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Effect of HIV/AIDS on fertility: historical evidence from South Africa's women educators

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Abstract

Context/Background: The HIV/AIDS epidemic remains a public health challenge. Globally, South Africa ranks second in HIV prevalence and has the second lowest fertility rate in sub-Saharan Africa. The effect of HIV/AIDS on fertility is contentious, although it is often assumed in population projections that HIV/AIDS reduces fertility. This study examines the effect of HIV/AIDS on the probability of getting pregnant among South Africa's educators controlling for confounders.

Data Source and Methods: The data consisted of a representative sample of educators in public schools in South Africa in 2004. Statistical analysis utilized multivariate logistic regression.

Results: Controlling for confounders, HIV positive women educators aged 18-34 had higher odds of being pregnant in the preceding 12 months compared with HIV negative women educators in the same age group.

Conclusion: There was no evidence from this study that HIV positive women were less likely to be pregnant than HIV negative women.

Keywords: HIV/AIDS, fertility, educators, pregnancy status, South Africa.

Introduction

Globally, the HIV/AIDS epidemic remains a public health challenge as no cure has been found for the virus. In 2015, about 36.7 million people were living with HIV worldwide. Of this number, 51.8% live in Eastern and Southern Africa while 17.7% live in Western and Central Africa (UNAIDS 2016). Globally, South Africa ranks second in HIV prevalence (after Swaziland). UNAIDS (2016) estimated adult (15-49 years) prevalence as 19.2% in South Africa and 28.8% in Swaziland in 2015. At the same time, South Africa currently has the second lowest total fertility rate after Mauritius in sub-Saharan Africa. Udjo (2014) estimated the total fertility rate in South Africa, based on the 2011 Census, as 2.7. Estimates of total fertility rates in sub-Saharan Africa during the period 2010-2015 ranged from 1.5 in Mauritius to 7.6 in Niger (United Nations 2015).

The association between HIV/AIDS and fertility could be in either direction – HIV/AIDS can affect fertility desires and outcomes and fertility can affect the risk of HIV/AIDS (United Nations Population Division 2002). Stanecki (2000) predicted negative population growth rates by the year 2003 in Botswana, South Africa and Zimbabwe owing to high levels of HIV prevalence and low fertility. Daniel (2000) also predicted that the combination of increased mortality and reduced fertility owing to HIV may cause population decline in some populations in sub-Saharan Africa. However, this prediction has not been realised in any country in sub-Saharan Africa. Contrary to early model predictions, Gregson, Nyamukapa, Lopman *et al.* (2007) observed that in Zimbabwe, HIV/AIDS has not turned positive population growth rates to negative. Apart from population growth, some studies have estimated low life expectancies at birth owing to HIV/AIDS in Southern African countries. For example, Stanecki (2000) predicted low life expectancies of less than 35 years by 2010 in Botswana, Namibia, Swaziland, and Zimbabwe. However, a re-examination of statistics on mortality by Udjo (2008), with particular reference to South Africa, contended that the low life expectancies at birth proffered by international bodies appeared to have underestimated life expectancy at birth in the context of HIV/AIDS in these countries.

An often cited, evidence of the lowering effect of HIV/AIDS on fertility is Zaba and Gregson's (1998) synthesis studies in Uganda, Zambia and Tanzania that concluded that overall fertility of HIV positive women is 25-40% lower than that of HIV negative women due to biological factors. Other studies on the lowering effect of HIV/AIDS on fertility include Ryder, Batter, Nsuami M *et al.*'s (1991) and Allen

Allen, Serufilira, Gruber, *et al.*'s (1993). However, Fortson's (2009) study, using individual birth histories from 12 countries in sub-Saharan Africa, suggests that HIV/AIDS had very little impact on fertility both overall and in a sample of HIV negative women.

Despite the effect of HIV/AIDS on fertility being contentious, the Futures Institute (undated) states that a number of studies generally show that fertility is lower in HIV positive women than in HIV negative women between the ages of 20-45. To support this statement, the Futures Institute calculated from national surveys for 20 countries and found that the average ratio of fertility among HIV+ to HIV- women drops from 0.765 among women 20-24 to just 0.47 among women 45-49. On the basis of these figures, it is often assumed in population and epidemiological projections that incorporate HIV/AIDS (such as in the AIM model in Spectrum by the Futures Institute (undated)), HIV/AIDS reduces fertility. This calculation is problematic and could be potentially misleading because the calculation is simplistic. It does not control for factors (direct and indirect) that could influence fertility. Confounders (as seen in a later section) have been shown to have impact on fertility. The veracity of the Futures Institute's claim of lower fertility among HIV infected women compared with uninfected women therefore needs to be tested controlling for confounders.

Objective of study

This study therefore seeks to add to the evidence on the effect of HIV/AIDS on fertility. The study examines the effect of HIV/AIDS on the probability of getting pregnant in the preceding 12 months among South Africa's educators who, as at 2005, were HIV positive in comparison with those who were HIV negative in the same period, controlling for confounders.

Methods

Data

The study utilised historical data from a nationally representative survey of educators carried out by the Human Science Research Council (HSRC) in 2005. The reason for using historical data was because it is currently the only publicly accessible data in South Africa suitable for examining the effect of HIV/AIDS on fertility. The target population was all education personnel at public schools in South Africa. The survey employed a stratified one-stage cluster sample. The overall sample was 21 358 cases. The data include biographical, teaching responsibilities, work load, impact of HIV, absenteeism, morale and job satisfaction, training and support, substance use, violence within schools, sexual behaviour, male condom accessibility, HIV/AIDS knowledge, communication about HIV/AIDS, risk perception, voluntary counselling and testing, tuberculosis, health service utilisation and HIV status (Human Sciences Research Council & Education Labour Relations Council) [2005]. The HSRC obtained ethical clearance for the survey from its Ethics Committee (Application Number REC2/20/08/030) (See Human Sciences Research Council & Education Labour Relations Council 2005). As already indicated, the anonymised survey data are now publicly available to researchers on request through an application process as was done by this author. The major weakness of using this dataset is that since women educators may not necessarily be representative of women in South Africa, the results may not be generalizable to the general population of South Africa. Furthermore, it is possible that the current situation may be different from the historical situation with regard to HIV/AIDS and fertility among women educators. Despite this weakness, historical data often provide useful insight to a phenomenon.

Underlying premise in the study

The analysis in this study is premised on the following: If HIV/AIDS reduces fertility, then the probability of women falling pregnant in the preceding 12 months should be significantly lower among HIV positive women in the reproductive age compared with HIV negative women in the reproductive age, controlling for demographic, proximate, epidemiological, and behavioural confounders. The confounders were selected on the basis of a review of the literature regarding their impact on fertility. Some of the literature is cited following each confounder identified.

The confounders are:

***Demographic*: age:** Owing to biological factors, natural fertility (i.e. fertility in the absence of deliberate control – see Henry (1961) within the reproductive age group (15-49 years) declines with age. See Gray (1979). The prime reproductive age is usually the 20-34 age group in human populations.

Migration: Migration may be used as a measure of spousal separation – sometimes women tend to be left behind in labour migration (Archambault 2010). Theoretically, spousal separation could have a depressing effect on fertility through reduction of frequency of intercourse. Phan's (2014) study did not find a link between migration and fertility in Vietnam. However, Rokicki, Montana and Fink's (2014) study found an increased risk of pregnancy among recent migrants in the first years post-move compared with those who had never moved in Accra.

Proximate: **contraception**: The use of contraceptives is one of the direct or proximate determinants of fertility, see Davis and Blake (1956); Bongaarts (1978) and the variable primarily responsible for the wide range in the levels of fertility within marriage (Bongaarts 1978).

Marital status: Marriage is a principal proximate determinant of fertility as many women may spend their potential reproductive life outside marriage (Bongaarts, 1978). This is true in societies where pre-marital sex is not common. However, pre-marital sex and child bearing are common in South Africa. Some studies have reported that in South Africa, by the age of 19, about 37% of girls aged 15-19 have been pregnant (see review in Makiwane and Udjo 2006). Chola and Michelo (2016) showed that marriage accounted for about 40% inhibiting effect on natural fertility in Zambia.

Epidemiologic: Sexually Transmitted Infections (STIs) can cause pelvic inflammatory disease, which if untreated, results in tubal factor infertility in 10-40% of women (Apari, de Sousa and Muller 2014).

CD4 Count Cells: In a cohort study in Abidjan, Marc-Arthur, Siaka, Dakoury-Dogbo, *et al.* (2005) found that the incidence of pregnancy and live birth decreased with decreasing CD4 count cells.

Behavioural: Alcohol: Eggert, Theobald and Engfiedt (2004) found that high alcohol consumption was associated with increased risk of infertility examinations among a random sample of 7 393 women in Stockholm County.

Social economic: Income and Education: Using Demographic and Health Survey data collected between 2003 and 2015 across 45 countries in Africa, Asia, Central and South America, the Caribbean, and the Middle East, Colleran and Snopkowski (2018) observed that the association between wealth and fertility differs substantially across populations, while associations between education and fertility are consistently negative.

Statistical analysis

Firstly, univariate analysis was used to examine the distribution of the pertinent variables in this study. Secondly, a bivariate cross-tabulation of the pregnancy status in the preceding 12 months (the dependent variable) by HIV status (the independent variable) as well as by each of the confounders, was done. Thirdly, a multivariate logistic regression was then used to examine the effect of HIV status on the probability of being pregnant within the preceding 12 months adjusting for confounders.

A logit model explains the outcome variable Y_i taking values 0 or 1 in terms of subject *i* in terms of a row vector covariate X_i (Freedman 2009). In this study, the model is expressed as:

$$Prob(Preg) = \frac{1}{1+\ e^{-(B_0+\ B_1X_1+\ B_2\,X_2+B_3\,X_3\ldots.+B_n\,X_n)}}$$

Hosmer and Lemeshaw (2000) where

Dependent variable:

Prob(Preg) is the probability of a woman being pregnant within the preceding 12 months or currently pregnant (*Preg*).

Preg = 1 if woman was pregnant preceding 12 months or currently pregnant;

Preg = 0 if woman was not pregnant preceding 12 months or not currently pregnant;

e = base of the natural logarithm;

β_0 = constant;

$\beta_{1\ ..n}$ = estimated coefficients corresponding to the covariates $X_1 \ldots X_n$ where:

Independent variable

X_1 = HIV status: 1 = HIV positive, 0 = HIV negative (reference category);

Confounders

Demographic

X_2 = Age group: 1 = 18-24, 0 = 25-34 (reference category)

X_3 = Migration status: 1 = Not away from family more than 1 month in preceding 12 months, 0 = Away from home in preceding 12 months (reference category).

Proximate

X_4 = Contraception: 1 = Not using condom or injectable, 0 = Using condom or injectable (reference category).

X_5 = Marital status: 1 = Ever married, 0 = Never married (reference category)

Epidemiologic

X_6 = Sexually transmitted infection (STI): 1 = No STI preceding 3 months, 0 = Diagnosed with STI in preceding 3 months (reference period).

X_6 = CD4 Count cells: 1 = Greater than 250, 0 = 250 or less (reference category).

Behavioural

X_6 = Alcohol use: 1 = Did not drink alcohol in preceding 12 months, 0 = Drank alcohol in preceding 12 months (reference category).

Social economic

X_7 = Gross Annual Income: 1 = R84 001 or higher, 0 = Less than R84 001 (reference category).

Education was excluded from the analysis because when the distribution of the women for the focus of the study according to highest level of qualification was examined, it turned out that 99.9% of the women had at least a first degree or higher i.e. very little variation in educational qualification among the women. This is not surprising since the universe of the study is the education sector.

The analysis was based on the weighted data.

Results

Selected characteristics of women educators aged 18-34 years by HIV status

According to the HSRC's (2005) study, overall, 12.8% of women educators in public schools who gave a specimen, were HIV positive while among the women educators aged 18-34, 16.0% were HIV positive (HSRC and Education Labour Relations Council data 2005). Table 1 shows the results of the classification of the women educators aged 18-34 by HIV status by selected characteristics. As seen in the table, of the women who reported they were pregnant within the preceding 12 months or pregnant at the time of the interview, about 8% were HIV+ while about 7.8% were not. The classification also shows that in the same period 51% of the women aged 18-24 were HIV+ while about 32% were not.

Furthermore, about 18% of the women who had been away from the family for more than one month in the preceding 12 months were HIV+. Of the women who were not using a condom or injectable about 23% were HIV+. About 41% of the ever married women were HIV+ while of the women who had been diagnosed with STIs in the preceding three months, about 4% were HIV+. Of the women who had CD4 count cells greater than 250 at the time of the survey, 57% were HIV+. Of the HIV+ women, 5% had had alcohol in the preceding 12 months. Of the women whose current gross annual income was less than R84 001, 74% were HIV+.

Table 1: Percentage distribution of women educators aged 18-34 (n = 4,095) years by current pregnancy status and selected variables, 2004.

	Percent INDEPENDENT VARIABLE	
VARIABLES	HIV+	HIV-
DEPENDENT VARIABLE		
Pregnancy Status		
Pregnant within the last 12 months or currently pregnant	8.0	7.8
Not Pregnant within the last 12 months or currently pregnant	92.0	92.2
CONFOUNDERS		
Demographic		
Age		
18-24	50.8	32.1
25-34	49.2	67.9
Migration status		
Not away from family more than 1 month in past 12 months	81.9	88.3
Away from family more than 1 month in past 12 months	18.1	11.7
Proximate		
Contraception		
Not using condom or injectable	23.1	56.8
Using condom or injectable	76.9	43.2
Marital status		
Ever married	41.2	69.3
Never married	58.8	30.6
Epidemiologic		
Sexually transmitted Infections (STI)		
Not diagnosed with STI in last 3 months	96.5	98.1
Diagnosed with STI in last 3 months	3.5	1.9
CD4 Count Cells		
Greater than 250	57.2	100
250 or less	42.8	0.0
Behaviour		
Alcohol		

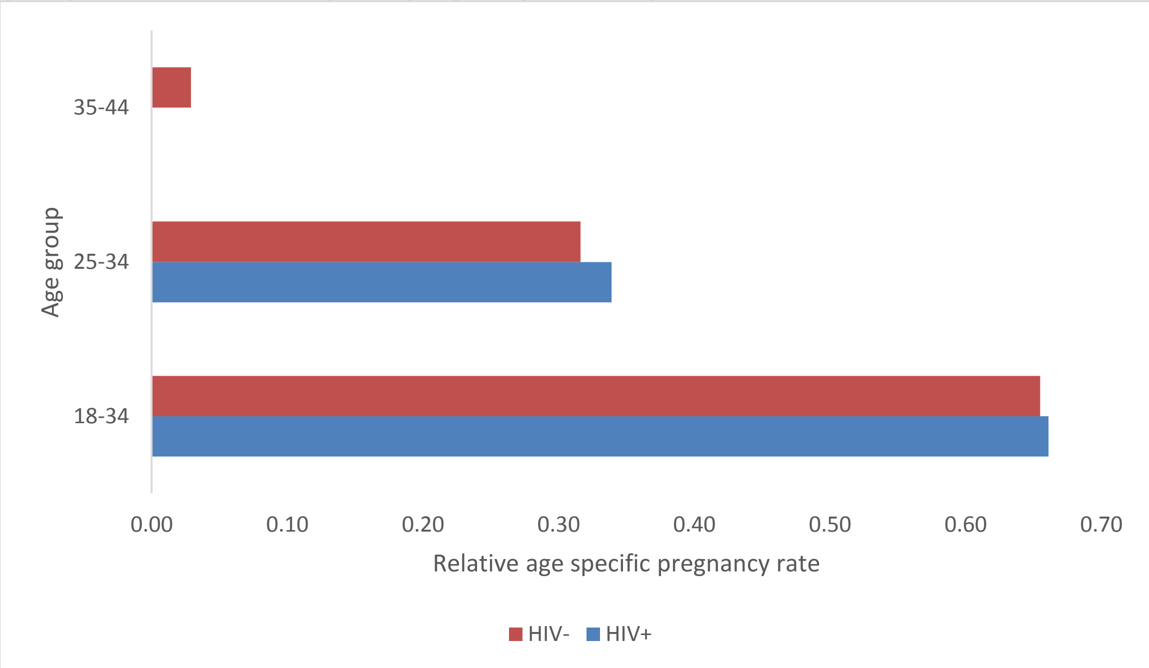
Did not drink alcohol in past 12 months	95.5	86.7
Drank alcohol in past 12 months	4.5	13.3
Economic: Gross annual income		
R84,000 or less	73.9	60.3
R84,001 or higher	26.1	39.7

Source: Computed from HSRC's The Health of our Educators data.

Relative pregnancy rates

Fig. 1 shows the relative age-specific pregnancy rates (with total pregnancy rate =1) i.e. the contribution of each group to the total number of pregnancies among women aged 18-34 within each HIV status category. As seen from the graph, there is very little difference in the pregnancy rate between HIV+ and HIV- women educators in any age group. For example, in the age group 25-34, HIV+ women contributed about 34% of the total number of pregnancies in the preceding 12 months or current pregnancies, whereas HIV- women in that age group contributed about 32%. It is also evident from the graph that the pregnancy rate was higher among women educators aged 18-34 compared with those aged 25-34, irrespective of HIV status.

Fig. 1: Relative pregnancy rates in the last 12 months among HIV positive (HIV+) and HIV negative (HIV-) women educators (Total pregnancy rate = 1), 2004.



Source: Computed from HSRC's The Health of our Educators data

Multivariate results

Four logistic regression models were used to examine the effect of HIV/AIDS on the probability of women educators aged 18-34 years being pregnant within the preceding 12 months or currently pregnant. The first model regressed HIV/AIDS status with pregnancy status without controlling for confounders. The second model added demographic (age, migration) and proximate (contraception and marital status) controls. The third model included variables already in the second model excluding migration because of improbably high odds ratios and added epidemiological (STIs status and CD4 count cells) controls. The fourth model included variables already in the third model excluding STIs status and added behavioural (alcohol intake) and economic (income) controls. Performance of the models was examined using the beta coefficients and the Nagelkerke R^2. Following this, the best model was fitted to the data. This involved regressing HIV/AIDS with pregnancy status and including age, contraception and marital status as controls. These controls constitute part of sexual exposure to the risk of pregnancy. The outcome is summarised in table 2 as Models 1 and 2.

Model 1 indicates the following: there is a positive relationship between HIV status and current pregnancy status as seen in the positive beta coefficient. Without controlling for confounders, women educators aged 18-34 who were HIV+ had about 1.03 times higher odds of being pregnant in the preceding 12 months or currently pregnant compared with women educators aged 18-34 who were HIV-. However, the difference was not statistically significant ($p > 0.05$). Controlling for demographic, proximate and economic factors, women educators aged 18-34 who were HIV+ had about 1.3 times higher odds of being pregnant in the preceding 12 months compared with women educators aged 18-34 who were HIV-. This difference was still not statistically significant ($p > 0.05$, Model 2). Therefore, Models 1 and 2 indicate no significant difference in the probability of falling pregnant between HIV+ and HIV- women educators aged 18-34, even after controlling for demographic, proximate and economic characteristics of the women.

Model 2 indicates the following related to controlling for HIV status and other factors:

(1) Women educators aged 18-34 were significantly more likely ($p < 0.000$) to fall pregnant in the preceding 12 months than women educators aged 25-34;

(2) Women educators not using a condom or injectable were significantly more likely ($p < 0.000$) to fall pregnant than women educators not using a condom or injectable;

(3) Ever married women educators were significantly less likely ($p < 0.000$) to be pregnant than women educators who had never been married; and

(4) Women educators with a higher income were less likely to be pregnant than women educators with a lower income although the difference was not statistically significant ($p > 0.05$).

While (2) above is not a new finding, (3) appears counter-intuitive. It is probable that ever married women educators were more likely to have attained their desired fertility level and therefore more likely to be using effective means of contraception to control fertility compared with never married women educators. Marriage is not universal in South Africa especially among the black population – they constitute about 80% of South Africa's population (Statistics South Africa 2012). Of women educators aged 18-34, 35% had never been married at the time of the survey.

Table 2: Logistic regression of pregnancy by HIV/AIDS status and demographic and proximate controls among women educators in public schools, 2004.

PROBABILITY OF BEING PREGNANT				
	Model 1		**Model 2**	
VARIABLES	**Coefficient**	**Odds ratio**	**Coefficient**	**Odds ratio**
INDEPENDENT VARIABLE **HIV Status**				
HIV positive	0.027(*0.039*)	1.028	0.264(*0.437*)	1.302
HIV negative (RF)				
CONFOUNDERS				
Demographic ***Age Group*** 18-24 years 25-34 years (RF)			2.800(*0.415*)*	16.453
Proximate ***Contraception*** Not using condom or injectable Using condom or injectable (RF)			1.572(*0.400*)*	4.814
Marital Status Ever married Never married (RF)			-1.434(*0.312*)*	0.238
Economic: Gross annual income				
R84 001 or higher			-17.535(1450.343)	0.000
R84 000 or less (RF)				
Constant	-2.472*(0.016)**		-4.826*(0.528)**	
Nagelkerke R^2	0.000		0.400	

RF = Reference category, standard errors in parenthesis.

*Statistically significant $p < 0.000$.

Source: Computed from HSRC's the health of our educators data.

Discussion and conclusion

As noted above, alcohol intake, CD4 count cells and STIs have been found in some studies to be associated with reduced fertility. However, in this study, owing to the small percentage of women educators who drank alcohol the preceding month, or were diagnosed with STIs in the preceding three months, the effects of these on current pregnancy could not be assessed. Another limitation of this study is that contraceptive use information in the data only pertained to condom and injectables and not the full range of contraceptives. Therefore, the effect of contraceptives is not fully captured in the study. Regarding HIV status, the time of infection is unknown for HIV+ women educators. For newly-infected women, the effect on the probability of falling pregnant may not be immediate. Therefore, cross-sectional data as in this study does not capture such effect.

Despite the above limitations, the following are noteworthy. Using the reduction in the average ratio of fertility among HIV+ to HIV- women aged 20-45, calculated from national surveys for 20 countries, the Futures Institute (undated) argues that fertility is lower in HIV positive women than in HIV negative women. This study did not find a significant difference in the probability of being pregnant within the preceding 12 months among HIV+ and HIV- women educators in South Africa, even after controlling for confounders. The finding in this study therefore does not collaborate the Futures Institute's finding nor those by Ryder, Batter, Nsuami M *et als* (1991) and Allen Allen, Serufilira, Gruber, *et al.* (1993) who found a lowering effect of HIV/AIDS on fertility. However, the result from this study is consistent with that of Fortson's (2009) that suggests HIV/AIDS had very little impact on fertility both overall and in a sample of HIV negative women from 12 countries in sub-Saharan Africa. Given these findings, the effect of HIV/AIDS on fertility remains contentious. However, in view of the Futures Institute's calculation about the lowering effect of HIV/AIDS on fertility, users of the AID Impact Model (AIM) software often assume that HIV/AIDS lowers fertility. This assumption is built into the software. It is probable that the assumption of lower fertility among HIV+ women compared with HIV- women in the AIM model and accompanying demographic models of population projections, lead to under-estimation of the size of the population in high HIV prevalence countries. Therefore, it is important that such models provide a critical analysis of the fertility of HIV+ women in comparison with that of HIV- women within the context of each country controlling for confounding factors. This study utilised historical data pertaining to women educators. While this has provided additional insight, historical data may not explain present day fertility outcomes. Furthermore, since the historical data were based on women educators, the results cannot be generalised to the entire population of women in South Africa. Future studies therefore need to utilise present day data to do the critical analysis suggested above. The denial of access to researchers by the HSRC to their more recent surveys data makes this impossible. It is hoped that the HSRC would rethink its policy on access to these datasets such that there is immediate access after releasing the main reports of the surveys.

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