ANALYZING HIV PREVALENCE AMONG INDIVIDUALS AGED 15-49 YEARS IN JAMAICA USING HOLT'S LINEAR METHOD

Dr. Smartson. P. NYONI1,

Thabani NYONI2

1ZICHIRe Project, University of Zimbabwe, Harare, Zimbabwe

2Independent Researcher & Health Economist, Harare, Zimbabwe

Abstract

This study uses annual time series data of HIV prevalence among individuals aged 15-49 years for Jamaica from 1990 to 2020 to predict future trends of HIV prevalence over the period 2021 to 2030. The study utilizes Holt's linear exponential smoothing model. The optimal values of smoothing constants α and β are 0.9 and 0.1 respectively based on minimum MSE. The results of the study indicate that annual HIV prevalence among individuals aged 15-49 years will remain constant around 1.4% over the out of sample period. Therefore, we encourage authorities to put emphasis on HIV case detection, prevention and treatment among high-risk groups especially key populations.

Keywords: - Exponential smoothing, Forecasting, HIV prevalence.

Introduction

For the year 2018, Jamaica reported an adult HIV prevalence of 1.5 percent and 32,617 people were infected with HIV (Ministry of Health, 2020). According to the Jamaica country progress report, the WHO Treat All strategy was adopted and implemented in January 2017. The Ministry of Health revealed that in 2018, Jamaica's achievement of the UNAIDS targets was 84-53-65. The WHO Treat All strategy has several objectives that include early diagnosis of HIV, immediate initiation of antiretroviral therapy (ART) and viral suppression (Tang *et al.* 2018). Young men (20–39 years old) are more likely than young women to be living with HIV but much less likely to be tested for HIV (Jamaica Ministry of Health, 2016). Increased testing coverage among communities has been shown to reduce chances of late diagnosis and initiation of antiretroviral therapy (WHO, 2015). In Jamaica HIV/AIDS is a leading cause of death in 15 to 49 age group and the second leading cause of death in children aged 1 to 4 years (Ministry of Health, 2017). The vulnerable populations are men who have sex with men, commercial sex workers and heterosexuals engaging in high-risk sexual behaviors. MSM in Jamaica have reported HIV infection rates of 28–30%, among the highest in the Caribbean (Figueroa *et al.* 2015; Figueroa *et al.* 2013). This figure is significantly higher than an estimated HIV prevalence of 1.7% among Jamaica's adult general population (De Boni *et al.* 2014). More than 34,125 HIV cases and 9,517 deaths attributed to AIDS were reported in Jamaica between 1982 and 2015, 1250 deaths in children 0–19 years (Ministry of Health, 2016), with continued rise in new infections to date (UNAIDS, 2020). The aim of this paper is to model and forecast HIV prevalence among individuals aged 15-49 years for Jamaica using double exponential smoothing. The findings of this

study are expected to facilitate allocation of resources towards targeted HIV prevention, treatment, care and support programs in the country in order to curb new infections.

Literature Review

Author(s)	Objective (s)	Methodology	Key finding (s)
Cushnie et al. (2023)	To examine trends and factors associated with uptake of HIV treatment among people living with HIV (PLHIV) in Jamaica and to assess the effectiveness of revised treatment guidelines.	secondary analysis used patient-level data from the National Treatment Service Information System	same day ART initiation increased between 2015–2019, however it remains too low
Dyer et al. (2022)	To characterize adherence patterns to antiretroviral therapy (ART) and identify factors affecting optimal adherence among adolescents living with HIV (ALHIV) in Kingston, Jamaica during the Covid-19 pandemic	cross-sectional study	Medication, caregiver-related and health system management factors are both enablers and barriers of adherence for ALHIV
Cushnie et al. (2021)	To assess changes in HIV treatment outcomes for Jamaica after the implementation of the WHO Treat All strategy in January 2017, as well as identify variables associated with clinical stage at diagnosis and viral load status, in order to understand implications for enhancing the HIV clinical cascade and boosting progress towards the UNAIDS 90-90-90 targets.	population-based study using the National Treatment Service Information System	Jamaica's HIV program outcomes have improved after Treat All was implemented. ART initiation time significantly decreased. Early diagnosis, viral load testing uptake and viral suppression increased
Figueroa et al. (2020)	To assess the status of the HIV epidemic and programmatic implementation in Jamaica while identifying strategies for achieving effective HIV control	The assessment included a review of the core indicators of the UNAIDS Global Monitoring Framework, a desk review of program reports, and unstructured interviews of stakeholders.	HIV prevalence among adults in Jamaica was 1.5% in 2018 with an estimated 32 617 persons living with HIV (PLHIV) and 27 324 persons (83.8%) diagnosed with HIV; 12 711 (39.0% of all PLHIV or 46.5% aware of their status) were on anti-retroviral therapy (ART) in the public health sector and 61.8% PLHIV on ART were virally suppressed. HIV prevalence among men who have sex with men remains high (31.4% in 2011, 29.6% in 2017) but has declined among female sex workers (12% in 1990, 2% in 2017)
Logie et al. (2016)	To examine correlates of HIV infection and HIV testing among transgender women in Jamaica.	-Cross-sectional survey with transgender women in Kingston and Ocho Rios, Jamaica. -Applied multivariable logistic regression to identify factors associated with HIV testing and HIV infection	HIV infection was associated with: homelessness (AOR: 5.94, CI: 1.27-27.74), perceived HIV risk (AOR: 1.67, CI: 1.02-2.72), depression (AOR: 1.39, CI: 1.06-1.82), STI history (AOR: 56.79, CI: 5.12-630.33), perceived (AOR: 1.26, CI: 1.06-1.51) and enacted (AOR:

			1.16, CI: 1.04-1.29) transgender stigma, forced sex (AOR: 4.14, CI: 1.4911.51), physical abuse (AOR: 3.75, CI: 1.39-10.12), and lower self-rated health [AOR: 0.55, CI: 0.30-0.98) and social support (AOR: 0.79, CI: 0.64-0.97)
Edwards et al. (2016)	To examine the impact of establishing multi-stakeholder leadership hubs on evidence-informed HIV care practices	A prospective quasi-experimental study in Jamaica, Kenya, Uganda and South Africa	Leadership hubs, comprising nurses and other stakeholders committed to change and provided with capacity building can collectively identify issues and act on strategies that may improve practice and policy. Overall, hubs did not provide the necessary force to improve the uptake of evidence-informed HIV care in their districts
Pierre et al. (2016)	To characterize infections and growth outcomes among HIV-EU infants in Jamaica during their first two years of life. By identifying these outcomes, specific interventions could be implemented to mitigate this risk of morbidity and mortality.	HIV-EU infants born between 1 January 2004 and 31 December 2006 in Kingston, Jamaica, were enrolled and followed in multicenter health facilities, using standardized protocols. HIV status was determined by RNA/DNA polymerase chain reaction (PCR) and confirmatory HIV enzyme-linked immunoassay (ELISA). Data were collected on demographic and anthropometric characteristics, infectious morbidity and mortality, and hospitalizations. Outcomes (incidence of infections and hospitalizations; growth (z scores for weight)) were determined, using univariate analyses.	Infectious disease morbidity was higher but growth was normal in this cohort of HIV-EU non-breast-fed infants, in comparison to published community controls

Methodology

This study utilizes an exponential smoothing technique to model and forecast future trends of HIV prevalence among individuals aged 15-49 years in Jamaica. In exponential smoothing forecasts are generated from the smoothed original series with the most recent historical values having more influence than those in the more distant past as more recent values are allocated more weights than those in the distant past. This study uses the Holt's linear method (Double exponential smoothing) because it is an appropriate technique for modeling linear data.

Holt's linear method is specified as follows:

Model equation

$J_t = \mu_t + \rho_t \mathbf{t} + \varepsilon_t$

Smoothing equation

$S_t = \alpha J_t + (1-\alpha)(S_{t-1} + b_{t-1})$

$0 < \alpha < 1$

Trend estimation equation

$b_t = \beta(S_t - S_{t-1}) + (1-\beta)b_{t-1}$

$0 < \beta < 1$

Forecasting equation

$f_{t+h} = S_t + h b_t$

J_t is the actual value of HIV prevalence at time t

ε_t is the time varying **error term**

μ_t is the time varying mean (**level**) term

ρ_t is the time varying **slope term**

t is the trend component of the time series

S_t is the exponentially smoothed value of HIV prevalence at time t

α is the exponential smoothing constant for the data

β is the smoothing constant for trend

f_{t+h} is the h step ahead forecast

b_t is the trend estimate (slope of the trend) at time t

b_{t-1} is the trend estimate at time t-1

Data Issues

This study is based on annual HIV prevalence among individuals aged 15-49 years in Jamaica for the period 1990 – 2020. The out-of-sample forecast covers the period 2021 – 2030. All the data employed in this research paper was gathered from the World Bank online database.

Findings of the study

Exponential smoothing Model Summary

Table 1: ES model summary

Variable	J
Included Observations	31
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.100
Forecast performance measures	
Mean Absolute Error (MAE)	0.054854
Sum Square Error (SSE)	0.336925
Mean Square Error (MSE)	0.010869
Mean Percentage Error (MPE)	-0.874921
Mean Absolute Percentage Error (MAPE)	5.433982

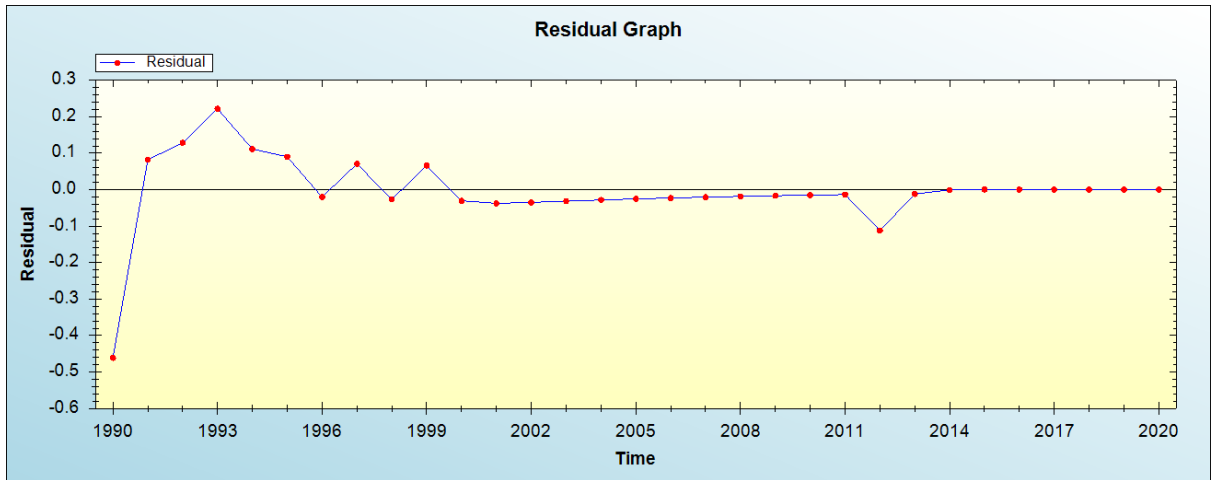Residual Analysis for the Applied Model

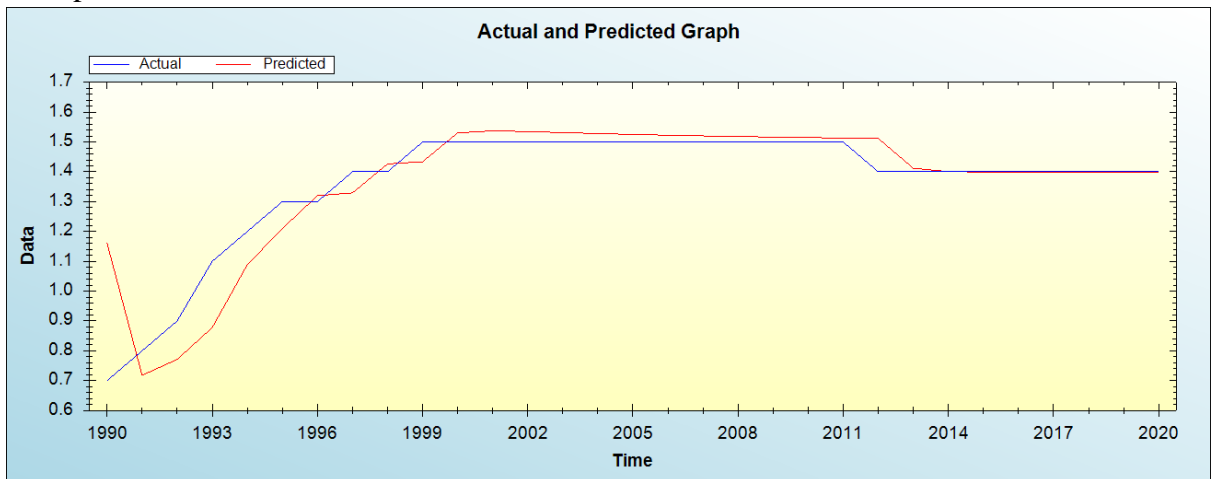Figure 1: Residual analysis

In-sample Forecast for J

Figure 2: In-sample forecast for the J series
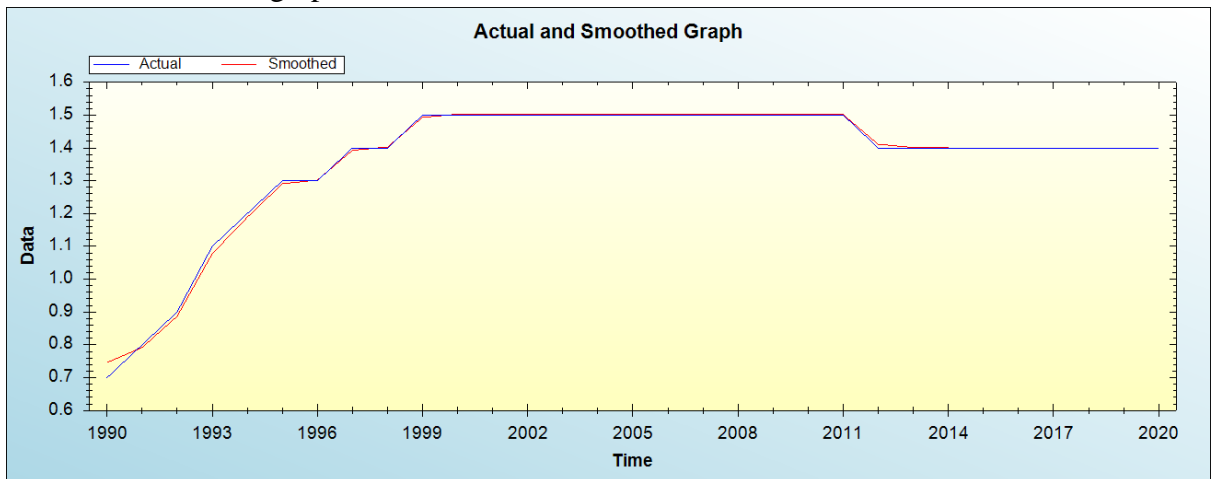
Actual and Smoothed graph for J series

Figure 3: Actual and smoothed graph for J series

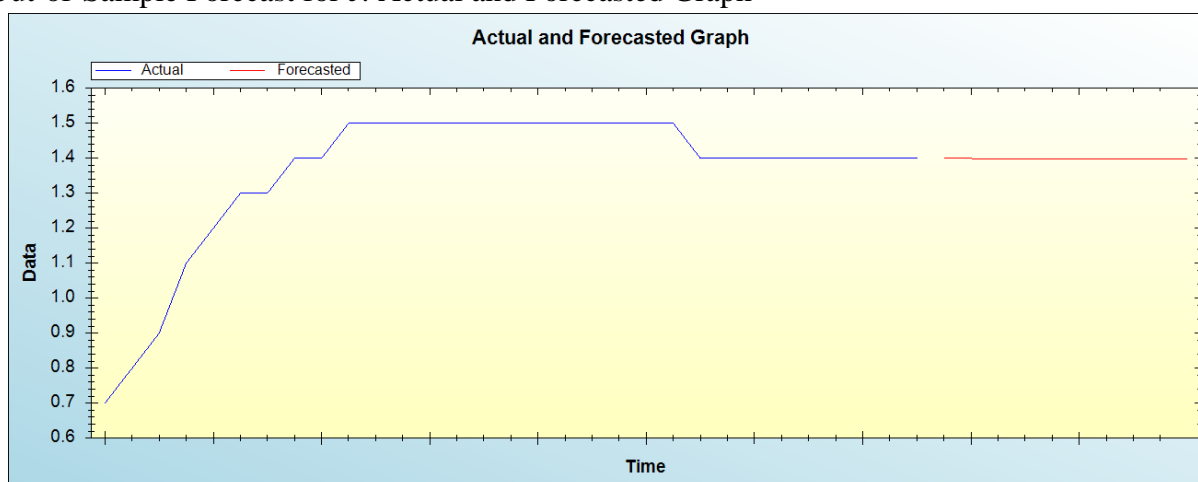Out-of-Sample Forecast for J: Actual and Forecasted Graph

Figure 4: Out-of-sample forecast for J: actual and forecasted graph

Out-of-Sample Forecast for J: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted HIV prevalence
2021	1.3997
2022	1.3994
2023	1.3991
2024	1.3988
2025	1.3985
2026	1.3982
2027	1.3979
2028	1.3976
2029	1.3973
2030	1.3971

The main results of the study are shown in table 1. It is clear that the model is stable as confirmed by evaluation criterion as well as the residual plot of the model shown in figure 1. It is projected that annual HIV prevalence among individuals aged 15-49 years will remain constant around 1.4% over the out of sample period.

Policy implication and conclusion

Our research findings indicate that annual HIV prevalence among individuals aged 15-49 years will remain constant around 1.4% over the out of sample period. Therefore, authorities must put emphasis on HIV case detection, prevention and treatment among high risk groups especially key populations.

References

1. Ministry of Health, Jamaica (2020). National HIV Strategic Plan (2020–2025).
2. Jamaica Country Progress Report (2016). Global AIDS Response Progress Report: Ministry of Health, Jamaica.
3. Ministry of Health, Jamaica (2018). 2018 HIV Fact Sheet.

4. Tang H, Mao Y, Tang W, Han J, Xu J, and Li J (2018). "Late for testing, early for antiretroviral therapy, less likely to die": results from a large HIV cohort study in China, 2006–2014. BMC Infect Dis, 18(1):272. Available from: https://doi.org/10.1186/s12879-018-3158-x

5. WHO (2015). Consolidated guidelines on HIV testing services. Available from: http://www.unaids.org/sites/default/files/media_asset/JC2484_ treatment-2015_en_1.pdf

6. Ministry of Health, Jamaica (2016). WHO Global HIV Cascade Workshop.

7. Ministry of Health (2017). Management of HIV Disease: Guidelines for Medical Practitioners 2017 (Internet). Jamaica; 2017(cited 2020 Sept 5). Available from https://moh.gov.jm/wp-content/uploads/2015/03/Clinical-Management-ofHIV-Disease-2017.pdf

8. UNAIDS (2020). 2020 Data. Available from https://www.unaids.org/sites/default/les/media_asset/2020_aids-data-book_en.pdf

9. Ministry Of Health (2016). Jamaica Annual HIV Epidemiological Profile. Available from https://www.moh.gov.jm/wpcontent/uploads/2019/03/HIV-EPIDEMIOLOGICAL-PROFILE-20161.pdf

10. Figueroa JP, Weir SS, Jones-Cooper C, Byfield L, Hobbs MM, and McKnight I (2013). High HIV prevalence among men who have sex with men in Jamaica is associated with social vulnerability and other sexually transmitted infections. West Indian Med J. 2013; 62(4):286–91.

11. Figueroa JP, Cooper CJ, Edwards JK, Byfield L, Eastman S, and Hobbs MM (2015). Understanding the high prevalence of HIV and other sexually transmitted infections among socio-economically vulnerable men who have sex with men in Jamaica. Plos One. 2015; 10(2): e0117686.

12. De Boni R, Veloso VG, and Grinsztejn B (2014). Epidemiology of HIV in Latin America and the Caribbean. Curr Opin HIV AIDS. 9(2):192–98.