World Bulletin of Public Health (WBPH)
Available Online at: https://www.scholarexpress.net
Volume-37, August 2024
ISSN: 2749-3644

PREDICTING HIV PREVALENCE AMONG INDIVIDUALS AGED 15-49 YEARS IN THE DRC USING HOLT'S DOUBLE EXPONENTIAL SMOOTHING TECHNIQUE

Dr. Smartson. P. NYONI[1], Thabani NYONI[2]
[1]ZICHIRe Project, University of Zimbabwe, Harare, Zimbabwe
[2]Independent Researcher & Health Economist, Harare, Zimbabwe

Article history:

Received: June 6th 2024
Accepted: July 4th 2024

Abstract:

This study uses annual time series data of HIV prevalence among individuals aged 15-49 years for the DRC from 1990 to 2020 to predict future trends of HIV prevalence over the period 2021 to 2030. The study utilizes Holt's double exponential smoothing model. The optimal values of smoothing constants α and β are 0.8 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 continue to decline over the out of sample period. Therefore, we encourage authorities to address major drivers of HIV transmission and strengthen prevention particularly among adolescents and other high risk groups.

Keywords: *Exponential smoothing, Forecasting, HIV prevalence*

BACKGROUND

In sub-Saharan Africa, one in six people living in extreme poverty resided in the DRC in 2021. According to the World Bank, women in the DRC encounter many barriers to economic opportunities, forcing some to engage in sex work as a livelihood. In 2022 there were approximately 526,000 sex workers in the country. The rate of condom use among sex workers was around 47 percent. HIV seroprevalence in this group stood at 7.5 percent in 2021, with 21,000 new infections annually. However, the reported national HIV prevalence rate in the general population was 0.7 percent (UNAIDS, 2022). The aim of this paper is to model and forecast HIV prevalence among individuals aged 15-49 years for the DRC using Holt's linear method. The findings of this paper will trigger an appropriate national HIV response particularly facilitating allocation of resources to targeted HIV programs in the DRC

LITERATURE REVIEW

Author(s)	Objective (s)	Methodology	Main finding(s)
Bongenya et al. (2023)	To determine the reasons behind the loss of patients on Antiretroviral Treatment (ART) after 6 months of follow-up.	descriptive survey	Nearly half of the patients no longer return to the treatment centers where they started
Bekolo et al. (2023)	to review current evidence for declining HIV prevalence despite increasing survival owing to 'universal test and treat' and to explore the reason for the decrease, particularly the role of behavioral change.	conducted a secondary analysis using HIV prevalence, behavioral and social determinants data of the Demographic and Health Survey Program databases	The observed decline in HIV prevalence is statistically valid and reflects the observed decline in risky sexual behavior that need to be sustained by the National HIV programme

World Bulletin of Public Health (WBPH)
Available Online at: https://www.scholarexpress.net
Volume-37, August 2024
ISSN: 2749-3644

Djiyou et al. (2023)	To prospectively assessed the rate of VS, and the factors associated with VF in a cohort of adolescents followed up according to the WHO guidelines in Cameroon.	cross-sectional study	The VS rate was 88.2% (CI: 83.8-91.7%) overall; 89.0% (CI: 82.0-93.1%) and 88.7% (CI: 81.2-93.0%) in females and males, respectively. Being on second or third-line ART, self-declared suboptimal adherence, and a history of past VF were independently associated with VF.
Mukadi-Bamuleka et al. (2022)	To determine the prevalence of HIV and to describe the sexual practices and behaviors among MSM recruited in Kinshasa, DRC.	prospective cross-sectional study	The study reported a high prevalence of HIV among MSM which is associated with the high-risk sexual practices and behaviors such as the bisexuality, the multiple sexual partners, and the diversity of anal intercourses
Martial et al. (2021)	To examine the long-term trend of the overall HIV/AIDS incidence rates in four countries of the central region of Africa, using data from the Global Burden of Diseases (GBD) 2019 study.	The Age–Period–Cohort statistical model analysis was used to measure the trends of HIV/AIDS incidence rates in each of the four countries	HIV/AIDS incidence rates are decreasing in each of the four countries.
Dane et al. (2020)	To describe the programme and report testing yields before and after the intervention.	utilized χ^2 tests to compare the testing yield at the start of the intervention to that 10 months after the start of programme implementation	HIV testing yield increased over the course of implementation
Pour et al.(2020)	To evaluate the prevalence of HIV in patients in the urban Kinshasa area.	HIV prevalence was determined from data obtained between March–July of 2018 from 8320 individuals over the age of 18 years receiving care at one of 47 clinics in Kinshasa.	The prevalence of HIV in our study was 11.0% (95% CI 10.3–11.6%) overall and 8.14% in the subset of N = 1240 participants who were healthy mothers seeking prenatal care.

World Bulletin of Public Health (WBPH)
Available Online at: https://www.scholarexpress.net
Volume-37, August 2024
ISSN: 2749-3644

METHODOLOGY

This study utilizes an exponential smoothing technique to model and forecast future trends of HIV prevalence among individuals aged 15-49 years in the DRC. 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

$D_t = \mu_t + \rho_t \mathbf{t} + \varepsilon_t$ .....[1]

Smoothing equation

$S_t = \alpha D_t + (1-\alpha)(S_{t-1} + b_{t-1})$ .....[2]

$0 < \propto < 1$

Trend estimation equation

$b_t = \beta (S_t - S_{t-1}) + (1-\beta) b_{t-1}$ .....[3]

$0 < \beta < 1$

Forecasting equation

$f_{t+h} = S_t + hb_t$ .....[4]

D_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

World Bulletin of Public Health (WBPH)
Available Online at: https://www.scholarexpress.net
Volume-37, August 2024
ISSN: 2749-3644

This study is based on annual HIV prevalence among individuals aged 15-49 years in the DRC 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	D
Included Observations	31
Smoothing constants	
Alpha (α) for data	0.800
Beta (β) for trend	0.100
Forecast performance measures	
Mean Absolute Error (MAE)	0.078757
Sum Square Error (SSE)	0.500045
Mean Square Error (MSE)	0.016130
Mean Percentage Error (MPE)	-0.582356
Mean Absolute Percentage Error (MAPE)	6.054942

Residual Analysis for the Applied Model

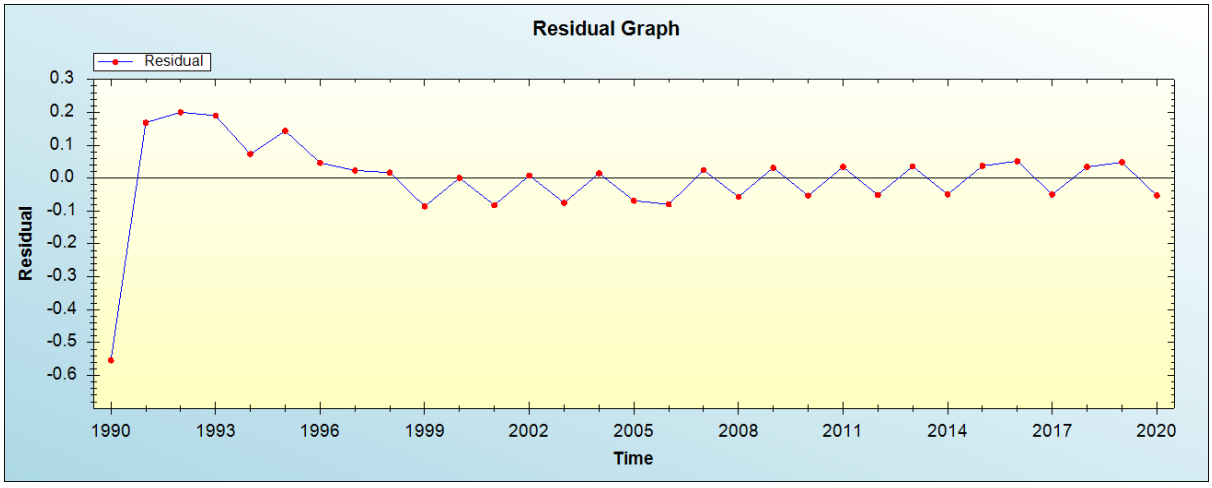

Figure 1: Residual analysis

In-sample Forecast for D

World Bulletin of Public Health (WBPH)
Available Online at: https://www.scholarexpress.net
Volume-37, August 2024
ISSN: 2749-3644

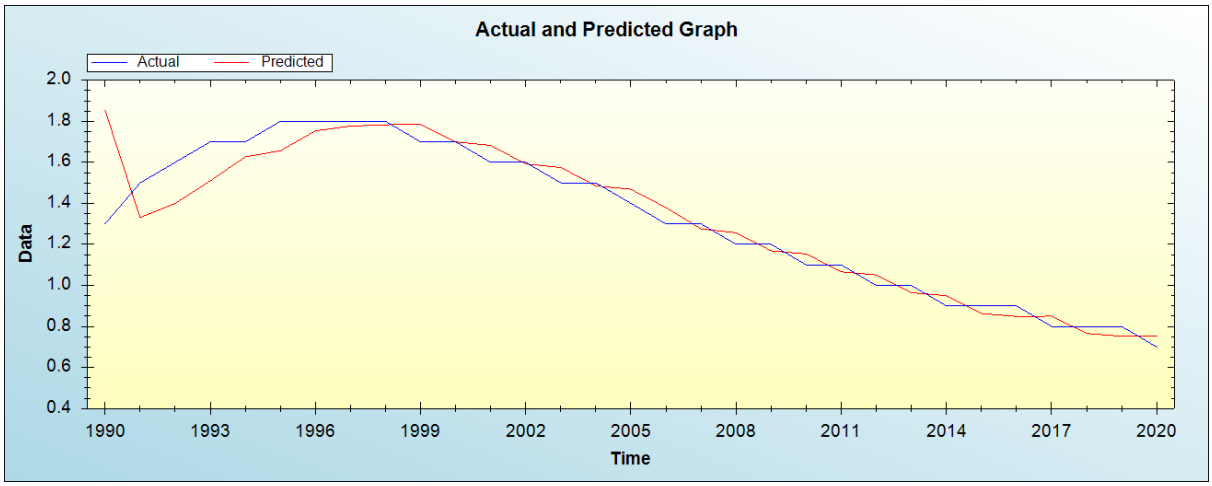

Figure 2: In-sample forecast for the D series

Actual and Smoothed graph for D series

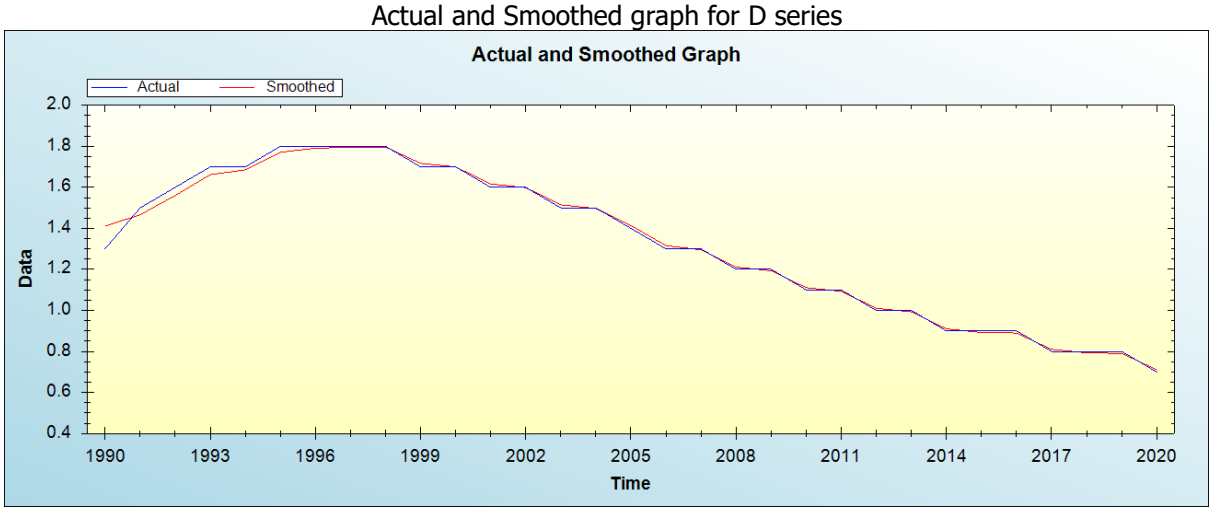

Figure 3: Actual and smoothed graph for D series

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

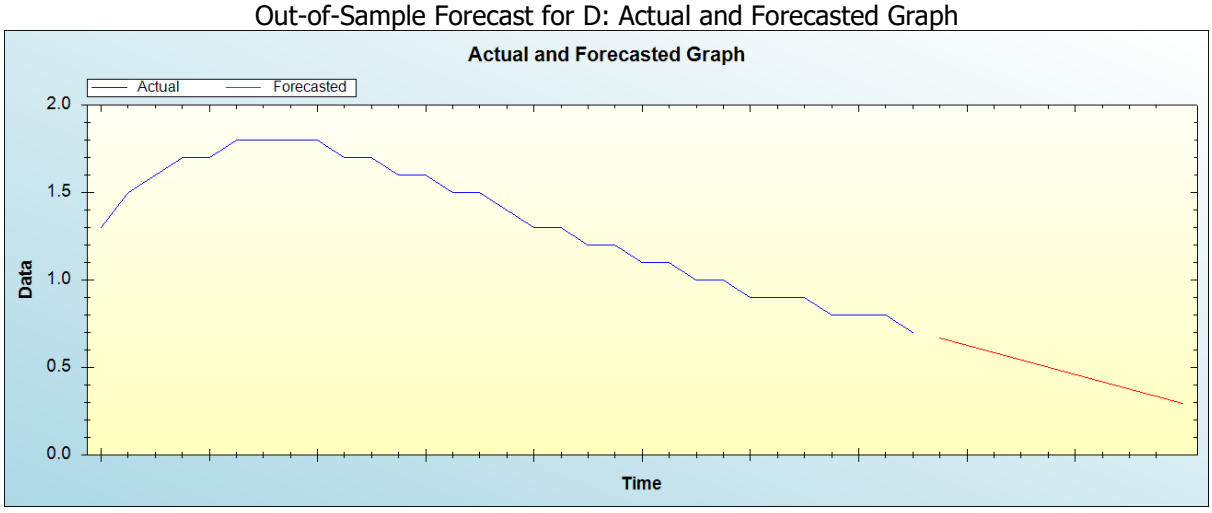

Figure 4: Out-of-sample forecast for D: actual and forecasted graph

World Bulletin of Public Health (WBPH)
Available Online at: https://www.scholarexpress.net
Volume-37, August 2024
ISSN: 2749-3644

Out-of-Sample Forecast for D: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Predicted HIV prevalence
2021	0.6689
2022	0.6273
2023	0.5856
2024	0.5439
2025	0.5023
2026	0.4606
2027	0.4190
2028	0.3773
2029	0.3356
2030	0.2940

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 continue to decline over the out of sample period.

POLICY IMPLICATION AND CONCLUSION

Our model predictions indicate that annual HIV prevalence among individuals aged 15-49 years will continue to decline over the out of sample period. Therefore, authorities are encouraged to address major drivers of HIV transmission and strengthen prevention particularly among adolescents and other high risk groups.

REFERENCES

[1] World Bank (2022). The World Bank in DRC. Available from: https://www.worldbank.org/en/country/drc/overview
[2] Joint United Nations Programme on HIV/AIDS (UNAIDS). Country factsheets: Democratic Republic of the Congo, 2022. Geneva: UNAIDS; 2022. Available from: https://www.unaids.org/en/regionscountries/countries/democraticrepublicofthecongo