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Short Report

Spatial variability in HIV prevalence declines in several countries in sub-Saharan Africa

Diego F. Cuadros [a,*], Laith J. Abu-Raddad [a,b,c]

[a] Infectious Disease Epidemiology Group, Weill Cornell Medical College—Qatar, Cornell University, Qatar Foundation—Education City, Doha, Qatar
[b] Department of Healthcare Policy and Research, Weill Cornell Medical College, Cornell University, New York, New York
[c] Vaccine and Infectious Disease Division, Fred Hutchinson Cancer Research Center, Seattle, WA, USA

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ABSTRACT

Evidence suggests substantial declines in HIV prevalence in parts of sub-Saharan Africa. However, the observed aggregate declines at the national level may obscure local variations in the temporal dynamics of the infection. Using spatial scan statistics, we identified marked spatial variability in the within-country declines in HIV prevalence in Tanzania, Malawi, Kenya, and Zimbabwe. Our study suggests that the declines in the national HIV prevalence in some of the SSA countries may not be representative of downward trends in prevalence in areas of high HIV prevalence, as much as the result of sharp declines in prevalence in areas of already low HIV prevalence. Our findings provide insights for resource allocation and HIV prevention interventions in these countries.

1. Introduction

Recent evidence suggests substantial declines in HIV prevalence in parts of West, Southern and East Africa (UNAIDS, 2010; UNAIDS WHO, 2011). HIV incidence appears to have declined by more than 50% between 2001 and 2011 in 25 low-and middle-income countries, mostly from sub-Saharan Africa (SSA) (UNAIDS, 2012). HIV prevalence has declined by about 10% from 2000 to 2012 in Cameroon and Zambia, and by about 30% in Kenya and Malawi (UNAIDS WHO, 2013). The drivers of such HIV prevalence declines are not well understood (Awad and Abu-Raddad, 2014). Several mechanisms have been proposed to explain these declines including reduction in sexual risk behavior (Awad and Abu-Raddad, 2014; Hallett et al., 2006; 2009; Kilian et al., 1999; UNAIDS, 1999), natural epidemic dynamics (Garnett et al., 2006), increased HIV-associated mortality (UNAIDS, 1999; Walker et al., 2008a), impact of interventions (Stoneburner and Low-Beer, 2004), and heterogeneity in host susceptibility to HIV infection (Nagelkerke et al., 2009).

Despite reported HIV prevalence declines at the national level, a number of studies have suggested striking geographical differences in HIV prevalence trends. For instance, two studies using antenatal-clinic data among young women in Zambia reported diverse declines during the period 1994–2008 in urban settings ranging between 10% and 68%, and in rural settings ranging between 0% and 86% (Kayeyi et al., 2012; Sandøy et al., 2006).

These studies highlighted the possibility that the observed declines in HIV prevalence could reflect aggregate measures at the national level, obscuring local variations in the temporal dynamics of the infection. Motivated by theoretical grounds (Abu-Raddad et al., 2008; Alsallaq et al., 2009; Anderson and May, 1991; Awad et al., 2012; Cuadros et al., 2013), and based on a recent characterization of HIV infection clustering in SSA (Cuadros et al., 2013), we hypothesized that HIV prevalence declines would be higher in areas with low HIV prevalence (closer to the epidemic threshold for HIV in the general population) compared to areas with high HIV prevalence (well above the epidemic threshold). In this article, we examined the plausibility of such hypothesis by characterizing the spatial variability in HIV prevalence declines in different countries in SSA.

2. Methods

The main source of data in our study was the Demographic and Health Surveys (DHS) for countries in SSA with at least two rounds including HIV serological biomarker survey and the geographical coordinates of each survey data point; that is all countries where

* Correspondence to: Weill Cornell Medical College—Qatar, Qatar Foundation—Education City, PO Box 24144, Doha, Qatar. Tel.: +974 4492 8489; fax: +974 4492 8222.
E-mail addresses: dfc2002@qatar-med.cornell.edu, dfcuad2@gmail.com (D.F. Cuadros).

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we could conduct this analysis. As a result, a total of 10 countries from SSA were analyzed: Cameroon (2004, 2011), Ethiopia (2005, 2011), Kenya (2003, 2008–2009), Lesotho (2004, 2009), Malawi (2004, 2010), Mali (2001, 2006), Rwanda (2005, 2010), Senegal (2005, 2010–2011), Tanzania (2003–2004, 2007–2008, 2011–2012), and Zimbabwe (2005–2006, 2010–2011).

We used spatial scan statistics analyses (Kulldorff, 1997) to identify the geographical clusters with high numbers of HIV

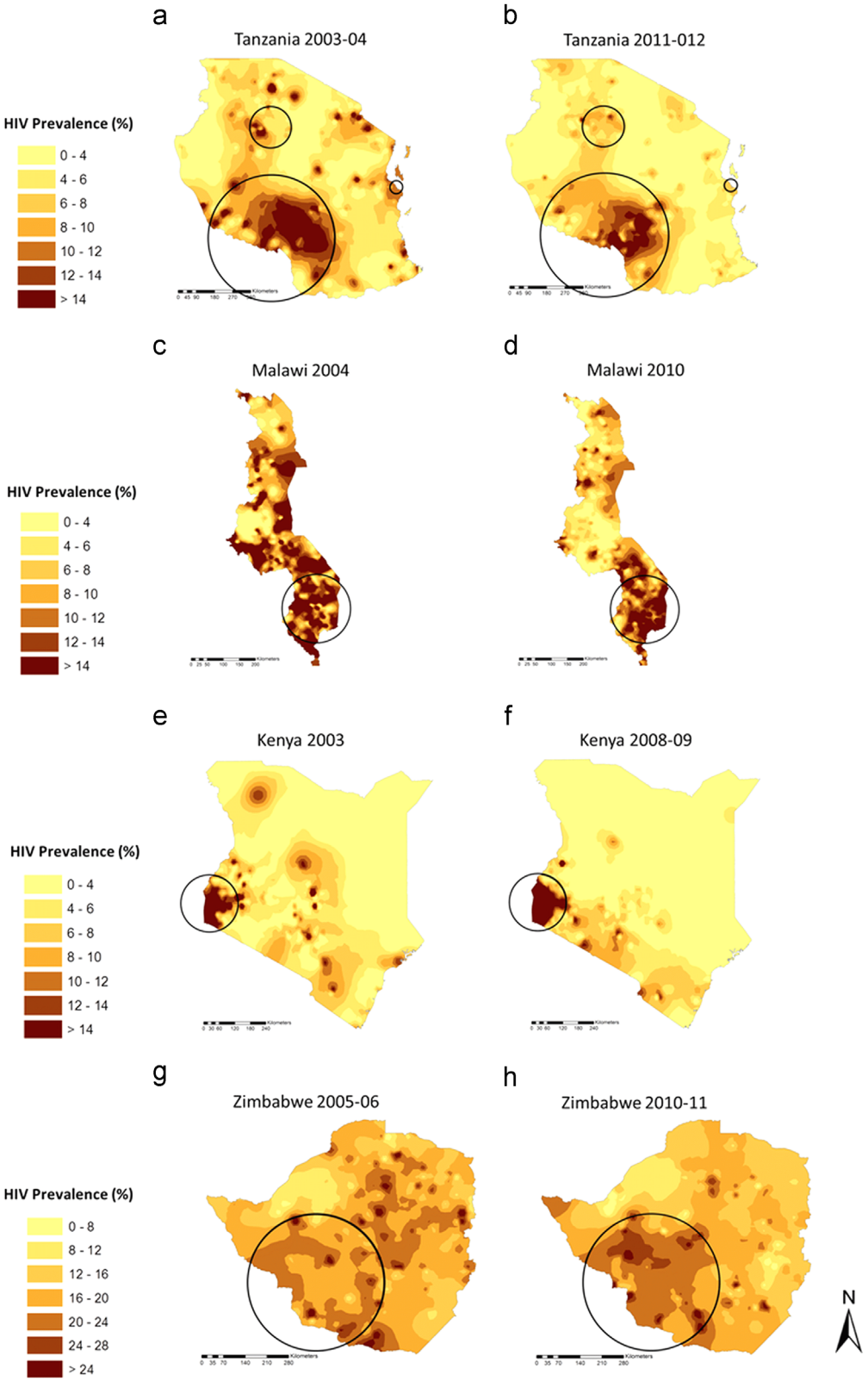

Fig. 1. Geographical clustering of HIV infection in Tanzania, Malawi, Kenya, and Zimbabwe. Spatial locations of the high HIV prevalence clusters in Tanzania ((a) and (b)), Malawi ((c) and (d)), Kenya ((e) and (f)), and Zimbabwe ((g) and (h)). Continuous surfaces of HIV prevalence within a country were generated using the inverse distance weighted mapping algorithm (ESRI, 2004).