International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 7, Issue 2, pp 210-216, February-2023

https://doi.org/10.47001/IRJIET/2023.702034

Forecasting Adolescent Fertility for Mauritania Using Holt's Linear Method

[1]Smartson. P. NYONI, [2]Thabani NYONI

[1]ZICHIRe Project, University of Zimbabwe, Harare, Zimbabwe
[2]Independent Researcher & Health Economist, Harare, Zimbabwe

***Abstract* - This study employs annual time series data of adolescent fertility rate for Mauritania from 1960 to 2020 to predict future trends of adolescent fertility rate 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 adolescent fertility will continue to decline throughout the out of sample period. Therefore, we encourage authorities in Mauritania to promote girl child education, protect sexual and reproductive health rights of women and girls and improve on the accessibility and affordability of adolescent health services.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Despite significant progress made in addressing adverse sexual and reproductive health outcomes, adolescent pregnancy remains a huge public health problem globally and is linked to many adverse maternal and child health outcomes(WHO, 2017). Low and middle income countries continue to bear the largest burden of maternal and under five mortality (WHO, 2017; Conde-Agudelo *et al.* 2005; Mayor, 2004). Persistent challenges such as teenage pregnancies have been identified as contributors to adverse SRH outcomes (WHO, 2017; WHO, 2014;Lyamuya, 2002). Although teenage pregnancy is preventable, the problem continues to take its toll especially in developing countries due to poverty, social norms, lower education level, unemployment, alcohol and drug abuse, incorrect and inconsistent use of condoms and lack of parental guidance (Ochen *et al.* 2019;Galvão*et al.* 2018; Martínez *et al.* 2017; Lemon *et al.* 2017). The 3rdsustainable development goal target 3.7.2 focuses on the provision of sexual and reproductive health services especially that of adolescents. The aim under this goal is to reduce bad obstetric outcomes such as sexually transmitted infections, unsafe abortions, and unintended pregnancies (WHO, 2019; UN, 2016; UN, 2015). The 5thgoal specifically addresses child marriage through elimination of harmful practices and forced child marriage (UN, 2015).

Mauritania has recorded a gradual decline of adolescent fertility over the past decades due to a variety of factors such increase in contraceptive prevalence, improvements in education, SRH knowledge increase and job opportunities. According to the National Statistics Office, as of 2015, 27.8 percent of adolescent girls aged 15-19 years were married or in union, 17.8 percent of women aged 20-24 years were married before the age of 15, and 37 percent of married or in union women aged 20-24 were got married before 18 years of age. In addition 16.7 percent of adolescent girls aged 15-19 had begun child bearing and 38.7 percent of adolescent girls aged 15-19 had unmet needs of family planning. In 2019, the number of new HIV infections among adolescents aged 15-19 was less than 100 (UNAIDS, 2019).Furthermore, adolescent fertility rate in 2019 was 63.9 births per 1000 women aged 15-19 years (UN, 2019).

The aim of this paper is to forecast future trends of adolescent fertility rate in Mauritania using the double exponential smoothing technique. The findings will depict the future burden of adolescent fertility in the out of sample period. This will guide national policies, planning and allocation of resources to teenage pregnancy prevention program activities.

II. LITERATURE REVIEW

Author(s)	Topic	Objectives	Methodology	Findings
Bop et al. (2022)	Determinants of low birth weight in the health district of Bounkiling in	to identify the determinants of LBW	Case-control study	The multivariate analysis showed that the determinants of

ISSN (online): 2581-3048
Volume 7, Issue 2, pp 210-216, February-2023
https://doi.org/10.47001/IRJIET/2023.702034

	Senegal			LBW ($p < 0.05$) were the female sex of the newborn, the Apgar score at birth, the maternal age <=19 years, the household income < 83.96 USD, maternal history of low birth weight and physical labor during pregnancy.
Zegeye et al. (2021)	Modern contraceptive utilization and its associated factors among married women in Senegal: a multilevel analysis	To examine modern contraceptive use and its associated factors among married women in Senegal.	multilevel logistic regression models	both individual and community level factors are significantly associated with modern contraceptive use among married women in Senegal
Ahinkorah et al. (2020)	Prevention of Adolescent Pregnancy in Anglophone Sub-Saharan Africa: A Scoping Review of National Policies	to identify and review national policies on the prevention of adolescent pregnancy in Anglophone sub-Saharan Africa	Systematic review and meta-analysis	Most policies acknowledged the importance of coordination and collaboration among public and private actors. All policies had objectives that addressed adolescent pregnancy but none were measurable or included timeframes.
Weddhi et al. (2019)	Prevalence and factors associated with neonatal mortality among neonates hospitalized at the National Hospital Nouakchott, Mauritania	To investigate factors associated with neonatal mortality at the Referral Hospital in Nouakchott, Mauritania.	cross-sectional study	neonatal mortality remains a significant burden in Mauritania
Yakubu & Salisu	Determinants of adolescent pregnancy in sub-Saharan Africa: a systematic review	To identify factors influencing adolescent pregnancies in sub-Saharan Africa in order to design	Systematic review	High levels of adolescent pregnancies in Sub-Saharan Africa is attributable to multiple factors.

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 7, Issue 2, pp 210-216, February-2023

https://doi.org/10.47001/IRJIET/2023.702034

		appropriate intervention program.		Our study, however, categorized these factors into three major themes; sociocultural and economic, individual, and health service related factors as influencing adolescent pregnancies.

III. METHODOLOGY

This study utilizes an exponential smoothing technique to model and forecast future trends of adolescent fertility rate in Mauritania. 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 double exponential smoothing model is specified as follows:

Model equation

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

Smoothing equation

$L_t = \alpha M_t + (1-\alpha)(L_{t-1}+b_{t-1})$

$0<\alpha<1$

Trend estimation equation

$b_t=\beta (L_t-L_{t-1}) + (1-\beta)b_{t-1}$

$0<\beta<1$

Forecasting equation

$f_{t+h}= L_t + hb_t$

M_t is the actual value of adolescent fertility rate 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

L_t is the exponentially smoothed value of adolescent fertility rate at time t

International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 7, Issue 2, pp 210-216, February-2023
https://doi.org/10.47001/IRJIET/2023.702034

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 slope of the trend at time t

b_{t-1} is the slope of the trend at time t-1

Data Issues

This study is based on annual adolescent fertility rate in Mauritania for the period 1960 – 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.

IV. FINDINGS OF THE STUDY

Exponential smoothing Model Summary

Table 1: ES model summary

Variable	M
Included Observations	61
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.100
Forecast performance measures	
Mean Absolute Error (MAE)	0.646360
Sum Square Error (SSE)	115.319402
Mean Square Error (MSE)	1.890482
Mean Percentage Error (MPE)	-0.064941
Mean Absolute Percentage Error (MAPE)	0.534326

Residual Analysis for the Applied Model

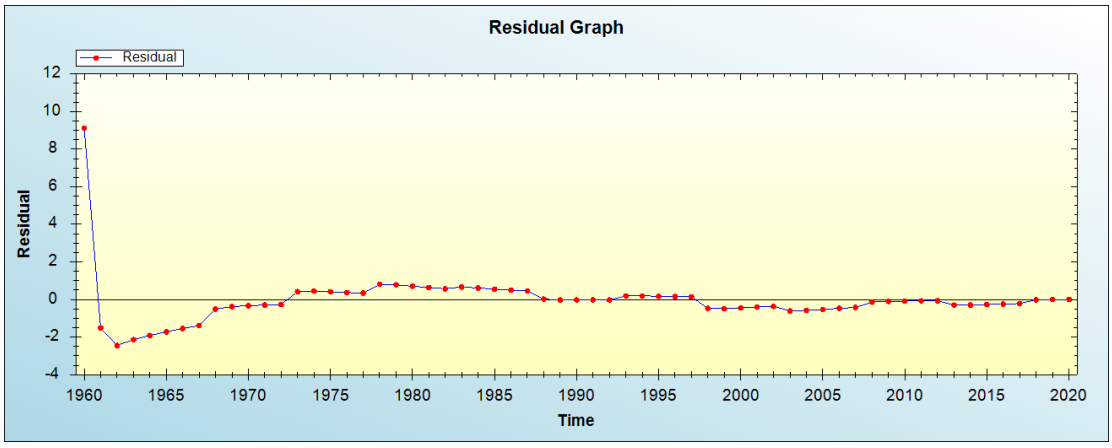

Figure 1: Residual analysis

International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 7, Issue 2, pp 210-216, February-2023
https://doi.org/10.47001/IRJIET/2023.702034

In-sample Forecast for M

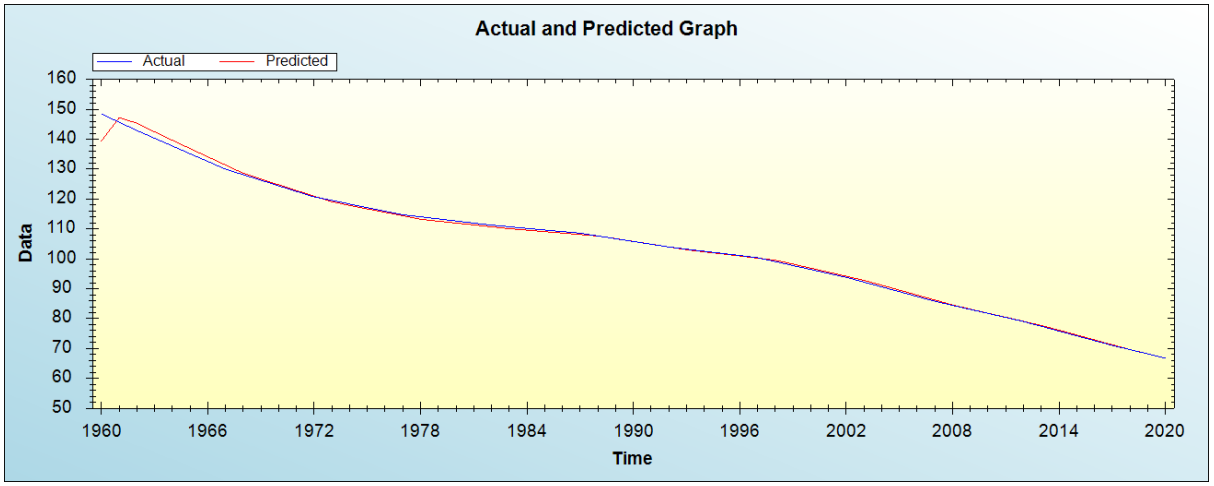

Figure 2: In-sample forecast for the M series

Actual and Smoothed graph for M series

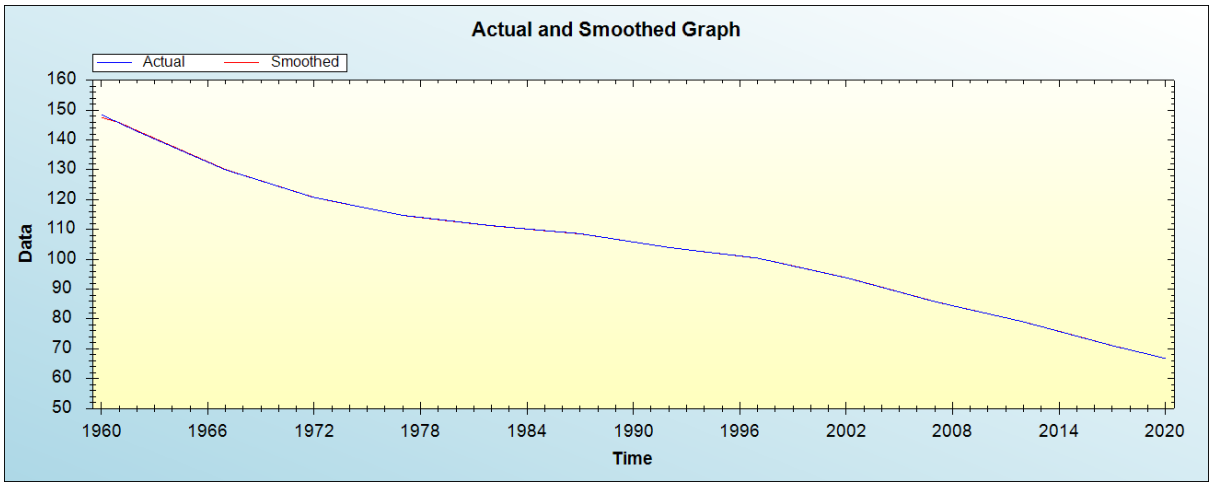

Figure 3: Actual and smoothed graph for M series

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

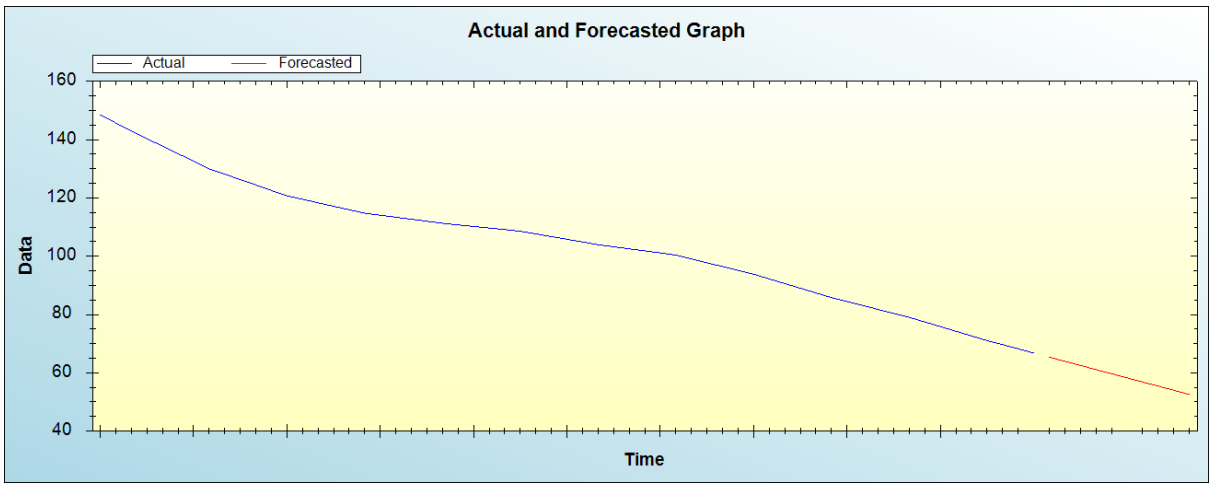

Figure 4: Out-of-sample forecast for M: actual and forecasted graph

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 7, Issue 2, pp 210-216, February-2023

https://doi.org/10.47001/IRJIET/2023.702034

Out-of-Sample Forecast for M: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	65.3630
2022	63.9402
2023	62.5174
2024	61.0946
2025	59.6718
2026	58.2490
2027	56.8262
2028	55.4034
2029	53.9806
2030	52.5578

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 adolescent fertility rate will continue to decline throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

Although teenage pregnancy is avoidable, the problem continues to take its toll especially in developing countries due to poverty, social norms, lower education level, unemployment, alcohol and drug abuse, incorrect and inconsistent use of condoms and lack of parental guidance. Mauritania has recorded a steady decline of adolescent fertility over the past decades due to a variety of factors such as the increase in contraceptive prevalence, improvements in education, SRH knowledge increase and job opportunities. This study applied Holt's double exponential smoothing technique to forecast adolescent fertility for Mauritius. Model projections indicated that adolescent fertility will continue to decline throughout the out of sample period. Therefore, we implore the government to promote girl child education, protect sexual and reproductive health rights of women and girls and improve on the accessibility and affordability of adolescent health services.

REFERENCES

[1] Office National de la Statistique. Enquête par grappes à indicateurs multiples MICS5 2015, Report Final. Nouakchott, Mauritanie: Office National de la Statistique; 2017.

[2] United Nations Department of Economic and Social Affairs, Population Division. World Population Prospects. Fertility data - 2020 - 2025. Available from: https://population.un.org/wpp/Download/Standard/Fertility/.

[3] UNAIDS (2019). Trends of new HIV infections. Available from: http://aidsinfo.unaids.org [Accessed 10th October 2020].

[4] WHO (2017). Adolescents: Health Risks and Solutions. Geneva. http://www.who.int/mediacentre/ factsheets/fs345/en

[5] Mayor S (2004). Pregnancy and childbirth are leading causes of death in teenage girls in developing countries. BMJ. 328(7449):1152.

[6] Conde-Agudelo A., Belizán J.M., and Lammers C (2005). Maternal-perinatal morbidity and mortality associated with adolescent pregnancy in Latin America: crosssectional study. Am J Obstet Gynecol. 192(2):342–9.

[7] WHO (2014). Adolescent Pregnancy. Geneva:http://www.who.int/mediacentre/factsheets/fs364/en/

[8] Lyamuya R (2002). Obstetric outcome among adolescent primigravidae delivering at Muhimbili National Hospital Dar es Salaam. Tanzania: Muhimbili University of Health and Allied Sciences.

[9] Ochen A.M., Chi P.C., and Lawoko S (2019). Predictors of teenage pregnancy among girls aged 13–19 years in Uganda: a community based case‐control study. BMC Pregnancy Childbirth. 19(1):211.

[10] Galvão R.B.F., Figueira C.O., Borovac‐Pinheiro A.., Paulino D.S.M., Faria‐Schützer D.B., and Surita F.G (2018). Hazards of repeat pregnancy during adolescence: a case‐ control study. Rev Bras Ginecol Obstet. 40(8):437–43.

[11] Martínez R.M., Numa T.L., Bernal R.D., de Galvis T.Y., and Sierra G (2017). Sexual abuse and neglect situations as risk factors for adolescent pregnancy. Rev Colomb Psiquiatr. 46(2):74–81.

ISSN (online): 2581-3048
Volume 7, Issue 2, pp 210-216, February-2023
https://doi.org/10.47001/IRJIET/2023.702034

[12] Lemon E., Hennink M., and Can Saquic NA (2017). Pathways to adolescent child‐ bearing among Kaqchikel women in Guatemala. Cult Health Sex. 19(10):1149–64
[13] United Nations (2015). Transforming our world: The 2030 agenda for sustainable development, A/RES/70/1. New York: UN General Assembly.
[14] United Nations (2016). Transforming our world: The 2030 agenda for sustainable development.
[15] World Health Organization (WHO) (2019). SDG 3: Ensure healthy lives and promote wellbeing for all at all ages.

Citation of this Article:

Smartson. P. NYONI, Thabani NYONI, "Forecasting Adolescent Fertility for Mauritania Using Holt's Linear Method" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 7, Issue 2, pp 210-216, February 2023. Article DOI https://doi.org/10.47001/IRJIET/2022.702034

****

