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

ISSN (online): 2581-3048

Volume 7, Issue 2, pp 480-485, February-2023

https://doi.org/10.47001/IRJIET/2023.702080

Illustrating the Suitability of Holt's Double Exponential Smoothing Technique in Forecasting Adolescent Fertility for the West Bank and Gaza

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***Abstract* - Public health policy-making is heavily dependent on reliable and accurate research evidence generated by various authors across the world. This study employs annual time series data of adolescent fertility rate for the West Bank and Gaza from 1960 to 2020 to predict future trends of adolescent fertility 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 0.4 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility will to decline from 49 births per 1000 women aged 15-19 years in 2021 to around 40 births per 1000 women aged 15-19 years by the end of 2030. Therefore, we encourage authorities in the West Bank and Gaza to relentlessly support girl child education and women empowerment, protect sexual and reproductive health rights of women and girls and offer affordable and accessible adolescent health services.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

The delivery of health care services during the time of conflict is difficult due to the incessant fighting and disruption of services, and sometimes destruction of critical infrastructure. The negative impacts of war are far reaching and can spill over to future generations who have a tendency to inherit long standing unresolved conflicts. The State of Palestine is a clear example of such conflict affected regions and has been affected by Israel occupation. In the occupied Palestinian territory the continued Israeli military occupation, the Separation Wall, Israeli army checkpoints, and the restrictions of the movement of people and goods have limited the access of Palestinians to healthcare services (Giacaman *et al.* 2009). This conflict has attracted international attention because it has been ongoing for decades now with variations in the intensity and nature of the conflict (Keelan, 2016;Giacaman*et al.* 2009;Batniji*et al.* 2009).The key determinant of access to health care services are the geographic divisions and checkpoints that can be either permanent or temporarily erected at the time of heightened conflict. Access to East Jerusalem, where the major Palestinian hospitals are located, is largely restricted to local residents with an Israeli-issued Jerusalem identity card (OCHA, 2016). This division of the territory makes movement within the West Bank very difficult even if there is no violent conflict (Tiziana *et al.* 2019).In addition, political infighting in the State of Palestine is another thorn on the flesh. Agenda 2030 for sustainable development was crafted to address such problems with the aim of establishing peace, security and creating an enabling environment for economic development and growth (UN, 2016; UN, 2015). In addition, target 3.7 focuses on the provision of adequate and accessible sexual and reproductive health services including that of adolescents. SDG 5 has a mandate of addressing child marriages by eliminating all harmful practices that promote child marriage and abuse of women. Peace and stability is an essential factor in the State of Palestine so that the country can achieve its national goals including addressing teenage pregnancy and child marriages.

This paper applies the double exponential smoothing technique to model and forecast future trends of adolescent fertility for the state of Palestine (West Bank and Gaza). The findings are expected to depict the future burden of adolescent fertility in the country. This will provide guidance during planning and allocation of resources to teen pregnancy prevention programs.

II. LITERATURE REVIEW

Author(s)	Study area	Topic	Methodology	Main finding(s)
Al-Jermmy et al.(2022)	Hodeida, Yemen	Prevalence and Correlates of	Cross- sectional study	The prevalence of anemia was 37.8%.

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		Anemia among Adolescents Living in Hodeida, Yemen		Female gender, khat chewing, excessive menstruation, and experiencing headaches, fatigue, or dizziness were independent predictors of anemia.
Leone et al. (2019)	Palestine	Maternal and child access to care and intensity of conflict in the occupied Palestinian territory: a pseudo longitudinal analysis (2000–2014)	Cross-sectional study	Preventative services (ANC and vaccinations) are the most affected by conflict
Ghouth et al. (2017)	Hadramout, Yemen	Profile of Teenage Pregnancy in Hadramout, Yemen	cross-sectional study	Teenage pregnancy was associated with maternal anemia and high perinatal mortality rate **(134 per 1000 live births)**
Sama et al.(2017)	Sub-Saharan Africa	Prevalence, predictors and adverse outcomes of adolescent pregnancy in sub-Saharan Africa: a protocol of a systematic review	Systematic review	High rates of teenage pregnancy have been reported with a resultant significant morbidity and mortality. All these are happening within the backdrop of high rates sexually transmitted diseases (STDs
Omoro et al.(2017)	Rural Western Kenya	Teen pregnancy in rural western Kenya: a public health issue	Cross-sectional study	Factors which increased the risk of teenage pregnancy were older teens, teens who were ever married or cohabiting, lower educational level and teens who experienced partner violence in the last 12 months

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III. METHODOLOGY

This study utilizes an exponential smoothing technique to model and forecast future trends of adolescent fertility rate for the West Bank and Gaza. 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

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

Smoothing equation

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

$0<\alpha<1$

Trend estimation equation

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

$0<\beta<1$

Forecasting equation

$f_{t+h} = L_t + \mathrm{h} b_t$

W_t is the actual adolescent fertility rate at time period 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 period 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 at time t

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

Data Issues

This study is based on annual adolescent fertility rate in West Bank and Gaza 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.

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IV. FINDINGS OF THE STUDY

Exponential smoothing Model Summary

Table 1: ES model summary

Variable	W
Included Observations	61
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.400
Forecast performance measures	
Mean Absolute Error (MAE)	1.404495
Sum Square Error (SSE)	419.374088
Mean Square Error (MSE)	6.874985
Mean Percentage Error (MPE)	0.075512
Mean Absolute Percentage Error (MAPE)	1.477579

Residual Analysis for the Applied Model

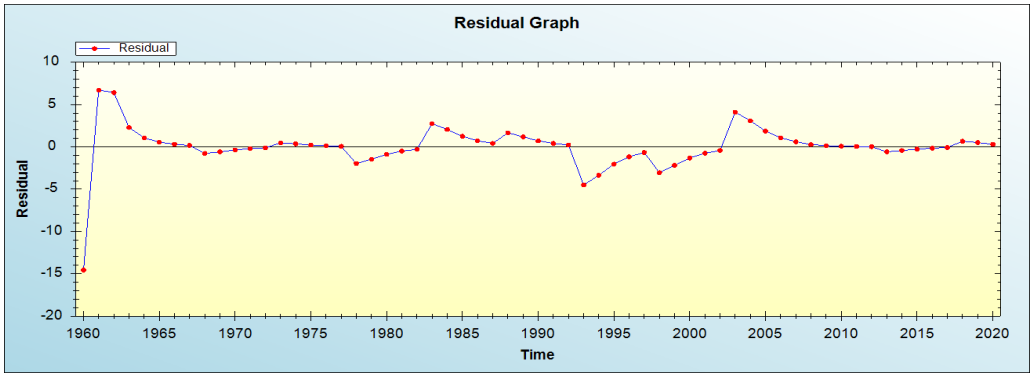

Figure 1: Residual analysis

In-sample Forecast for W

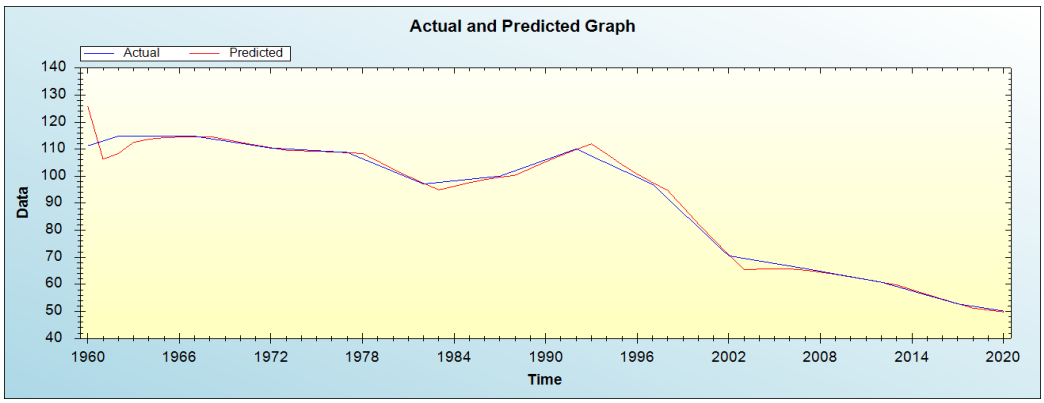

Figure 2: In-sample forecast for the W series

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Actual and Smoothed graph for W series

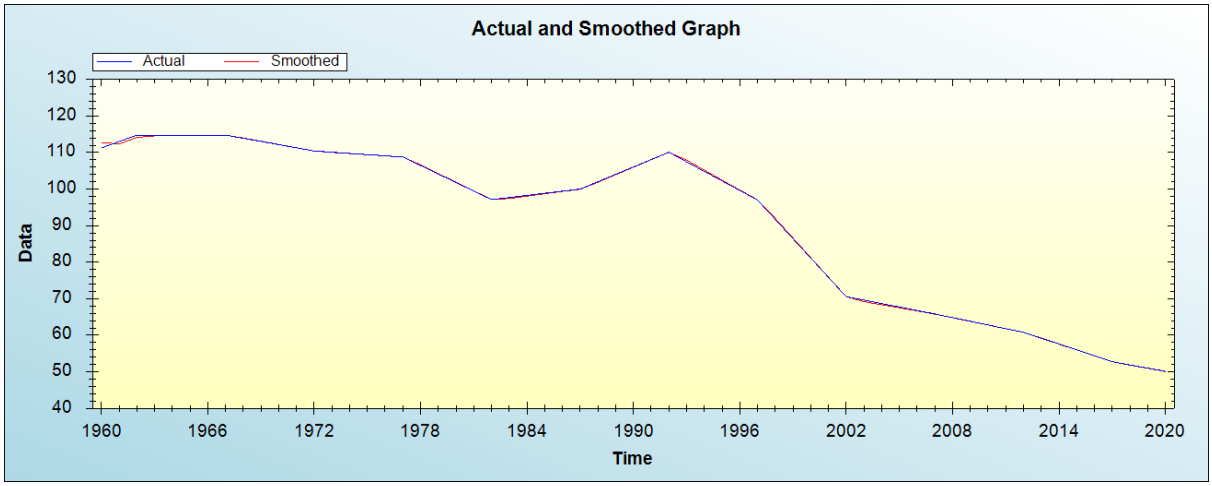

Figure 3: Actual and smoothed graph for W series

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

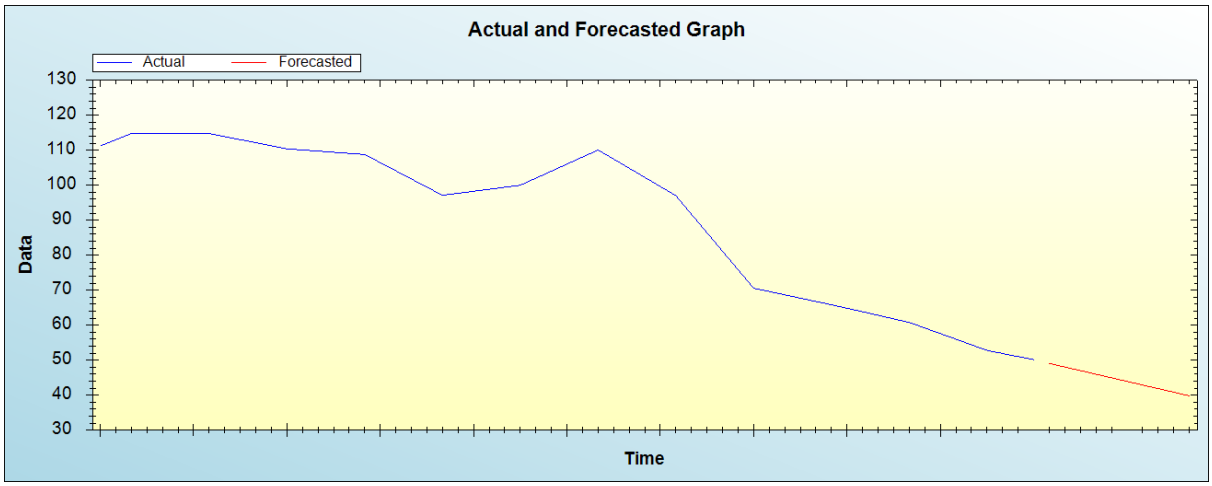

Figure 4: Out-of-sample forecast for W: actual and forecasted graph

Out-of-Sample Forecast for W: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	49.0561
2022	48.0265
2023	46.9970
2024	45.9674
2025	44.9379
2026	43.9083
2027	42.8788
2028	41.8492
2029	40.8197
2030	39.7902

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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 drop throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Addressing challenges being faced by adolescents is anticipated to reduce teenage pregnancy and its complications. The decline in adolescent fertility in the West Bank and Gaza reflects improvements in education, increase in contraceptive prevalence and knowledge on comprehensive sexual and reproductive health. This paper applied the double exponential smoothing technique to forecast adolescent fertility for the West Bank and Gaza. Research findings suggested that adolescent fertility will decline throughout the out of sample period from 49 births per 1000 women aged 15-19 years in 2021 to around 40 births per 1000 women aged 15-19 years by the end of 2030. Hence, authorities in the West Bank and Gaza are encouraged to adopt our 3-fold policy recommendations which are stated as follows:

i) Continuously support girl child education and women empowerment
ii) To relentlessly uphold sexual and reproductive health rights of women and girls
iii) To ensure availability of affordable and accessible adolescent sexual and reproductive health services.

REFERENCES

[1] Giacaman R., Khatib R., Shabaneh L., Ramlawi A., Sabri B., Sabatinelli G (2009). Health status and health services in the occupied Palestinian territory. Lancet. 373(9666):837–49.
[2] Batniji R., Rabaia Y., Nguyen–Gillham V., Giacaman R., Sarraj E., Punamaki (2009). Health as human security in the occupied Palestinian territory. Lancet. 373(9669):1133–43.
[3] Keelan E (2016). Medical Care in Palestine: working in a conflict zone. Ulster Med J. 85(1):3–7.
[4] OCHA (2016). Movement and access restrictions. https://www.ochaopt.org/ content/2015-overview-movement-and-access-restrictions
[5] Tiziana Leone., Diego Alburez-Gutierrez., Rula Ghandour., Ernestina Coast., and Rita Giacaman (2019). Maternal and child access to care and intensity of conflict in the occupied Palestinian territory: a pseudo longitudinal analysis (2000–2014), Conflict and Health (2019) 13:36 https://doi.org/10.1186/s13031-019-0220-2
[6] United Nations. (2015). transforming our world: The 2030 agenda for sustainable development, A/RES/70/1. New York: UN General Assembly.
[7] United Nation (2016). Transforming our world: The 2030 agenda for sustainable development.

Citation of this Article:

Smartson. P. NYONI, Thabani NYONI, "Illustrating the Suitability of Holt's Double Exponential Smoothing Technique in Forecasting Adolescent Fertility for the West Bank and Gaza" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 7, Issue 2, pp 480-485, February 2023. Article DOI https://doi.org/10.47001/IRJIET/2022.702080

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