

Published: March 2015

## Are HIV prevalence and incidence declines in sub-Saharan Africa driven by changes in sexual risk behaviour?

Susanne F. Awad - Mathematical Epidemiologist, Infectious Disease Epidemiology Group at Weill Cornell Medical College Qatar.

Laith J. Abu-Raddad - Associate Professor of Healthcare Policy and Research, Infectious Disease Epidemiology Group at Weill Cornell Medical College Qatar.

The HIV epidemic in sub-Saharan Africa (SSA) has shocked us by how rapidly it has grown in the 1980s through mid-1990s. Yet, today it is striking us by how rapidly it is declining across the African continent. HIV incidence appears to have dropped by more than 50% between 2001 and 2011 in as much as 20 countries in SSA (1,2). All the sudden it seems that the HIV epidemic has run out of steam. But why?

The drivers for this decline remain not well-understood and are subject to debate. Several mechanisms could have contributed, such as impact of HIV prevention interventions, epidemic dynamics, and/or reduction in sexual risk behaviour. Although HIV interventions are being scaled up across SSA, such as anti-retroviral therapy (ART) and voluntary medical male circumcision (VMMC), it does not seem likely that the declines have occurred because of interventions. The declines in HIV prevalence and incidence appear to have occurred about a decade before the scale-up of ART, VMMC, and other interventions.

Empirical data suggests that changes in different aspects of sexual behaviour may have occurred in different countries in SSA such as fewer sexual partners, increased condom use, or delay in sexual debut. However, it is not clear whether such changes in sexual behaviour have occurred widely across SSA. The extent of these changes, their timing and the duration over which they occurred are also poorly understood.

*Have declines in HIV burden occurred due to reductions in sexual risk behaviour?*

We hypothesized in our study that the declines in prevalence and incidence have occurred as a result of large and rapid reductions in sexual risk behaviour (3). We used mathematical modelling to shed light on the validity of this hypothesis by demonstrating the

consistency and plausibility of such scenario for sexual risk behaviour across SSA. We also described the nature of these reductions in sexual risk behaviour in terms of their scale (by how much sexual risk behaviour was reduced), timing (the mid-year of the transition in risk behaviour), and duration (length of time over which the transitions have occurred).

We found that our hypothesis can explain the reductions in prevalence and incidence. The results of the mathematical model suggest substantial reductions in sexual risk behaviour in 18 countries in SSA: Botswana, Burundi, Cameroon, Central African Republic, Cote d'Ivoire, Eritrea, Gabon, Ghana, Kenya, Lesotho, Liberia, Malawi, Mali, Namibia, Niger, Tanzania, Togo, and Zimbabwe. The transitions in risk behaviour were remarkable in terms of their intensity, rapidity, and synchronicity across much of SSA. The reduction in sexual risk behaviour ranged between 32% in Botswana and 89% in Liberia, with an average reduction of 69% across countries. The turning-point year of the transition in behaviour ranged from 1993 in Burundi to 2001 in Namibia, but was mostly clustered around 1995 across countries. The duration of the change in risk behaviour ranged between 3 years in Botswana and 17 years in Gabon, with an average of 8 years across countries.

### *Implications of our results*

Our mathematical modelling study did not strictly prove that the reductions in incidence and prevalence occurred as a consequence of rapid and large changes in sexual risk behaviour. However, our results demonstrated the consistency and plausibility of this hypothesis and that such hypothesis can explain the nature of the epidemic declines. After the rapid rise of the HIV epidemic in SSA in the late 1980s through the mid-1990s, HIV epidemiology appears to have experienced a remarkable transformation, within only few years (by the late 1990s).

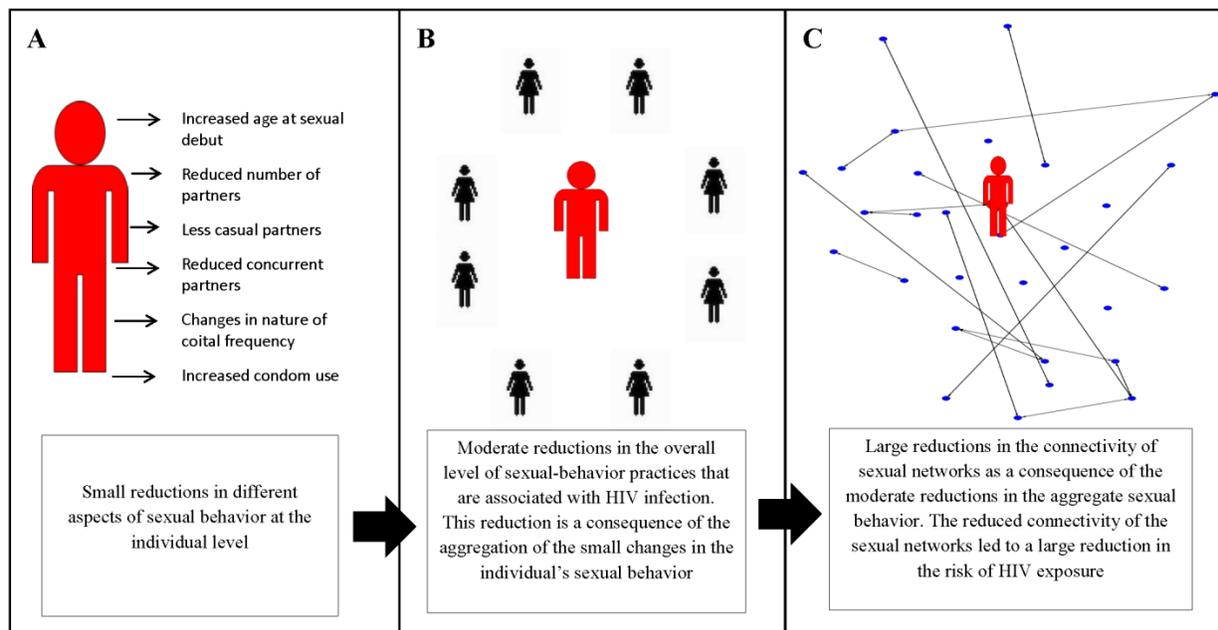
*How could such rapid changes in sexual risk behaviour occur?*

The scale and rapidity of such changes in sexual risk behaviour are striking. Is it possible for human sexual risk behaviour to decline so rapidly within only a decade or so? We believe this is possible.

Figure 1 illustrates a conceptual diagram of our interpretation of the predicted reductions in sexual risk in SSA. We suspect that individual sexual behaviour has changed, but probably not dramatically. Instead, we hypothesize that what has happened are only small changes in individual sexual behaviour such as an increase in age at sexual debut, reduction in the number of sexual partners, reduction in contacts with commercial sex workers, and/or increased condom use, among others (Figure 1A).

These different small changes in individual sexual behaviour, however, have added up together to yield an overall moderate reduction in aggregate individual sexual behaviour (Figure 1B).

Sexual risk for a given individual is only partially captured by that person's sexual behaviour. The sexual network surrounding this person determines the risk environment that this person will experience. It can be shown, as has been done as an example in our study, that even moderate changes in individual sexual behaviour can translate into massive disruptions in the connectivity of sexual networks at the population-level (Figure 1C). This is the rapid reduction in population-level sexual risk behaviour that our model predicted to explain the rapid changes in HIV incidence and prevalence.



**Figure 1.** Conceptual diagram to illustrate how the rapid declines in HIV incidence and prevalence in sub-Saharan Africa may have occurred. The diagram demonstrates how (A) small changes in different aspects of individual sexual behaviour can lead to (B) an overall moderate change in the aggregate individual sexual behaviour, which in turn translates into (C) massive disruption in the connectivity of sexual networks (3).

*Why did the changes in individual sexual behaviour occur?*

The predicted timing of these changes is curious. Most of HIV prevention programs were still in their infancy in the 1990s. It is difficult to link these prevention programs to the changes in sexual behaviour. Nevertheless, we found that these rapid changes in sexual risk behaviour occurred at the time when AIDS mortality peaked. While this is merely an observed association, it seems plausible that part of

the changes in sexual risk behaviour may have been driven by the nearly sudden visibility of AIDS in the mid-1990s; a disease with tragic morbidity and mortality.

**Susanne F. Awad** - Mathematical Epidemiologist, Infectious Disease Epidemiology Group at Weill Cornell Medical College Qatar. Areas of interest: infectious disease epidemiology, mathematical modelling, health economics.  
[sua2006@qatar-med.cornell.edu](mailto:sua2006@qatar-med.cornell.edu)

**Laith J. Abu-Raddad** - Associate Professor of Healthcare Policy and Research, Infectious Disease Epidemiology Group at Weill Cornell Medical College Qatar. Areas of interest: infectious disease epidemiology and mathematical modelling. [lja2002@qatar-med.cornell.edu](mailto:lja2002@qatar-med.cornell.edu)

*This article is based on Awad SF, Abu-Raddad LJ. Could there have been substantial declines in sexual risk behavior across sub-Saharan Africa in the mid-1990s? Epidemics. 2014; 8: 9-17.*

**References:**

1. UNAIDS. UNAIDS World AIDS Day Report 2012. Geneva: UNAIDS; 2012.
2. Taaffe J, Fraser-Hurt N, Gorgens M, Harimurti P. A comprehensive review of empirical and modeled HIV incidence trends (1990-2012), Volume 1. World Bank Group; 2014.
3. Awad SF, Abu-Raddad LJ. Could there have been substantial declines in sexual risk behavior across sub-Saharan Africa in the mid-1990s? *Epidemics*. 2014; 8: 9-17.