Scaling-up spatiotemporal dynamics of HIV/AIDS prevalence rates of Sub-Saharan African countries

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Abstract: With approximately two in three global HIV/AIDS cases, Sub-Saharan Africa (SSA) countries are enduring enormous HIV/AIDS disease burden. This study used GIS to investigate the spatiotemporal variability of HIV/AIDS prevalence rates of SSA countries. Data acquired from the UNAIDS Global Report and World Reference Database are used for geospatial analysis, longitudinal study and modelling. Accordingly, in SSA, on average, 5.75% of the adult population were infected in 2014. The epidemics were relatively lower in the western ($\mu = 1.8 \pm SD = 0.28$) and eastern ($\mu = 2.4 \pm SD = 5.3$); average in the central ($\mu = 3.15 \pm SD = 2.0$) and significantly ($p = 0.05$) higher in the southern African countries ($\mu = 16.4 \pm SD = 60$). There is an encouraging trend of significant (i.e., $R^2 = 0.60$; $\alpha = 0.05$) decline between 2001 and 2014, although the strength of decline vary from country to country.

Keywords: HIV/AIDS; health GIS; prevalence rate; HIV/AIDS epidemics; spatiotemporal analysis; geospatial analysis; trend analysis; geography of HIV/AIDS; Sub-Saharan Africa; Africa.

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1 Introduction

With approximately 64% of global HIV/AIDS cases, economic burden of HIV/AIDS is becoming unbearable for many Sub-Saharan countries (Dixon et al., 2001; UN Department of Economic and Social Affairs, 2012; WHO and UNICEF, 2013; Murray and Lopez, 2013). According to UN Department of Economic and Social Affairs (2012), the economic burden of HIV/AIDS has adversely affected gross national product at rates between 1% to 2% percentages for every 10% increase in HIV/AIDS prevalence rate. Countries with high prevalence of HIV/AIDS have overseen reduced gross domestic production in the order of 2% to 4% a year in comparison to countries where the rates are low (Dixon et al., 2001). In general, HIV/AIDS impacts the economy by slowing or reversing growth in the national workforce; reducing saving and investment of the families; increase governments’ public spending and increasing economic disparity between haves and have-nots.

The most glaring report is, however, that Sub-Saharan African is the major epicentre in the world where HIV/AIDS prevalence rate has been high over the years and showing no revealing trend (Murray and Lopez, 2013; Shete, 2013; Roser, 2016). According to Shete (2013), the number of new cases of HIV/AIDS has reduced from 3.2 million in 2001 to 2.5 million in 2011. However, deaths from HIV/AIDS increased from 0.30 million in 1990 to 1.5 million in 2010, with a peak of 1.7 million in 2006 (Murray and Lopez, 2013). Additionally, for example, in Swaziland, where the first HIV
case was identified in 1986, there is a steady rise in HIV prevalence since 2003 with a huge burden on children and women. The percentage of people ages 15–49 who are infected with HIV has increased by 10.8% between 2002 and 2011. Furthermore, Roser (2016) reported a massive increase in the number of people infected and died with HIV/AIDS 1990s, which after 1997, the number of new diagnoses and death began to slow around 2005, and steady decline ever since. In general, reports on morbidity and mortality associated with HIV/AIDS are not decisive. Even those documented a definitive direction are reporting trends at global or continental scale, which may not hold at local or national scale.

Several studies have indicated apparent local and national variability (Fylkesnes et al., 2001; Asamoah-Odei et al., 2004; Msisha et al., 2008; UNAIDS, 2016). At local scale, Fylkesnes et al. (2001) observed higher prevalence rate in urban compared to rural Zambia; whereas at intermediate scale Msisha et al. (2008) found the rates depending on neighbourhoods and regions of Tanzania. On a larger-scale looking at Mali, Angola, South Africa and Botswana, Asamoah-Odei et al. (2004) observed national variability in HIV/AIDS prevalence rates. According to Asamoah-Odei et al. (2004), countries with higher urban-to-rural ratio (e.g., Botswana and South Africa) have higher HIV/AIDS prevalence rates compared with countries with lower ratio (e.g., Angola and Mali). However, this study is omitted countries (e.g., Swaziland and Lesotho), which are known for their higher HIV/AIDS prevalence rates (UNAIDS, 2016).

Subtle trend and its potential regional variability necessitated the study of spatially dynamic trend on adult HIV/AIDS prevalence rates for Sub-Saharan African countries. This would improve our understanding of regional dynamics, while also shedding light on the sizes of regionally endured hardship and its future outlook. Therefore, the objectives of this study are to:

a. investigate and evaluate the geographical distribution of variability of HIV/AIDS prevalence rates of Sub-Saharan African countries

b. conduct a longitudinal analysis for countries with significantly higher adult HIV/AIDS prevalence rates to evaluate directions and epidemic trends over time.

2 Materials and methods

2.1 Study area

Africa, with 30.2 million km² landmass, is the world’s second largest continent comprising of 54 independent nations. Additionally, with the total population over 1.1 billion people in 2013, i.e., 15% of the world population, Africa is the second most populous continent in the world (UN Department of Economic and Social Affairs, 2012). The continent of Africa is generally segmented into five regions Southern Africa, Central Africa, West Africa, East Africa and North Africa by cardinal direction. The countries included in each region vary depending on certain factors such as geographic, political and or predefined boundaries by international organisation such as UNICEF, WHO, CDC, etc… African countries in the northern region excluded owing to distinct cultural composition, lack of data and/or very low HIV/AIDS prevalence rates that could potential skew the results. Additionally, islands and developing states are excluded from the study analysis. The remaining four regions, Southern Africa, Central Africa,
West Africa, and East Africa are included owing to their apparent socio-cultural similarities. This research study focused on the Sub-Saharan Africa countries as illustrated in Figure 1.

Figure 1  Sub regions of Sub-Saharan Africa (see online version for colours)

There are 42 countries on the Sub-Saharan African mainland. Western African region consists of 15 countries, namely Benin, Burkina Faso, Gambia, Ghana, Guinea-Bissau, Guinea, Ivory Coast, Liberia, Mali, Mauritania, Nigeria, Niger, Senegal, Sierra Leone and Togo; whereas eastern African region has 12 countries. These are Tanzania, Burundi, Rwanda, Uganda, Sudan, Ethiopia, Eritrea, Djibouti, Somalia, and Kenya. Southern African region is comprising of ten countries, namely Botswana, Lesotho, Mozambique, Namibia, South Africa, Swaziland, Malawi, Zambia, and Zimbabwe, while Central Africa region consists of seven countries including Cameroon, Central African Republic, Chad, Congo (Brazzaville), Democratic Republic of the Congo (Kinshasa), Equatorial Guinea, and Gabon.
2.2 Research data

The data for this study were obtained from the UNAIDS Global Report and World Reference Database (CIA). UNAIDS does not only fund Third World Countries but also is heavily involved in accumulation of research data and their evaluation, which is necessary to identify research gaps and need within these countries (WHO and UNICEF, 2013; UNAIDS, 2015). UNAIDS also collaborates with other international organisations such as the Centers for Disease Control and Prevention (CDC) that partners with countries directly.

World Reference Database consists of a wide range of information from history, people, economic, geography, energy, etc. Both USAID and CIA’s World Fact Book reference database are on public domain for agencies or researchers. The database has data of Adult HIV/AIDS prevalence rates for Sub-Saharan African countries starting from 2000 to 2014, which made the trend analysis possible. Both, UNAIDS Global Report and World Reference Database are estimates derived from national population-based surveys, which are reported as better HIV/AIDS prevalence rate estimate when compared with estimates based on antenatal care (ANC) surveillance sites (Marsh et al., 2014)

Finally, a base map for African continent was obtained from Environmental Systems Research Institute (ESRI). Foundation in 1969, ESRI is the organisation has grown to be a leader of geographic analytics and providing spatial data. With high technical partners such as Amazon Web Services, Citrix, IBM, Microsoft, Oracle, SAP, SAS, and others, ESRI manages to stay up to date with software and optimally qualified spatial data.

2.3 Methods

2.3.1 Data pre-processing

Data pre-processing stage involved three main activities. The first was mining adult HIV/AIDS prevalence rate data of Sub-Saharan African countries from a huge reference database. The reference database contains the summary of the demographics, geography, communications, government, economy, and military of 267 countries or territories recognised by the USA as independent international entities. All 42 Sub-Saharan African countries are recognised as independent entities and their reference data including adult HIV/AIDS prevalence rate is available. At this stage, the data of Adult HIV/AIDS prevalence rates of African countries were sorted and isolated for subsequent investigation and evaluation of the regional variability of HIV/AIDS prevalence and a longitudinal analysis for countries with significantly higher prevalence. Secondly, ESRI provides ready-to-use global base maps and layers as a resource in its living atlas of the world. The map of African continent, which contains all 54 independent states of Africa was extracted. Because, the study is limited to mainland Sub-Saharan Africa states, northern African as well as island states and territories were clipped-off the base-map. Finally, a tabular data containing country-based adult HIV/AIDS prevalence rates for Sub-Saharan African countries was joined to attribute table of corresponding to geometries (polygons) of the 42 countries on the base-map, for subsequent geospatial analysis of regional HIV/AIDS prevalence rates in Sub-Saharan Africa.
2.3.2 Geospatial analysis of adult HIV/AIDS prevalence rates in Sub-Saharan Africa

Exploratory Spatial Data Analysis (ESDA) tools of geographical information system (GIS) were used to resolve the variability of adult HIV/AIDS prevalence rates of Sub-Saharan African countries. ESDA examines statistics that describe the location, spread, and the patterns of distribution for adult HIV/AIDS prevalence rates among countries and the four regions of the continent (Rushton, 2003; Shepard et al., 2011; Tanser and Le Sueur, 2015). Two GIS-based indices for exploring dispersion in prevalence rates were histogram and standard deviation-based classification tools. Histogram is consisted of classes, which represented the adult HIV/AIDS prevalence rates and frequencies, which depict the number of countries in each class. It is simple and yet sounds graphical exploratory tools of dispersion of adult HIV/AIDS prevalence rates for Sub-Saharan African countries. The standard deviation maps a widely used measure of dispersion. It calculates the average continental adult HIV/AIDS prevalence rate and depicts the unit deviation of each country’s rate from the continental average.

The results of the above two indices of ESDA setup a stage for hypothesis testing of the regional orientation of variability in the current adult HIV/AIDS prevalence rates of 2014. Accordingly, the non-parametric independent samples Kruskal-Wallis test (K-W test) was conducted to see if regional median prevalence rates were significantly different in Sub-Saharan Africa countries. The K-W test is used when the population from which a sample has been taken is not normal or unknown and/or has smaller sample (i.e., N < 30), which is the case with regard to the acquired Adult HIV/AIDS prevalence rates data of 2014. Furthermore, the two independent samples test Mann-Whitney (U-pair-wise test) was conducted to test if the median regional variations adult HIV/AIDS prevalence rates were significantly different between regions.

2.3.3 Longitudinal study and modelling of HIV/AIDS prevalence rates for Sub-Saharan African countries

Longitudinal study is performed for countries with significantly higher prevalence rates to evaluate trends over time. A time series analytic technique appropriate approach for analysing data sequentially measured over a time interval to extract a meaningful information on the direction and strength the trend (Nelson, 2012). The initial step of trend analysis involves applying a moving means and centred moving means for removing noise and ensuring smoothness in the time series data and not to allow a break point in trend modelling. Once the data were smoothed, the process of constructing models that best fit temporal adult HIV/AIDS prevalence rate from 2000 to 2014 for each countries was implemented. The developed models looked like the equation below:

$$Y_t = Y_0 + \beta_t + \epsilon_t$$

where prevalence rates is \(Y\); time (year) is \(t\); \(Y_0\) intercept is \(Y_0\); slope is \(\beta\) and random error is \(\epsilon\).

Generally, slope indicates the direction of the trend. A positive slope value indicates increasing trend, while the negative slope shows a decreasing trend. The magnitude of the coefficient of determination \(R^2\) indicates the strength of the trend. \(R^2\) would assume the values between 0 and 1; such that 0 signify no trend, while 1 represents a sign of a strong trend. Finally, the statistical significance of the trend was tested against a threshold.
3 Results and discussion

3.1 Spatial distribution of HIV/AIDS prevalence rates variability in Sub-Saharan Africa

The distribution of adult HIV/AIDS prevalence rates for 42 Sub-Saharan African countries in 2014 is shown in Figure 2. Accordingly, while Niger has the lowest adult HIV/AIDS prevalence rate (0.04%); Swaziland experiences the highest rate at 27.7%. The average adult HIV/AIDS prevalence rate for Sub-Saharan Africa is 5.75%. The prevalence data is skewed right toward the lower rate values such that most African countries (31) exhibited HIV/AIDS prevalence rate below the continental average (5.75%). This is approximately 74% of the Sub-Saharan African countries; while the remaining 26% of the countries (i.e., 11) experienced the prevalence rates above the continental average.

Additionally, the frequency distributions of the countries’ prevalence rates, whose class boundaries were set by the units of standard deviation, (Figure 2) have showed that nine countries (i.e., Zambia, Mozambique Namibia, Zimbabwe, South Africa, Malawi, Swaziland, Lesotho and Botswana) exhibited HIV prevalence rates, which were above 9.35%, i.e., > 1/2 the standard deviations above the mean. Of these, the prevalence rates of Namibia, Zimbabwe and South Africa were between 16.5% and 20.1% (i.e., 1 1/2 and 2 1/2 standard deviations above the mean), while Swaziland, Lesotho and Botswana have
shown rates greater than 23.74%, i.e., > 2 1/2 standard deviation above the continental average rate.

**Figure 3** Map showing the geographical distribution of variability in HIV/AIDS prevalence rates of Sub-Saharan African countries (see online version for colours)

Figure 3 shows spatial distribution of the variability observed above. Accordingly, there is a clear geographical controls of the adult HIV/AIDS prevalence rates variability in Sub-Saharan African countries. In general, countries in the western and eastern African countries experience HIV/AIDS prevalence rate that was < 1/2 standard deviation below the continental average. Most countries in the western region (e.g., Mali, Senegal, Niger, and Burkina Faso) experience a much lower adult HIV/AIDS prevalence rates (on average 0.6%); whereas, Central African countries such as Congo, Central African Republican and Equatorial Guinea have a prevalence rate about the continental average (i.e., 5.5%). On contrary, the higher adult HIV prevalence rates are located among
countries of the southern region of Africa. The nine countries (i.e., Zambia, Mozambique, Namibia, Zimbabwe, South Africa, Malawi, Swaziland, Lesotho and Botswana) that was found to have >= 1/2 standard deviation above the mean are all located in southern region of Sub-Saharan Africa.

The non-parametric independent samples K-W test found statistically significant difference in HIV/AIDS prevalence rates of Sub-Saharan African regions (Central, East, South, and West) (Figure 4). The median adult HIV/AIDS prevalence rate of eastern ($\mu = 2.4 \pm SD = 5.3$), southern ($\mu = 16.4 \pm SD = 60$), central ($\mu = 3.15 \pm SD = 2.0$), and western ($\mu = 1.8 \pm SD = 0.28$), found significant differences (P-value = 0.05). A follow-up Mann-Whitney multiple pair-comparison test of regions, however, revealed that it was the rate of the southern region that stood out and was indeed significantly higher than the rest of the region (Table 1). The remaining regions did not demonstrate a significantly different HIV/AIDS prevalence rates from one another. Furthermore, the distribution of regional HIV/AIDS prevalence rate further suggests and confirms varying variability within these regions. While the southern region shows the greatest variability of adult HIV/AIDS prevalence rates with the lowest prevalence at 2.41% (Angola) and highest at 27.73% (Swaziland); the variability of rates in the western African countries is relatively the smallest.

Figure 4 Comparison of the median HIV/AIDS prevalence among the regions Sub-Saharan Africa (see online version for colours)

Note: K-W test and Mann-Whitney pairwise comparisons test, p < 0.05 different letter indicate significant difference between the regional medians.
Regional and national differences in adult HIV/AIDS prevalence rates are perhaps attributed to regions’ or countries’ exposure to varying risk factors. For instance, studies have shown that countries with polygamous culture (Auerbach et al., 2011), unequal participation and service opportunities for women (Buseh et al., 2002), scarce ART treatment (Williams et al., 2015); and transnational economic migration (Voeten et al., 2010) found to have higher HIV prevalence rates. Additionally, in the countries with culturally motivated gender inequality characterised by lesser control of women over their sexual and reproductive health, increased economic dependence on men and violent relationships risk higher HIV/AIDS prevalence rate (Jewkes et al., 2010; Shannon et al., 2012).

Table 1  
K-W test and Mann-Whitney pairwise comparisons test of differences in the adult HIV/AIDS prevalence rates among regions of Sub-Saharan Africa

<table>
<thead>
<tr>
<th>Region comparison</th>
<th>Difference in means</th>
<th>95% confidence limits</th>
<th>α</th>
</tr>
</thead>
<tbody>
<tr>
<td>South–Central</td>
<td>13.2</td>
<td>7.61</td>
<td>18.83 ***</td>
</tr>
<tr>
<td>South–East</td>
<td>13.9</td>
<td>9.34</td>
<td>18.65 ***</td>
</tr>
<tr>
<td>South–West</td>
<td>14.4</td>
<td>10.21</td>
<td>18.78 ***</td>
</tr>
<tr>
<td>Central–South</td>
<td>−13.2</td>
<td>−18.83</td>
<td>−7.61 ***</td>
</tr>
<tr>
<td>Central–East</td>
<td>0.77</td>
<td>−4.66</td>
<td>6.21</td>
</tr>
<tr>
<td>Central–West</td>
<td>1.27</td>
<td>−3.849</td>
<td>6.40</td>
</tr>
<tr>
<td>East–South</td>
<td>−13.9</td>
<td>−18.65</td>
<td>−9.34 ***</td>
</tr>
<tr>
<td>East–Central</td>
<td>−0.77</td>
<td>−6.21</td>
<td>4.66</td>
</tr>
<tr>
<td>East–West</td>
<td>0.5</td>
<td>−3.55</td>
<td>4.55</td>
</tr>
<tr>
<td>West–South</td>
<td>−14.49</td>
<td>−18.77</td>
<td>−10.21 ***</td>
</tr>
<tr>
<td>West–Central</td>
<td>−1.27</td>
<td>−6.397</td>
<td>3.85</td>
</tr>
<tr>
<td>West–East</td>
<td>−0.50</td>
<td>−4.55</td>
<td>3.55</td>
</tr>
</tbody>
</table>

Several studies have substantiated similar regional variability HIV/AIDS burden in Africa (Auvert et al., 2001; Msisha et al., 2008). Auvert et al. (2001) analysed risk of HIV infection rates in four urban populations of sub-Saharan Africa and reported regional variations. Similarly, Msisha et al. (2008) investigated HIV/AIDS distribution in Tanzania and found geographical (regional) controls of the prevalence rate. In addition, Asamoah-Odei et al. (2004) and UNAIDS (2015) also documented similar regional controls. Asamoah-Odei et al. (2004) documented the relative higher adult HIV/AIDS prevalence rate for southern African countries (South Africa and Botswana) vis-à-vis the west African; while the 2013 UNAIDS reports indicated likewise geographical variability of the rates such that rates in southern African countries were above 20% while it was as low as 0.5% in Western African countries. Unique contributions of this study are, however that not just reported geographical controls of HIV/AIDS prevalence rates at national or regional scale; but also controls of political boundaries on HIV/AIDS prevalence rates. For example, in the central African region, the rate in Congo is lower than surrounding countries, which had the higher rates. Also, in the western region, Côte d’Ivoire, Guinea-Bissau and Nigeria illustrate slightly higher adult HIV/AIDS prevalence in comparison with the neighbouring countries; indicating perhaps countries’ differential investment towards adult HIV/AIDS disease intervention.
3.2 Trend analysis capturing a longitudinal analysis for countries with significantly higher prevalence in Sub-Saharan Africa

The trend of adult HIV/AIDS prevalence rates for countries selected for having significantly higher rates are shown in Figure 5. The adult HIV prevalence rate was started with an average rate of 22.2% in 2001 (i.e., estimate of 1999). Botswana had the highest prevalence rate, where more than a third of the population was infected; followed by Zimbabwe and Swaziland, where a fourth of the population was infected. In general, trend of adult HIV prevalence peaked at about 2003 (i.e., estimate of 2001), with Botswana leading the pack with 38.8% rate followed by Zimbabwe 37.7% and Swaziland (33.4%). In these countries, one in every three individuals had HIV/AIDS in 2003. On the other hand, the lower end of the pack was occupied by Mozambique (13%) and Malawi (15%), where relatively one in seven people were infected.

Figure 5  HIV/AIDS prevalence trends from 2001–2014 (see online version for colours)

Additionally, the trend (Figure 5) shows two distinct clusters of countries with regard to adult HIV/AIDS prevalence rates: group of countries with relatively higher and lower rates. In the early 2000s, Botswana, Swaziland, Zimbabwe, and Lesotho form a cluster with higher prevalence rate (i.e., above 20%); while Mozambique, Malawi, Namibia, Zambia, and South Africa form a cluster with lower prevalence rate (less than 20%). The constituents and trends of the clusters have not changed much even in 2014, except for Zimbabwe, which joined the lower cluster with a reduction of the rate to 16.7% in 2014.

The modelling of adult HIV prevalence rate for southern Sub-Saharan African countries (Table 2) also shown similar findings. In general, a significant decreasing trend in adult HIV/AIDS prevalence rates was found for all countries (i.e., $R^2 = 0.60; p = 0.05$), with the exception of South Africa, whose decreasing trend was significant only at $p = 0.1$. The strength of the decreasing trend in the two distinct clusters of countries are also variable. Ironically, the decreasing trends seem stronger for countries with relatively lower prevalence rate than countries in the cluster of higher prevalence rates. For instance, strong decreasing trends were observed for Malawi ($R^2 = 0.91; p = 0.05$),
Zimbabwe ($R^2 = 0.71; \alpha = 0.05$), and Botswana ($R^2 = 0.68; \alpha = 0.05$). Such a strong decrease is, especially, important for Zimbabwe and Botswana where one in three adults were suffering from AIDS in the early 2000s. On the hands, weak decreasing trends were seen in South Africa ($R^2 = 0.30; \alpha = 0.1$), Lesotho ($R^2 = 0.46; \alpha = 0.05$) and Swaziland ($R^2 = 0.42; \alpha = 0.05$). Again, weak decreasing trends in these countries is alarming as the countries exhibit relatively higher HIV/AIDS prevalence rate, where approximately one in four people still suffer with the disease in 2014.

Table 2  Time series analysis, trends and corresponding $R^2$ of adult HIV/AIDS prevalence rates Southern African countries (2001 to 2014)

<table>
<thead>
<tr>
<th>Country</th>
<th>Trend</th>
<th>$R^2$</th>
<th>$\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botswana</td>
<td>$y = -1.1089x + 2,252.7$</td>
<td>0.68</td>
<td>0.003***</td>
</tr>
<tr>
<td>Lesotho</td>
<td>$y = -0.3764x + 779.48$</td>
<td>0.46</td>
<td>0.030**</td>
</tr>
<tr>
<td>Swaziland</td>
<td>$y = -0.5264x + 1,084.1$</td>
<td>0.42</td>
<td>0.045**</td>
</tr>
<tr>
<td>South Africa</td>
<td>$y = -0.1766x + 372.57$</td>
<td>0.30</td>
<td>0.09*</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>$y = -1.5557x + 3,142.3$</td>
<td>0.71</td>
<td>0.002***</td>
</tr>
<tr>
<td>Zambia</td>
<td>$y = -0.5133x + 1,044.2$</td>
<td>0.69</td>
<td>0.003***</td>
</tr>
<tr>
<td>Namibia</td>
<td>$y = -0.5827x + 1,184.9$</td>
<td>0.59</td>
<td>0.010**</td>
</tr>
<tr>
<td>Malawi</td>
<td>$y = -0.4634x + 942.03$</td>
<td>0.91</td>
<td>0.000***</td>
</tr>
<tr>
<td>Mozambique</td>
<td>$y = -0.1135x + 239.24$</td>
<td>0.64</td>
<td>0.005***</td>
</tr>
<tr>
<td>Average</td>
<td>$y = -0.7488x + 1,526.2$</td>
<td>0.60</td>
<td>0.008***</td>
</tr>
</tbody>
</table>

Several studies have attributed declining HIV/AIDS prevalence rates to improving educational attainment in Africa (Fylkesnes et al., 2001; Michelo et al., 2006). For instance, Fylkesnes et al. (2001) indicated declining HIV prevalence rate was associated with on childbearing women of Zambia with higher educational attainment; while the rate was stable or rising prevalence among those less educated. Likewise, Michelo et al. (2006) conducted a long-term study of the role of educational attainment on HIV prevalence rate and documented a clear shift towards a reduced risk of HIV infection in groups with higher rather than lower education in both sexes among urban young people. Moreover, recent studies (Baker et al., 2011; Fortson, 2011; Brent, 2014) illustrated a trend of declining HIV/AIDS incidence and prevalence rates due to education aimed at bringing behavioural changes, improved cognitive skills, and informed decision making and risk assessment skills among the population. According to these studies, a prevalence rate of 10% was associated with a decline in completed schooling of about 0.5 years, a 6% rate decrease was associated with the probability of attending school, and 8% fall was associated with the probability of completing primary school, illustrating perhaps the significant achievement of Africa’s educational investment in reducing trends of HIV prevalence rates.

However, our finding is not unanimously corroborated (e.g., Asamoah-Odei et al., 2004; Murray and Lopez, 2013). A longitudinal analysis of HIV prevalence over time from 1990 to 2010 shown a general increase in prevalence, especially for the top 5 countries in the southern region of the Sub-Saharan Africa (Murray and Lopez, 2013). Similarly, for Asamoah-Odei et al. (2004), while the median HIV prevalence rates of western African countries was relatively unchanged between 1997 and 2002; and were reduced for eastern African countries; rates for the southern African countries have
increased; indicating geographical controls of trends of HIV/AIDS burden. The strength of this study, in this contentious subject, is that it did not just discover the direction of HIV/AIDS trends, but also the relative strengths of the declines and associated statistical significances.

4 Conclusions

With, approximately 35 million people currently living with HIV/AIDS worldwide, the disease has global importance. Nearly, 70% of HIV/AIDS epidemics is confined to the continent of Africa and especially to the region of Sub-Saharan African. In Sub-Saharan African, on average, 5.75% of the adult population are infected in 2014, although the rate varies from county to country and region to region. Countries exhibited adult HIV/AIDS prevalence rate from as low as 0.04% in Niger to 27.7% in Swaziland and regionally, rates are relatively lower in the western and eastern African countries, while the centre is about average and higher in the southern African countries. However, only the southern African countries registered significantly higher regional HIV/AIDS prevalence rates, perhaps due to unique exposure to risk factors, such as but not limited to polygamous culture, less control of women over their sexual and reproductive health and transnational migration.

Two distinct clusters of the trends of HIV/AIDS prevalence rates were discovered. A cluster which represents a group with highest prevalence rate, where nearly one in four adults was HIV/AIDS infected and the other cluster, which was occupied by countries where only one in seven is infected. An encouraging sign of significant trend of HIV/AIDS prevalence rate is observed for southern African countries The adult HIV/AIDS prevalence rate, which was 25.8% in 2003, declined to 17.8% in 2014; although the strength of decline vary from country to country. The decline was, however, stronger among the countries in the cluster lower prevalence rate than the higher cluster, which may be attributed to countries differential investment in HIV/AIDS education. The weaker trends among countries in the higher HIV/AIDS prevalence rate cluster (e.g., Swaziland and South Africa) is perhaps a clear indication of inadequate investment or a realisation of a proverb, which says, that ‘old habit die had’. It is also a reminder that the world must not only look for solutions to the HIV/AIDS problem elsewhere; but to eastern African countries, which have remarkably dealt with the problem in the past 20 years.

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References


Scaling-up spatiotemporal dynamics of HIV/AIDS prevalence rates


