Systematic Difference in HIV Prevalence Rates between Pregnant Women and the General Female Population in a rural area of Tanzania

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Abstract
HIV prevalence rates and trends constructed using data collected from pregnant women who visit ante-natal clinics assume that pregnant women are representative of the whole female population. However, women who are HIV positive have lower fertility than women who are HIV negative, thereby downward biasing HIV prevalence estimates from clinic based samples. This article examines the scale of underestimation of HIV prevalence based on pregnant women compared to all women in a rural area in Tanzania. We find that the ratio of prevalence for pregnant women to women in the whole population varies dramatically. Standardizing for age and marital status does not reduce the difference between pregnant women and the whole population. Adjusting for the nulliparous and parous status of women offers significant improvement. Estimates based on antenatal clinic data cannot be taken as representative and adjustments are necessary for accurately estimating HIV prevalence.

Introduction

Information collected at ante natal clinics used to estimate population level HIV prevalence suffer from the differential fertility of HIV positive and negative women. A simple method of standardization or adjustment would reduce this bias and provide reliable estimates of HIV prevalence for many countries and communities in sub-Saharan Africa to better organize public health policies, allocate resources, and track the epidemic. This information is useful for estimating statistics because of the large scale size[1] of ante natal clinic coverage and the absence of extra costs for governments. The main issue that arises with this method is a bias stemming from the lower fertility among HIV positive women[2], and thus their underrepresentation in ante natal clinics. HIV prevalence estimates from ante natal clinic data thus tend to underestimate HIV prevalence in women of reproductive ages[3,4,5].

In populations with low rates of contraceptive use and high fertility, the bias is caused by lower fertility in HIV positive women and that, in turn, is driven by behavioral as well as biological factors[3,6]. Pregnancy in HIV positive women has been shown to accelerate HIV progression, thus lowering the number of fertile HIV positive women[6]. Biological factors lowering fertility include a higher frequency of amenorrhea, spontaneous abortions, and sexually transmitted infections[3,6]. Behavioral factors such as higher rates of divorce and widowhood also reduce fertility in HIV positive women compared to the general population[2]. Since few women are aware of their HIV status, elevated levels of contraceptive use are not thought to greatly increase the observed difference in fertility rates[6].

Several attempts have been made to find a simple method of correction for translating HIV prevalence in pregnant women to the general female population. Glynn et al 2000 have found significant factors including age, marital status, having children, education, and contraceptive use[7]. The relationship between age and HIV prevalence as well as age and fertility make it a logical standardization consideration. For all but the earliest ages, HIV prevalence is higher in the general population than in pregnant women. This is reversed for ages 15-19, when there is a related selection for pregnancy and HIV infection[5,6,8]. Therefore, a sample of pregnant women will lead to overestimates of HIV prevalence for the youngest age group, while underestimating prevalence in older women[8]. Zaba et al 2000 caution against standardizing for age structure, which may increase the bias because of the additional importance placed on the oldest age groups, where the difference in prevalence between pregnant women and the general female population is the largest[1].

Zaba et al propose accounting for the bias in pregnancy data caused by the overrepresentation of the most fertile by weighting observations by the length of the previous birth interval[1]. This would give greater weight to births by less fecund women. Difficulties in this approach arise from data constraints and the challenge in determining the length of exposure for first births. Changalucha et al 2002 propose a simplification which lessens the data requirements to the classification of women as nulliparous or parous[9]. Observed prevalence for each subgroup is multiplied by a correction factor to represent the ratio of prevalence between each group and the general female population. Then each group is weighted by its composition in a general female population[9]. These adjustments account for the childless and low fertility women with high HIV prevalence in the general populations and the low prevalence in high fertility women.

In this study, we apply several standardization and adjustment techniques to the population originally used by Zaba, a demographic surveillance system in Kisesa, Tanzania, but extend this analysis to compare all pregnant women to the general population from 1994 to 2008.

Data

The data for this analysis comes from the Kisesa Ward in the Mwanza region of northwest Tanzania, where a demographic surveillance system has been in place since 1994. Serological surveys are conducted every 3 years and household censuses ever 6 months. Data from 5 serological surveys (1994, 1996, 1999, 2003, 2006) are used to determine the HIV status of individuals, and 22 demographic surveys provide information on births. A detailed description of the collection methodology can be found in Boerma et al 1999[10].

A women is classified as under observation from the date of the start of her residence episode in the study area or the date of her 15th birthday, whichever is later; and up to the end of her residence episode or her 45th birthday, whichever is earlier. The time spent outside of the area by the women who left and then returned is not used in the analysis, nor are births that occurred outside the study area during those times. A woman's HIV status at a given time is classified as positive, negative, or unknown. Women who never attend a sero-survey are classified as having unknown status throughout their observation period. Person-years of observation of women 2 years after their latest HIV test are classified as unknown if that last test was negative, and person-years 2 years prior to the earliest HIV test are classified as unknown if the earliest test was positive. For women who have had both a negative and a positive test, sero-conversion is assumed to take place at the mid-point of the interval, and positive and negative person-years are allocated accordingly. Person-years are included in this analysis for a maximum of 2 years prior to the first sero-test and 2 years post the final sero-test.

To account for pregnancy, the 6 months prior to a birth were considered “pregnant person-months,” corresponding to the time when a woman was most likely to visit an ante natal clinic. This analysis assumes that fetal loss after the period when a woman would initially visit a clinic is negligible. The data set included HIV positive and negative women-years classified by the woman’s pregnancy status, for a sample of 11,176 women contributing 53,099 person years. Person-years were also classified by age, marital status, and ever-parous status. The data were then split into 3-year calendar time intervals and period prevalence was computed for the general female population and the pregnant population in each interval.

Methods

Several standardization and adjustment methods were constructed to reduce the bias resulting from using data from pregnant women to estimate the female population’s HIV prevalence. First, two standardized populations were constructed to estimate the HIV prevalence if the pregnant population had the age or martial structure of the general population. Second, HIV prevalence was constructed for the 15-year data set for each age group, marital status, and ever-parous status for pregnant women and the general female population. By dividing the prevalence of pregnant women by the respective prevalence in the general female population, an adjustment measure was estimated. Calculating prevalence for each variable for pregnant women (age, marriage, parous) in 3-year periods, the adjustments were applied and pregnant HIV prevalence was weighted by the proportion of each group in the general female population to arrive at estimated population level prevalence for data collected from pregnant women. Analysis of this data was conducted using STATA 11.

Results

Results of standardized and adjusted estimates are shown in Figures 1 through 4. Figure 1 illustrates the prevalence by 3-year window for the general female population, the pregnant population, and both standardization methods. Figure 2 shows the ratio of prevalence for the pregnant population (standardized and unstandardized) to the general female population. A ratio near one suggests a standardization method which transforms the pregnant population prevalence into a close representation of the general female population. Figures 3 and 4 report estimates for the three adjustment methods.

The initial relationship between the pregnant and general female population illustrates the need for adjustment. The pregnant population prevalence is 55% to 77% of the prevalence of all women. As Figure 1 illustrates, standardizing for the age and marital distributions of the population does not improve prevalence estimates. Age standardization actually worsens estimates of prevalence (50% to 74% of the population prevalence). Marriage standardization offers a slight improvement, but does not offer an acceptable estimation technique.

Adjustment methods provide a more satisfactory estimation technique, as Figures 3 and 4 illustrate. The adjustment based on ever having children provides the best estimation technique, in line with empirical findings from Zaba and Changalucha. Ratios of adjustment pregnant prevalence to the general female population range from 89% to 116%, a vast improvement from the standardization techniques. The adjustment based on marital distribution also improves estimation, more so than age standardization, which offers the least improvement of the adjustment techniques. Interestingly, all adjustment measures overestimate prevalence in the last time interval (2006-2008), which may be related to the introduction of antiretroviral therapy in Kisesa in 2005.

Discussion

Differences exist between the pregnant and the general female population which make raw comparisons of HIV prevalence impossible. Differential fertility based on HIV status distorts the prevalence found in the pregnant population. Age standardization increases this distortion, while marital standardization reduces the distortion, but does not lead to a viable estimate of general prevalence because it does not account for biological factors which reduce fertility in HIV infected women. Using adjustment provides better estimates for estimating population prevalence from pregnant women. Adjustments based on ever-parous status offer the best simple means of estimation. The challenge is to find an appropriate adjustment, which should be estimated from numerous sites across time. Special adjustments may be necessary for population with varying levels of contraceptive use and the availability of antiretroviral therapy in the community. By constructing estimates from nullipaorus and parous women, adjustment procedures will be better able to account for the subfertility of HIV positive women.

Conclusion

Data collected at ante natal clinics provides a wide spread source of information about the HIV epidemic at the community and country level. The difference in fertility of HIV positive and negative women drastically biases HIV prevalence estimates based on data collected at ante natal clinics, but simple adjustments could reduce this bias and provide estimates more reflective of the general population. Such estimates are useful when developing health policies, allocating resources, and studying the HIV epidemic.

Figure 1

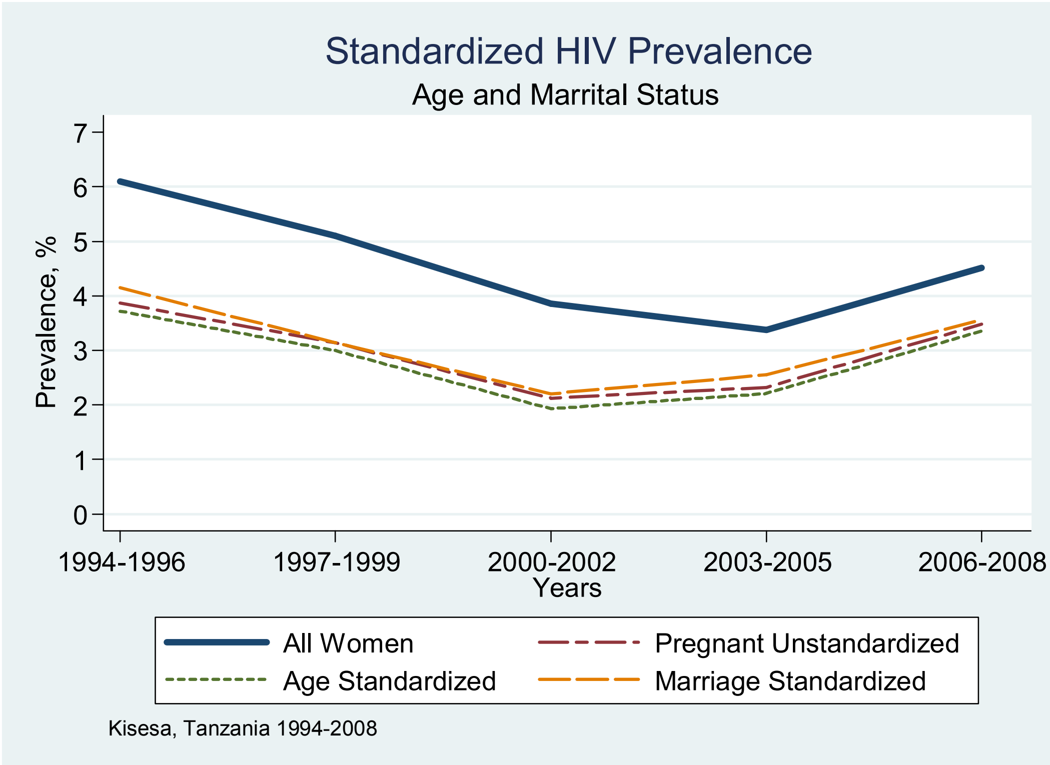


Figure 2

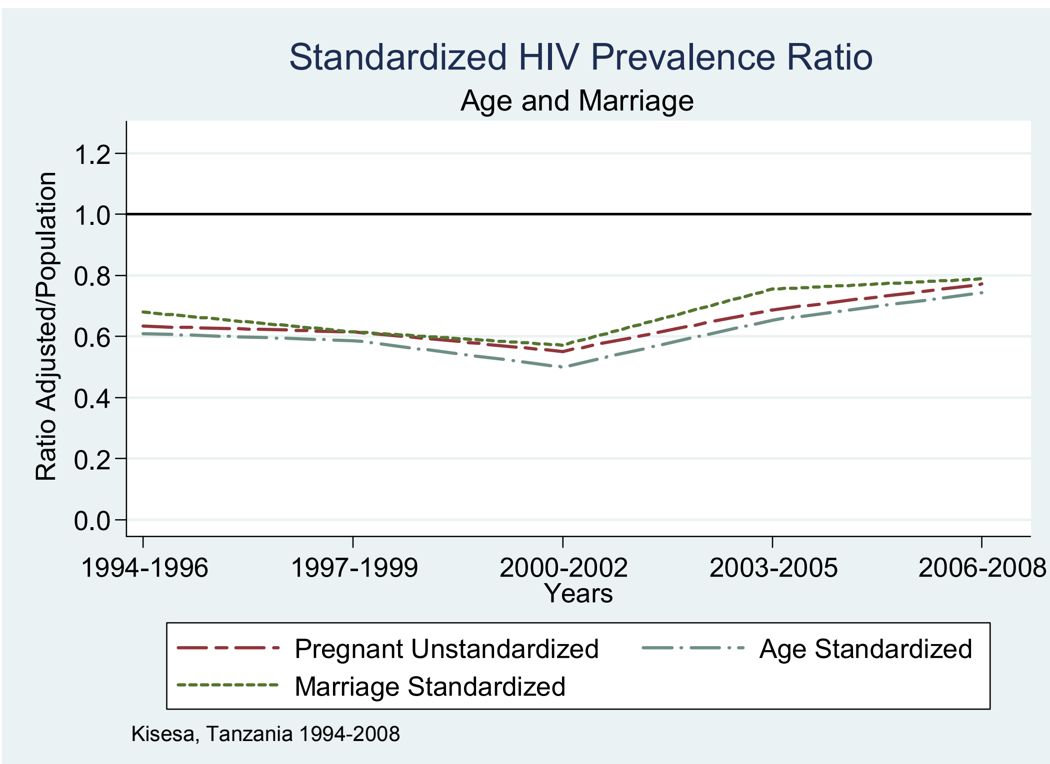


Figure 3

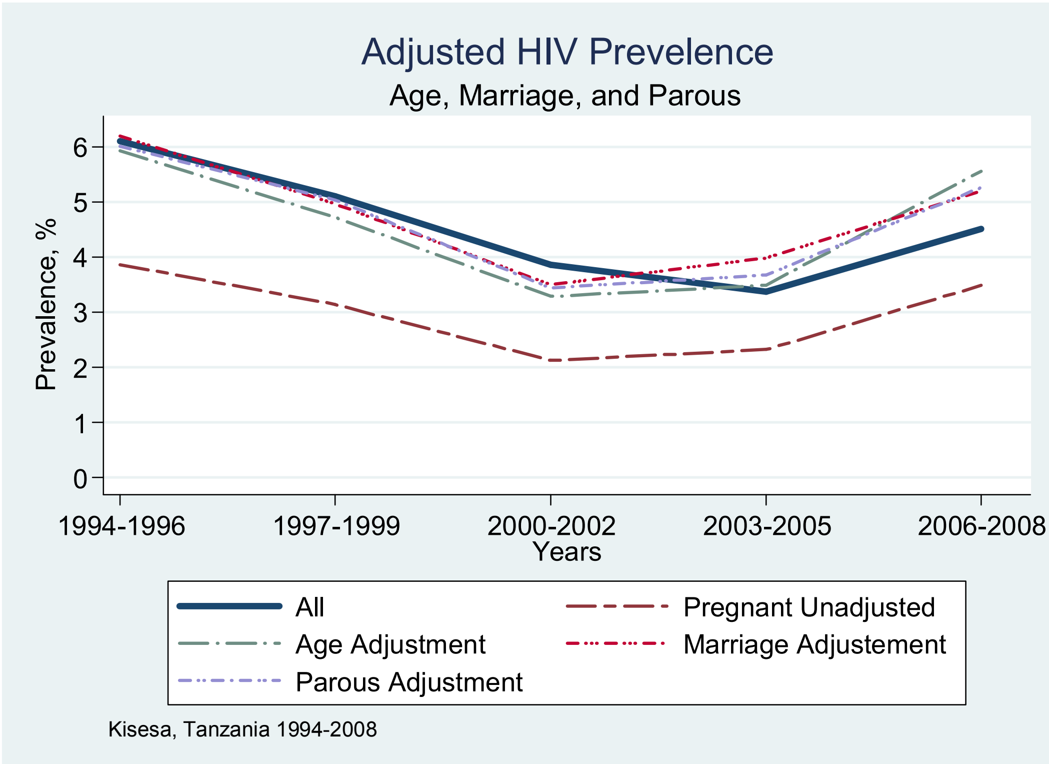
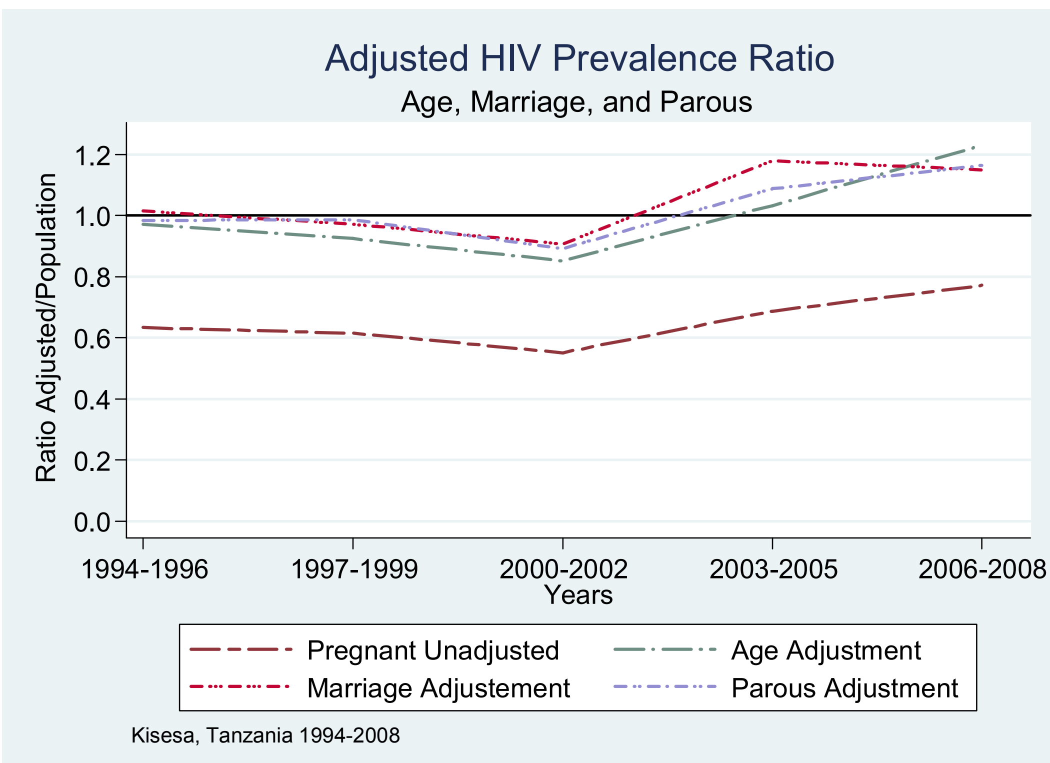


Figure 4



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