surveys and are thus excluded from our sample. The death of these individuals, and the fact that they are thus missing from the work force entirely, is a labor market consequence of the HIV epidemic that is not captured by this analysis. While mortality selection does not impair our ability to estimate the labor market impact of HIV for those currently living with the disease, it represents another reason why the estimates in this paper are likely to be a downwardly biased estimate of the overall impact of HIV on employment.

5.2 Robustness Check: Heterogeneous effects by HIV prevalence

If the interaction between circumcision and exposure is predictive of employment due to the protective effect of circumcision against HIV, then one would expect the relationship to be largest in areas where HIV prevalence is highest, since men in regions with high HIV prevalence are presumably more exposed to the virus. We investigate this possibility by stratifying our results by whether regional HIV prevalence is higher than median regional HIV prevalence. These regressions are shown in Table 4. In Panels B and C, note that the interaction between circumcision and exposure is more predictive of HIV and employment status in high HIV prevalence regions. Indeed, the interaction is statistically insignificant for both employment measures in low HIV prevalence areas.

Since we expect the circumcision-exposure interaction to be larger in high HIV prevalence areas, testing this claim serves as another way to ensure that our results are not simply an artifact of an omitted factor correlated with circumcision and exposure. This specification amounts to a difference-in-difference-in-difference estimator, where HIV prevalence serves as the third difference. Results from this model are shown in Appendix Table 2 panels B and C. For HIV and for both work status variables, we find that the circumcision-exposure interaction is significantly larger in high HIV prevalence regions. This provides further evidence that the circumcision-exposure interaction is indeed capturing the protective effect of circumcision against HIV with increased exposure.

5.3 Robustness Check: Probit Specification

Thus far we have employed linear probability models, due to the ease of interpretation of interaction effect parameters in these models. With a linear specification, for example, the coefficient on an interaction between two indicator variables can be interpreted as a difference-in-difference estimator, which is not the case with a limited dependent variable model, where special care must be taken when generating marginal effects for an interaction effect. The results in this paper are, however, robust to alternative empirical specifications. To illustrate this, we implement a probit specification and calculate marginal effects of the circumcision-exposure interaction using the method outlined by Chunrong Ai and Edward C. Norton (2003). These results are shown in Appendix Table 3, and the marginal effects of the interactions between circumcision and exposure are similar to those in Table 3.

5.4 Bivariate Probit

The analysis so far has focused on estimating the first stage impact of circumcision on HIV and the reduced form impact of circumcision on employment. We now turn to estimating the impact of HIV on work status, using the circumcision-exposure interaction to help identify exogenous variation in HIV status. As mentioned in the methodology section, we use a bivariate probit model, since there is compelling Monte Carlo evidence that bivariate probit performs better than two-stage least squares when both the treatment and the outcome are binary (Bhattacharya, Goldman and McCaffrey, 2006; Terza, Bradford and Dismuke, 2008).

Results are shown in Table 5. Estimating the bivariate probit without any exclusion restrictions, we obtain a negative but statistically insignificant impact of HIV on work status. When we use circumcision status as an instrument for HIV, this has virtually no impact on our estimate for the impact of HIV on employment. Next we instrument for HIV status with the interaction between circumcision and time since sexual debut. When we do this, the point estimate for the impact of HIV on work status gets substantially larger for both employment measures, and the impact of HIV on working this year becomes statistically significant. Thus, in a sample of countries where approximately 76 percent of 15-59 year old men have worked in the past year, we find that circumcision is associated with about a 10 percentage point reduction in working at any point over the past year, which amounts to approximately a 13 percent reduction in employment.

5.5 Robustness Check: Selection on HIV test

One concern with the DHS/AIS surveys is that some men choose not to be tested. It may be that the least or most healthy men are more likely to opt out of the test, which could result in biased estimates of the impact of HIV on employment. Indeed, in this sample of thirteen countries, HIV status is unknown for 6,683 of the 15-59 year old men who were interviewed, which is approximately 12 percent of the interviewed sample. Since HIV status is unknown for these men, we cannot include them in our bivariate probit model, nor can we estimate the impact of circumcision on HIV for these men. However, we can check whether the reduced form impact of circumcision on employment differs for those men for whom HIV status is missing.

We do this in Table 6, and there is some evidence that those with a missing HIV test are different, with the interaction between circumcision and exposure being less predictive of work status for these men, although this difference is significant at conventional levels only for the continuous measure of exposure and when looking at work status over the past year. This result is consistent with two possible explanations. On the one hand, it may be that circumcision is less protective against HIV with increasing time since sexual debut for those who with missing HIV status. This would be the case, for example, if those with missing HIV tests have less frequent sex or if they engage in sex with fewer partners. On the other hand, it may be that circumcision is equally protective with time since sexual debut for those with unknown HIV status, but that these men are more likely to be employed, perhaps because they are slower to progress from HIV to AIDS.

Regardless of the selection process causing men with missing HIV tests to differ from those without, if effect sizes are smaller for those with missing HIV status, there is the potential that we could overstate the impact of circumcision and HIV on employment if we exclude them from the analysis. To investigate this possibility, in Appendix Table 4 we estimate the reduced form specifications using all men, regardless of whether they completed the HIV test. We find that the inclusion of these men has minimal impact on our estimates of the reduced form parameters, and no impact on the statistical significance or substantive conclusions that we drew from the original analysis in Table 3. We view this as strong evidence that excluding those with missing HIV status from our analysis does not have a substantial impact on our estimates.

6 Conclusion

There is little prior evidence on the impact of the HIV epidemic on economic outcomes. One reason for this is that estimating this relationship is problematic, since it is difficult to determine whether HIV and labor outcomes are correlated because HIV causes low employment, or because low employment causes higher HIV prevalence. Using longitudinal data, researchers have shown that individuals with HIV exhibit declining job performance as the disease progresses (Fox et al., 2004) and increasing performance when treated with antiretrovirals (Thirumurthy, Zivin and Goldstein, 2008), yet both of these studies are limited to small samples in rural Kenya, raising the question of how generalizable the results are to other contexts. Meanwhile, cross-country regression models have generated mixed results of the impact of HIV on economic growth, and have struggled to find valid instruments for HIV prevalence.

We contribute to this literature by exploiting the recent finding that circumcision is protective against HIV to identify exogenous variation in HIV prevalence. Leveraging our individual level data, we utilize the fact that the protective effect of circumcision should be larger for individuals who have had greater exposure to the virus, which allows us to rule out the possibility that our results are driven by unobserved differences between circumcised and uncircumcised men. Using this exogenous variation in HIV prevalence, we find that HIV is associated with a 13 percent reduction in employment. We conduct this analysis with a random sample of men spanning thirteen countries, thus ensuring that our results are relevant to a wide variety of contexts.

Our analysis also generates estimates of the impact of circumcision on employment. We do not find a statistically significant relationship between circumcision and HIV, but it is important to consider that circumcision is not randomly assigned in our sample. Given the strong evidence from randomized trials that circumcision is protective against HIV, along with the fact that circumcision is correlated with sexual practices and social status in our sample, we conclude that this is most likely a result of non-random selection into circumcision. On the other hand, we find that exposure to HIV has a reduced impact on HIV status for circumcised men, with circumcised men being 0.1 percentage points less likely to contract HIV for each year since their sexual debut. Consequently, we find that circumcised men are 0.2 percentage points more likely to be working for each year since their sexual debut. As one would expect if these correlations are due to the protective effect of circumcision against HIV, we find that these effects are larger in high HIV prevalence areas, and statistically insignificant in areas with low HIV prevalence.

In 2007, the World Health Organization and the Joint United Nations Programme on HIV/AIDS recognized male circumcision interventions as an important tool in the fight to prevent the spread of HIV, but this recommendation has proven to be controversial, given the strong social norms surrounding circumcision practices. While our primary goal in this paper is to measure the impact of HIV on employment, our results also pertain to the debate surrounding male circumcision, since we find that, at least in areas with high HIV prevalence, circumcision has benefits beyond HIV prevention. More specifically, we find that, as the number of years since sexual debut increases, circumcised men are less likely to contract HIV and thus more likely to remain employed. That said, the use of circumcision as an intervention is a complex moral issue, and these economic benefits need to be weighted alongside the ethical issues associated with influencing this complex social practice.

There are two major limitations of this study, both of which are inherent to the study design. First, because DHS/AIS does not collect information on household finances, we look at the impact of HIV on employment, but we are unable to measure the impact of HIV on more direct measures of economic well-being, such as wealth, income, and expenditures. Second, because we use cross-sectional surveys, which collect no information for men who died prior to their household's interview date, we estimate the impact of HIV on employment for those living with HIV, but ignore the impact of HIV on employment via increased mortality. Men with HIV die earlier, on average, than those without HIV, particularly in developing countries, where antiretroviral use remains rare. As a result, the estimates produced in this paper are likely to be downwardly biased, with the true impact of HIV on employment (including mortality) being substantially larger.

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Table 1: HIV and Circumcision Prevalence, by Country

	HIV	Circumcision
Lesotho, 2004	18.6	51.6
	(0.4)	(0.6)
Malawi, 2004	10.0	24.4
	(0.4)	(0.5)
Tanzania, 2003	5.7	72.2
	(0.3)	(0.4)
Kenya, 2003	4.5	85.6
	(0.3)	(0.5)
Cameroon, 2004	4.0	94.9
	(0.3)	(0.4)
Rwanda, 2005	2.4	11.0
	(0.3)	(0.4)
Cote d'Ivoire, 2005	2.4	96.2
	(0.3)	(0.5)
Haiti, 2005	1.9	5.5
	(0.3)	(0.4)
Burkina Faso, 2003	1.8	85.2
	(0.3)	(0.5)
Ghana, 2003	1.6	92.7
	(0.3)	(0.4)
Ethiopia, 2005	1.4	92.6
	(0.3)	(0.4)
Guinea, 2005	1.2	98.7
	(0.3)	(0.5)
Senegal, 2005	0.5	98.2
	(0.3)	(0.5)
Overall	3.6	70.4
	(0.1)	(0.2)
Observations	49455	56138

Standard errors in parentheses.

Table 2: Pre-HIV Outcomes

	Risk Factors at Sexual Debut		Finished
	Condom	Unmarried	Primary School
Panel A			
Circumcised	0.030	0.028	0.044
	[1.99]	[5.53]	[5.87]
Panel B			
Circumcised	0.058	0.020	0.038
	[2.76]	[3.30]	[4.37]
Years since debut	-0.030	0.018	0.003
	[-15.45]	[36.39]	[5.51]
Circumcised * (Years since debut)	-0.004	-0.000	0.000
	[-1.49]	[-0.18]	[0.72]
Panel C			
Circumcised	0.028	0.032	0.058
	[1.84]	[5.19]	[6.54]
(Years since debut > 8)	-0.141	0.121	0.041
	[-11.48]	[17.66]	[4.47]
Circumcised * (Years since debut > 8)	0.018	-0.009	-0.029
	[1.02]	[-1.49]	[-3.37]
Mean of Outcome Variable	0.227	0.891	0.439
Observations	10286	39614	49455

Robust t-statistics in brackets, clustered by household. Regressions control for country, region, urbanicity, religion, age, log household size, and a household wealth index.

Table 3: First Stage and Reduced Form

	HIV Status	Currently Working	Worked This Year
Panel A			
Circumcised	0.002	-0.004	-0.007
	[0.40]	[-0.63]	[-1.05]
Panel B			
Circumcised	0.015	-0.032	-0.028
	[3.74]	[-3.88]	[-3.54]
Years since debut	0.002	0.004	0.004
	[8.28]	[7.04]	[9.65]
Circumcised * (Years since debut)	-0.001	0.002	0.002
	[-7.41]	[6.52]	[5.19]
Panel C			
Circumcised	0.017	-0.029	-0.024
	[4.42]	[-3.45]	[-3.06]
(Years since debut > 8)	0.039	-0.001	0.012
	[9.62]	[-0.17]	[1.51]
Circumcised * (Years since debut > 8)	-0.031	0.047	0.034
	[-8.29]	[5.82]	[4.46]
Mean of Outcome Variable	0.036	0.696	0.756
Observations	49455	49455	49455

Robust t-statistics in brackets, clustered by household. Regressions control for country, region, urbanicity, religion, age, log household size, years of education, and a household wealth index.

Table 4: First Stage and Reduced Form – Heterogenous Effects by HIV Prevalence

	HIV Status		Currently Working		Worked This Year	
	Low HIV Prevalence	High HIV Prevalence	Low HIV Prevalence	High HIV Prevalence	Low HIV Prevalence	High HIV Prevalence
Panel A						
Circumcised	-0.002	0.000	0.003	-0.009	-0.003	-0.011
	[-0.47]	[0.07]	[0.32]	[-1.07]	[-0.36]	[-1.36]
Panel B						
Circumcised	0.001	0.024	-0.004	-0.062	-0.011	-0.052
	[0.33]	[3.98]	[-0.32]	[-5.51]	[-0.97]	[-4.79]
Years since debut	0.001	0.003	0.004	0.004	0.004	0.006
	[3.08]	[6.57]	[6.23]	[4.23]	[6.62]	[7.26]
Circumcised * (Years since debut)	-0.000	-0.002	0.001	0.004	0.001	0.003
	[-1.85]	[-6.63]	[1.33]	[7.79]	[1.37]	[6.39]
Panel C						
Circumcised	0.002	0.023	-0.004	-0.052	-0.009	-0.046
	[0.58]	[3.98]	[-0.31]	[-4.70]	[-0.71]	[-4.24]
(Years since debut > 8)	0.011	0.058	0.018	-0.018	0.021	0.003
	[3.49]	[7.46]	[1.47]	[-1.37]	[1.79]	[0.22]
Circumcised * (Years since debut > 8)	-0.008	-0.046	0.015	0.082	0.010	0.065
	[-2.49]	[-6.41]	[1.31]	[6.85]	[0.94]	[5.92]
Mean of Outcome Variable	0.013	0.068	0.726	0.655	0.771	0.736
Observations	28405	21050	28405	21050	28405	21050

Robust t-statistics in brackets, clustered by household. Regressions control for country, region, urbanicity, religion, age, log household size, years of education, and a household wealth index.

Table 5: Bivariate Probit – Impact of HIV on Labor Market Outcomes

	Currently Working	Worked This Year
Panel A		
No instrument	-0.051	-0.074
	[-0.69]	[-1.54]
Panel B		
Instrument:	-0.047	-0.070
Circumcised	[-0.64]	[-1.45]
Panel C		
Instrument:	-0.108	-0.107
Circumcised * (Years since debut)	[-1.77]	[-2.31]
Panel D		
Instrument:	-0.085	-0.097
Circumcised * (Years since debut > 8)	[-1.30]	[-2.12]
Mean of Outcome Variable	0.696	0.756
Observations	49455	49455

Marginal effects with robust t-statistics in brackets, clustered by household. Models control for country, region, urbanicity, religion, age, log household size, years of education, and a household wealth index.

Table 6: Reduced Form – Investigating Selection on HIV Test

	Currently Working	Worked This Year
Panel A		
Circumcised	-0.005	-0.007
	[-0.69]	[-1.14]
Circumcised * Missing HIV	0.002	-0.001
	[0.11]	[-0.12]
Panel B		
Circumcised * (Years since debut)	0.002	0.002
	[6.40]	[5.09]
Circumcised * (Years since debut) * Missing HIV	0.000	-0.002
	[0.04]	[-1.78]
Panel C		
Circumcised * (Years since debut > 8)	0.047	0.033
	[5.92]	[4.46]
Circumcised * (Years since debut > 8) * Missing HIV	-0.034	-0.047
	[-1.61]	[-2.73]
Mean of Outcome Variable	0.697	0.759
Observations	56138	56138

Robust t-statistics in brackets, clustered by household. Regressions control for country, region, urbanicity, religion, age, log household size, years of education, and a household wealth index.

Appendix Table 1: First Stage and Reduced Form – Cutoff for Years since Debut

	HIV Status	Currently Working	Worked This Year
Panel A			
Circumcised	0.002	-0.004	-0.007
	[0.40]	[-0.63]	[-1.05]
Panel B			
Circumcised * (Years since debut)	-0.001	0.002	0.002
	[-7.41]	[6.52]	[5.19]
Panel C			
Circumcised * (Years since debut > 0)	-0.030	0.100	0.077
	[-8.82]	[9.47]	[7.35]
Circumcised * (Years since debut > 2)	-0.032	0.092	0.068
	[-9.45]	[9.39]	[7.03]
Circumcised * (Years since debut > 4)	-0.033	0.079	0.055
	[-9.52]	[8.83]	[6.30]
Circumcised * (Years since debut > 6)	-0.033	0.063	0.043
	[-9.26]	[7.54]	[5.35]
Circumcised * (Years since debut > 8)	-0.031	0.047	0.034
	[-8.29]	[5.82]	[4.46]
Circumcised * (Years since debut > 10)	-0.031	0.039	0.025
	[-7.72]	[4.88]	[3.38]
Circumcised * (Years since debut > 12)	-0.032	0.037	0.027
	[-7.59]	[4.74]	[3.68]
Circumcised * (Years since debut > 14)	-0.027	0.038	0.027
	[-6.15]	[4.81]	[3.78]
Circumcised * (Years since debut > 16)	-0.024	0.040	0.028
	[-5.10]	[5.11]	[3.99]
Circumcised * (Years since debut > 18)	-0.021	0.040	0.029
	[-4.34]	[4.94]	[3.96]
Circumcised * (Years since debut > 20)	-0.021	0.036	0.025
	[-4.05]	[4.28]	[3.39]
Mean of Outcome Variable	0.036	0.696	0.756
Observations	49455	49455	49455

Robust t-statistics in brackets, clustered by household. Regressions control for country, region, urbanicity, religion, age, log household size, years of education, and a household wealth index.

Appendix Table 2: First Stage and Reduced Form – Interacted with HIV Prevalence

	HIV Status	Currently Working
Panel A		
Circumcised	-0.006	-0.002
	[-1.60]	[-0.24]
Circumcised * High Prevalence	0.012	-0.003
	[1.73]	[-0.21]
Panel B		
Circumcised * (Years since debut)	-0.000	0.001
	[-1.84]	[1.55]
Circumcised * (Years since debut) * High Prevalence	-0.002	0.004
	[-5.13]	[5.13]
Panel C		
Circumcised * (Years since debut > 8)	-0.008	0.017
	[-2.48]	[1.52]
Circumcised * (Years since debut > 8) * High Prevalence	-0.037	0.065
	[-4.70]	[3.98]
Mean of Outcome Variable	0.036	0.696
Observations	49455	49455

Robust t-statistics in brackets, clustered by household. Regressions control for country, region, urbanicity, religion, age, log household size, years of education, and a household wealth index.

Appendix Table 3: First Stage and Reduced Form using a Probit Model

	HIV Status	Currently Working	Worked This Year
Panel A			
Circumcised	-0.002	-0.005	-0.016
	[-1.02]	[-0.64]	[-2.34]
Panel B			
Circumcised * (Years since debut)	-0.001	0.003	0.003
	[-0.70]	[3.46]	[3.23]
Panel C			
Circumcised	-0.018	0.058	0.061
	[-2.46]	[5.73]	[5.45]
Mean of Outcome Variable	0.036	0.696	0.756
Observations	49455	49455	49455

Marginal effects with robust t-statistics in brackets, clustered by household. Regressions control for country, region, urbanicity, religion, age, log household size, years of education, and a household wealth index.

Appendix Table 4: Reduced Form – HIV Sample vs. Entire Sample

	Currently Working		Wor This
	HIV Sample	Entire Sample	HIV Sample
Panel A			
Circumcised	-0.004	-0.004	-0.007
	[-0.63]	[-0.68]	[-1.05]
Panel B			
Circumcised	-0.032	-0.031	-0.028
	[-3.88]	[-4.04]	[-3.54]
Years since debut	0.004	0.003	0.004
	[7.04]	[7.07]	[9.65]
Circumcised * (Years since debut)	0.002	0.002	0.002
	[6.52]	[6.58]	[5.19]
Panel C			
Circumcised	-0.029	-0.027	-0.024
	[-3.45]	[-3.40]	[-3.06]
(Years since debut > 8)	-0.001	-0.003	0.012
	[-0.17]	[-0.34]	[1.51]
Circumcised * (Years since debut > 8)	0.047	0.043	0.034
	[5.82]	[5.59]	[4.46]
Mean of Outcome Variable	0.696	0.697	0.756
Observations	49455	56138	49455

Robust t-statistics in brackets, clustered by household. Regressions control for country, region, urbanicity, religion household size, years of education, and a household wealth index.