The Role of Young Women in the HIV epidemic in Benin, West Africa

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Background

- Young women in Sub-Saharan Africa are typically more likely than men to be living with HIV, and have been identified as a vulnerable risk population [1].
- In Cotonou, Benin, a comprehensive HIV prevention programme funded by the Canadian International Development Agency was introduced in 1993 (Projets SIDA 1/2/3), promoting condom use, STI testing and treatment among female sex workers (FSWs), and extended to their clients in 2000.
- According to several years of interview-based bio-behavioural surveys, HIV prevalence in FSWs has declined from 53% in 1993 to 30% in 2008 [2], attributed to their observed increase in condom frequency [3].
- Within the general population, prevalence has also significantly declined from 3% to 0.5% in young men (aged 15 – 29) between 1998 and 2008, while the prevalence in young women did not significantly change [4].
- While previous work has been carried out estimating the contribution of FSWs to the epidemic in Benin [3], little has been done to estimate the contribution of young women.

Objectives

- Using a previously calibrated dynamic model of HIV transmission for Cotonou, we estimated the fraction of HIV infections acquired and the fraction transmitted by young women (aged 15-24)

Methods

- We used an age-structured transmission dynamic model of HIV and gonorrhoea infection in Cotonou, representing disease progression, AIDS related mortality, and varying infectivity at each stage.
- The model included several risk groups (FSWs, clients of FSWs, men and women at low and medium risk), different types of partnerships (long term, casual, commercial), and existing intervention information (rate of condom use and ART uptake).
- The biological and sexual behavioural parameters were informed by literature review and 15 years of site specific behavioural and HIV prevalence data collected as part of the SIDA-1/2/3 interventions, including the number of clients seen by FSWs, the frequency of condom use over time among FSWs, the distribution of FSWs by nationality, number of partners and condom use among low and medium risk adults, and age-specific sexual contact rates (further details are provided in Williams et al. 2014 [3]).
- Latin hypercube sampling was used to identify 472 parameter sets that fit within acceptable bounds of the data and were used to simulate HIV prevalence and incidence over time.
- We derived the cumulative number of new HIV infections (noted $CI_B(T)$) occurring under existing conditions, and for the relevant counterfactual scenarios (noted $CI_C(T)$) over the same time period, T.
- The counterfactual for the A-PAF(T) and T-PAF(T) assumes 0% probability of acquiring or transmitting HIV respectively, for the relevant risk group over time period T.
- Contribution of different groups was measured by the acquisition (A-PAF) and transmission (T-PAF) population attributable fractions (PAF) (Equation 1).
- The PAF represents the fraction of total infections acquired (A-PAF) and transmitted (T-PAF) by the group over the specified time period.

$$PAF(T) = 1 - (CI_C / CI_B) \qquad \textbf{Equation 1}$$

Results

Figure 1

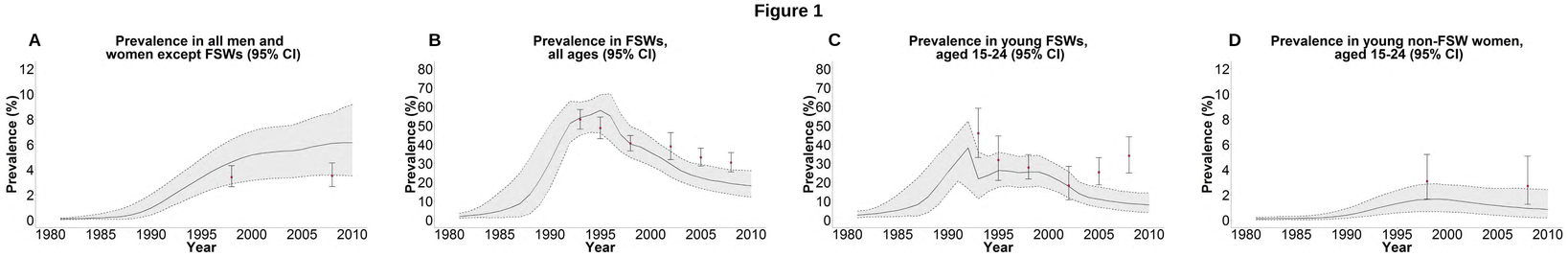


Figure 1: Model fits to HIV prevalence data. Median model prevalence (solid lines) and 90% uncertainty intervals (UI) (dotted lines) from the 472 model fits. The points are prevalence data collected during the SIDA 1/2/3 interventions, which serve as cross-validation of the model estimates.

Figure 2

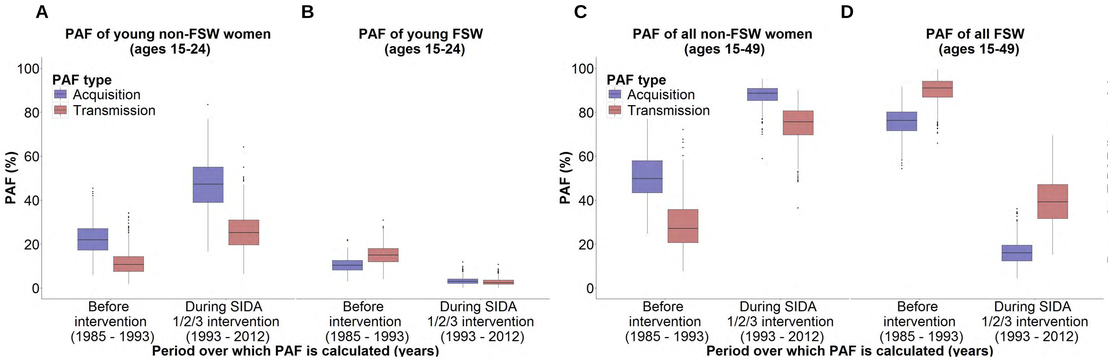


Figure 2: A-PAF and T-PAF of four risk groups derived for the period T= 1985-1993 (before SIDA 1/2/3) and T = 1993-2012 (during SIDA 1/2/3). The box lines represent the 25th/50th/75th percentiles of the model predictions, while the whiskers extend to 1.5 * IQR (inter-quartile range).

Figure 3

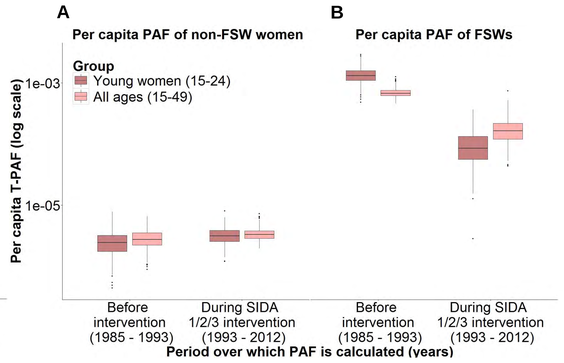


Figure 3: Per-capita T-PAF of four risk groups derived before and during SIDA1/2/3 intervention, years 1985-1993 and 1993-2012 respectively

Young non-FSW women acquire more HIV than they transmit (Figure 2A)

- The A-PAF of young women is about twice the T-PAF both at the start (1985-1993) and later in the HIV epidemic (1993-2008).
- The A-PAF of young women increases from 21.9% (12.0 – 35.7, 5th & 95th percentiles) in the early epidemic stage to 47.2% (27.7 – 66.9) in the later stage. The T-PAF also increases in the later stage of the epidemic but remains around 25.2% (12.6 – 42.4). The contribution of young women increases as HIV increases and spreads from males to young women who constitute a sizeable fraction of the population (model: ~48% (90%CrI 38 - 51); data: 44% [5]).

Young FSWs transmit slightly more HIV than they acquire (Figure 2B)

- Before SIDA1/2/3, the T-PAF of young FSWs was higher (15.0% (8.9 – 23.5), than their A-PAF (10.2% (6.2– 16.9)). However, despite being young and susceptible, and rapidly getting infected, young FSWs represent a very small fraction of the total population (model: 0.16% (0.034 – 0.31)), and contribute moderately to all HIV acquisition (A-PAF) and transmission (T-PAF) even early in the epidemic compared to FSWs of all ages (Figure 2D), owing to their smaller numbers and lower HIV prevalence.
- The A-PAF and T-PAF of young FSWs decreased considerably after 1993, as condom use increased over time, and HIV prevalence increased in the rest of the population, who also contribute to HIV spread.
- FSWs of all ages also contribute more substantially to HIV transmission than acquisition.

The contribution of FSWs declines over time (Figures 2C,D)

- This is partly because of increases in condom use after the intervention, but also because HIV prevalence increases among the male population who transmit to non-FSW women. FSWs form a small fraction of the population (model: 1.1% (90%CrI 0.8-1.4%); data: 1.4% [6]), therefore their relative contribution decreases as prevalence rises in non-FSW women.

Per capita, FSWs of all ages contribute disproportionately to transmission (Figures 3A,B)

- Despite the A-PAF and T-PAF of FSWs declining over time (Figures 2C,D), their T-PAF per capita (Figure 3B) is larger than that of non-FSW women (Figure 3A), displaying higher transmission efficiency.

Conclusions and Implications

- The leading contribution of FSWs of all ages early in the epidemic underlines their vulnerability while emphasising their role as an important driver of the HIV epidemic in Cotonou.
- Overall, young FSWs contribute less to the epidemic than young non FSWs females (Figure 2A), because they represent a smaller fraction of the population. However, per capita transmission is more efficient from young FSWs than young non-FSW women, thus focusing intervention on the former is more effective.
- Young women are more vulnerable to HIV acquisition than transmission, and therefore not an epidemic driver able to sustain HIV transmission on their own even if their contribution increases over time.
- Comparing A-PAF and T-PAF over time is helpful in understanding the position of each group in the transmission network and designing more appropriate interventions.

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