European Science Methodical Journal
ISSN (E): 2938-3641
Volume 2, Issue 4, April- 2024

PROJECTION OF HIV PREVALENCE AMONG INDIVIDUALS AGED 15-49 YEARS IN UKRAINE 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 Ukraine 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 0.7 and 0.9 respectively based on minimum MSE. The results of the study indicate that annual HIV prevalence among individuals aged 15-49 years will continue on an upward path but still remain around 1% over the out of sample period. Therefore, there is need to strengthen HIV prevention measures, treatment and scale up HIV testing among this age group.

Keyword(s): - Exponential smoothing, Forecasting, HIV prevalence

Introduction

The use of antiretroviral therapy has brought a huge relief to the world as HIV treatment prolongs and improves the quality of life for people living with HIV. However, antiretroviral drugs have been found to be associated with side effects such as occurrence of chronic medical conditions such as hypertension and Diabetes Mellitus (Cahill & Valadez, 2013). According to UNAIDS 2018 data, Eastern Europe and Central Asia (EECA) continues to report the highest increases in HIV incidence and mortality, overtaking Southern and Eastern Africa. Ukraine's HIV epidemic is the worst in Europe with a prevalence of 1.2% and the second-largest in EECA with 240,000 PWH (Ukraine Ministry of Health, 2018; UNAIDS, 2018). UNAIDS revealed that in 2017, Ukraine made a serious commitment to 90-90-90 UNAIDS HIV targets. However the reported ART coverage of 52% in 2019 was far short of this target (PERPFAR, 2020). HIV treatment and prevention services in Ukraine have focused on young adults particularly those 15–24 years (UNAIDS, 2018; USAID, 2016; Ukraine MOH, 2014; Vitek et al. 2014; WHO, 2009). Therefore there is need to consider and scale up ART services among the elderly in the National ART program (UNAIDS, 2014). The purpose of this paper is to model and forecast HIV prevalence among individuals aged 15-49 years for Ukraine using Holt's double exponential smoothing technique. The study findings are expected to inform policy, planning and allocation of resources towards targeted HIV prevention and treatment programs in order to control the HIV epidemic especially among high risk and vulnerable groups in Ukraine.

European Science Methodical Journal
ISSN (E): 2938-3641
Volume 2, Issue 4, April- 2024

Literature Review

Author (s)	Objective (s)	Methodology	Key finding (s)
Friedman et al. (2023)	To describe the negative future impact of the Russian war in Ukraine particularly its impact on TB, HIV and associated conditions	Descriptive study	The postwar period will pose great economic and political difficulties for Ukrainians, including large populations of people physically and/or psychically damaged and in pain who might become people who inject drugs
Stijnberg et al. (2023)	To evaluate the cascade of care for the elimination of mother-to-child-transmission of human immunodeficiency virus (HIV) in Suriname and identify sociodemographic and clinical factors preventing transmission to exposed infants	A mixed-methods study design was used. Antenatal care data from the 2018 cross-sectional multi- indicator cluster survey on 1 026 women aged 15–49 years who had had a live birth in the previous 2 years were used.	Of the pregnant women with HIV, 84.2% received antiretroviral therapy, while 95.5% of their infants received HIV prophylactic treatment. Receiving antiretroviral therapy for the mother (odds ratio (OR) 45.4, 95% confidence interval (CI) 9.6–215.3) and the child (OR 145.7, 95% CI 14.4–1477.4) significantly increased the odds of a negative HIV test result in infants. Conversely, living in the interior decreased the odds (OR 0.2, 95% CI 0.4–0.7) compared with urban living
Karagodina et al. (2023)	To examine the barriers and facilitators of HIV detection, initiation of treatment, and adherence to antiretroviral therapy (ART) among WWID	-in-depth interviews	The ongoing war against Ukraine continues to have a detrimental impact on all aspects of the population's life, particularly affecting WWID
Stijnberg et al. (2022)	To identify sociodemographic and clinical factors influencing HIV diagnosis, linkage to care, antiretroviral therapy (ART) initiation and retention, and viral suppression in Suriname	Applied multiple regression looking into sociodemographic and clinical factors was executed. Indicators evaluated were 'knowing HIV status', people initiating ART, 1-year ART retention, and viral suppression with ART.	Men initiate treatment at a more advanced stage of disease (CD4≤200) than women (47.4% versus 31.4%), leading to higher mortality rates. People from the interior were less likely linked to care (aOR, 0.6; 95% CI, 0.4–0.8) than those from urban regions but did not display significant differences in treatment initiation.

Rozanova et al. (2021)	To examine HIV diagnoses in older people living with HIV (OPWH) in Ukraine, a country emblematic of the EECA region	Analyzed incident HIV diagnoses from 2015–2018 and mortality trends from 2016–2018 for three age groups: 1) 15–24 years; 2) 25–49 years; and 3)50 years. AIDS was defined as CD4<200cells/mL	Newly diagnosed OPWH had the same-year mortality ranging from 3 to 8 times higher than age-matched groups in the Ukrainian general population
Jenkins et al. (2019)	To examine STI risk as a factor of drug misuse and HIV status	Participants completed surveys of risk and behavior and were screened (genital and oral) for chlamydia (CT) and gonorrhea (GC).	Given the reported risky behaviors of study participants, actual STI prevalence was surprisingly low
Herpai et al. (2019)	To describe the historical events leading up to the current conflict and explore its politico-socio-economic consequences as related to HIV risk	Performed Archival research to examine the structural factors related to the current conflict and its politico-socio-economic consequences.	The ensuing conflict has ignited several factors known to contribute to HIV risk such as violence, migration and increased mobilization of armed forces might be expected to exacerbate prevalence
Bello et al. (2018)	To reconstruct the spatiotemporal pattern of spread of “BPANDEMIC” lineage and of non-pandemic subtype B viral lineages circulating in French Guiana and Suriname	Major Guianese/Surinamese BPANDEMIC and BCAR lineages were identified by Maximum Likelihood phylogenetic analysis and the spatiotemporal and demographic parameters estimated using a Bayesian coalescent-based method	Results showed that the HIV subtype B epidemic in French Guiana and Suriname has been driven by multiple active BCAR and BPANDEMIC transmission chains that arose since the middle 1970s onward and operate in both countries simultaneously. Although no significant differences in the epidemic potential of major BCAR and BPANDEMIC lineages were observed, relevant associations between the infecting subtype B lineage and epidemiological and clinical characteristics were detected in French Guiana

Methodology

This study utilizes an exponential smoothing technique to model and forecast future trends of HIV prevalence among individuals aged 15-49 years in Ukraine. 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
$A_t=\mu_t + \rho_t \mathbf{t} + \varepsilon_t$
Smoothing equation
$S_t= \alpha A_t + (1-\alpha) (S_{t-1} + b_{t-1})$
$0<\propto<1$
Trend estimation equation
$b_t= \beta (S_t-S_{t-1}) + (1-\beta)b_{t-1}$
$0<\beta<1$
Forecasting equation
$f_{t+h}= S_t + hb_t$
A_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 Ukraine 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	A
Included Observations	31
Smoothing constants	
Alpha (α) for data	0.700
Beta (β) for trend	0.900
Forecast performance measures	
Mean Absolute Error (MAE)	0.023526
Sum Square Error (SSE)	0.046803
Mean Square Error (MSE)	0.001510
Mean Percentage Error (MPE)	0.049567
Mean Absolute Percentage Error (MAPE)	6.924095

European Science Methodical Journal
ISSN (E): 2938-3641
Volume 2, Issue 4, April- 2024

Residual Analysis for the Applied Model

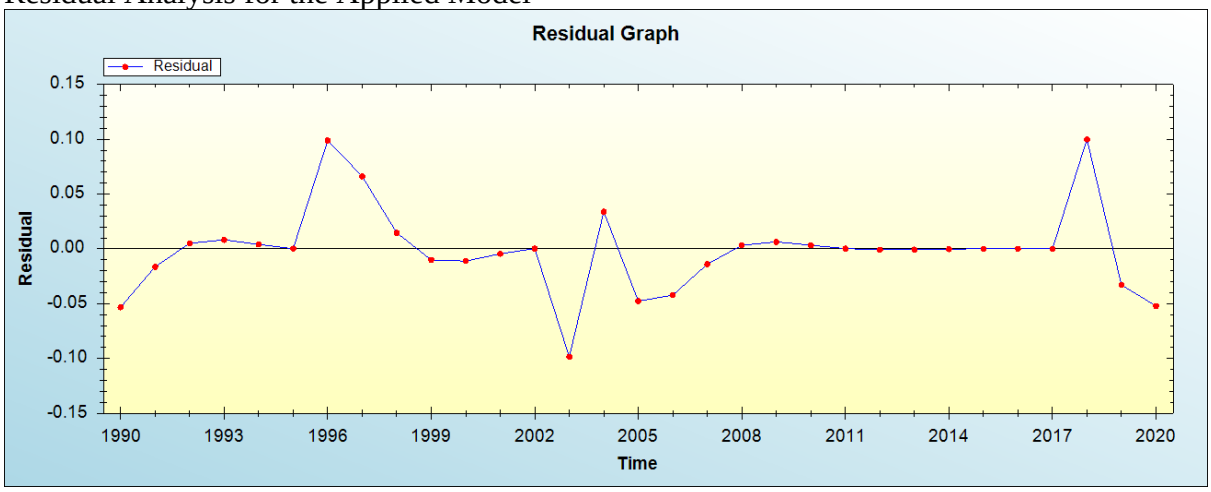

Figure 1: Residual analysis

In-sample Forecast for A

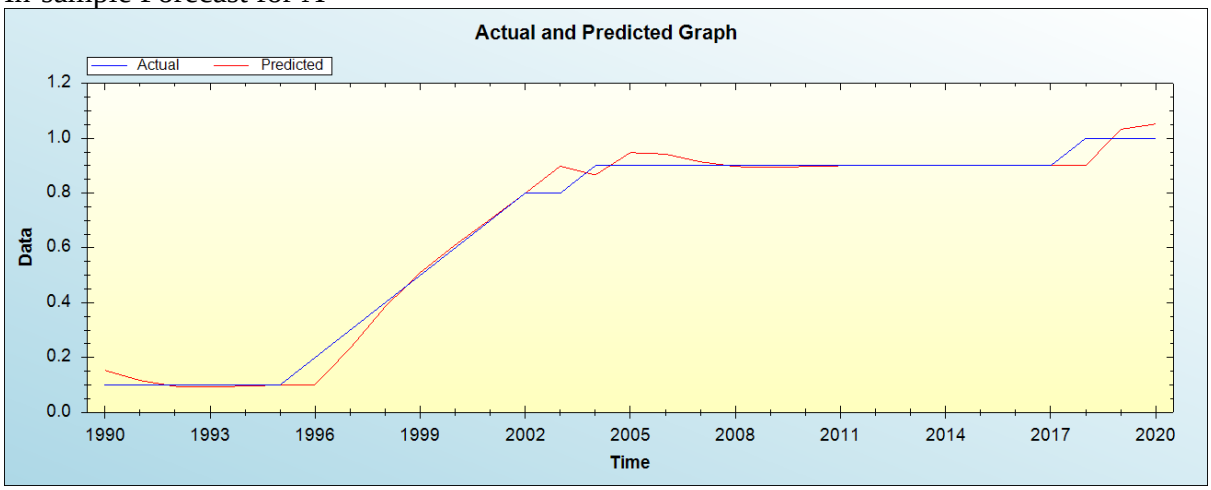

Figure 2: In-sample forecast for the A series

Actual and Smoothed graph for A series

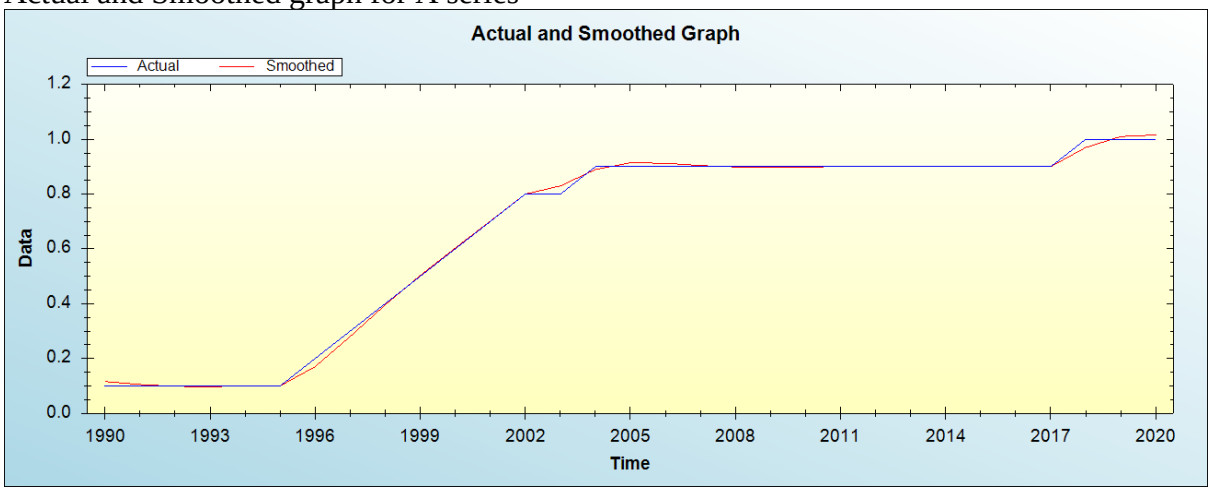

Figure 3: Actual and smoothed graph for A series

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

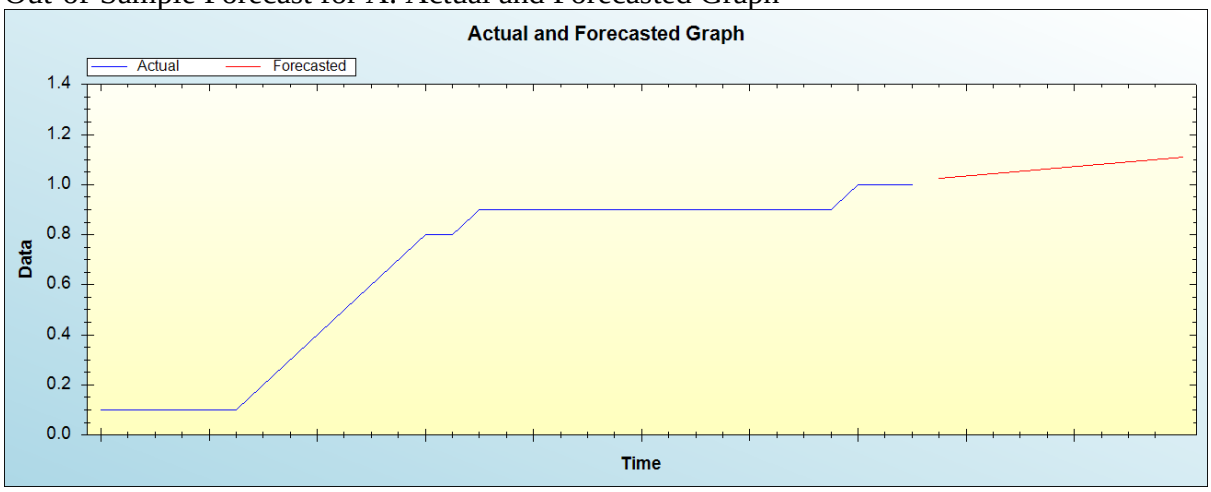

Figure 4: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted HIV prevalence
2021	1.0250
2022	1.0344
2023	1.0438
2024	1.0532
2025	1.0625
2026	1.0719
2027	1.0813
2028	1.0907
2029	1.1001
2030	1.1094

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 on an upward trend but still remain around 1% over the out of sample period.

Policy implication and conclusion

The double exponential smoothing technique projections suggest that annual HIV prevalence among individuals aged 15-49 years will continue on an upward trend but still remain around 1% over the out of sample period. Therefore, there is need to strengthen HIV prevention measures, treatment and scale up HIV testing among this age group. The aim is to curb HIV transmission among high risk groups or key populations.

References

[1] Cahill S & Valadez R (2013). Growing older with HIV/AIDS: new public health challenges. Am J Public Health. 2013; 103(3):e7–e15. https://doi.org/10.2105/AJPH.2012.301161 PMID: 23327276
[2] UNAIDS (2018). Global AIDS Monitoring 2018, Geneva.
[3] UNAIDS (2018). Country Factsheets: Ukraine 2017.

[4] Center for Public Health of the Ministry of Health of Ukraine (2018). HIV/AIDS—Statistics Kyiv, Ukraine. Available from: https://phc.org.ua/en/pages/diseases/hiv_aids/statistics
[5] UNAIDS (2018). Global AIDS Update 2018: Miles to Go. Geneva, Switzerland.
[6] WHO (2009). Priority Interventions: HIV/AIDS Prevention, Treatment, and Care in the Health Sector. Available from: http://www.who.int/hiv/pub/priority_interventions_web.pdf.
[7] Vitek CR, Cakalo JI, Kruglov YV, Dumchev KV, Salyuk TO & Bozicevic I (2014). Slowing of the HIV epidemic in Ukraine: evidence from case reporting and key population surveys, 2005–2012. PLoS One. 9(9):e103657. https://doi.org/10.1371/journal.pone.0103657 PMID: 25251080
[8] USAID (2016). HIV and AIDS Estimates (2016) Ukraine http://www.unaids.org/en/regionscountries/countries/ ukraine2017. Available from: http://www.unaids.org/en/regionscountries/countries/ukraine.
[9] Ministry of Health of Ukraine (2014). Plan for monitoring and evaluation of effectiveness of implementation of the State target social program for prevention and treatment of HIV infection and AIDS for 2014–2018 Kyiv, Ukraine. Available from: https://zakon.rada.gov.ua/rada/show/v0002828-15.
[10] UNAIDS (2014). The Gap Report. Geneva, Switzerland. Available at: http://www.unaids.org/en/media/unaids/contentassets/documents/ unaids publication//unaids_gap_report_en.pdf