Demonstrating How to Use Forecasts Generated by Holt's Linear Method to Craft Appropriate and Evidence Based Neonatal Healthcare Policies in Libya

[1]Dr. 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 on neonatal mortality rate (NMR) for Libya from 1972 to 2021 to predict future trends of NMR over the period 2022 to 2030. Holt's linear method (HLM) was used in this study. Optimal values of smoothing constants α and β are 0.9 and 0.1 respectively based on minimum MSE. The study findings suggest that neonatal mortality will continue to decline to reach levels below 5 deaths per 1000 live births by the end of 2030.Therefore, it is important for the Libyan authorities to focus on rebuilding health infrastructure and capacitating primary healthcare facilities so that they are able to offer basic &emergency obstetric and essential neonatal care.**

Keywords: ARIMA, Forecasting, NMR.

I. INTRODUCTION

Libya is currently facing a political conflict with armed groups battling to gain control of the state. The ongoing impasse has negative impact on the health delivery system particularly maternal and child health (MNCH) service delivery. Displacement of people and damage to infrastructure may shutter the country's quest to achieve set targets of sustainable development goals (SDGs) by the end of 2030.Sub-Saharan countries which have been witnessing instability mostly are the ones which have been reporting high numbers of maternal and under 5 mortality rates due to poor infrastructure, limited medical supplies to war or conflict zones and mass exodus of skilled personnel. This paper aims to model and project future trends of neonatal mortality rate (NMR) for Libya using Holt's linear method, an ideal tool for analyzing linear data. The statistical model is an underutilized surveillance tool in public health programming especially in low and middle income countries. This study being the first of its kind in Libya will facilitate planning, decision making and allocation of resources towards maternal and child health programs. Furthermore, the findings are envisioned to assist in tracking the progress towards achieving the set SDG 3 targets 3.1 & 3.2 by 2030 which aim to reduce maternal mortality ratio and neonatal mortality rate to less than 70 maternal deaths per 100 000 live births and at least 12 neonatal deaths per 1000 live births respectively (Yaya *et al*. 2020; UN, 2020; UNICEF, 2019WHO, 2019; IOM, 2019; UNFPA, 2018, UN, 2016; UN, 2015).

II. LITERATURE REVIEW

Under five mortality is a common finding in Sub-Saharan Africa hence several previous studies in the region extensively examined the determinants of neonatal mortality, however forecasting studies are rare. Nove *et al.*(2020)estimated the potential impact of midwives on reducing maternal and neonatal deaths and stillbirths under several intervention coverage scenarios. The study used the Lives Saved Tool as a model to estimate the number of deaths that would be averted by 2035, if coverage of health interventions that can be delivered by professional midwives were scaled up in 88 countries that account for the vast majority of the world's maternal and neonatal deaths and stillbirths. The findings of the study indicated that a substantial increase in coverage of midwife-delivered interventions could avert 41% of maternal deaths, 39% of neonatal deaths, and 26% of stillbirths, equating to 2·2 million deaths averted per year by 2035.Yaya *et al.*(2019) investigated the changes in maternal healthcare services utilization between 2007 and 2016 in Post war Liberia. The cross-sectional study utilized 2007 and 2013 Liberia Demographic and Health Survey (LDHS) and the 2016 Malaria Indicator Survey. The outcomes of interest were: place of delivery and antenatal care visits. Univariate analysis was conducted using percentages and means (standard deviations) and multiple binary multivariable logistic models were used to examine the factors associated with the outcome variables. The study findings indicated that key maternal healthcare utilization indicators have improved substantially, especially facility-based delivery. However, a large proportion of women remain deprived of these life-saving health services in the post-war era.In a 2018 study Merabet *et al* described neonatal deaths and identified their risk factors at the Al Hoceima Provincial Hospital. The study findings suggested that

neonatal mortality in the Al Hoceima hospital remains high and is mainly related to the course of pregnancy and childbirth as well as the characteristics of the newborn at birth. Another study by Brault *et al.*(2018) examined factors contributing to the reductions in under-five mortality in Postwar Liberia by conducting a case study mixed methods approach drawing on data from quantitative indicators, national documents and qualitative interviews were used to describe factors that enabled Liberia to rebuild their maternal, neonatal and child health (MNCH) programmes and reduce under-five mortality following the country's civil war. The findings revealed that three main factors contributed to the reduction in under-five mortality: national prioritization of MNCH after the civil war; implementation of integrated packages of services that expanded access to key interventions and promoted inter-sectoral collaborations; and use of outreach campaigns, community health workers and trained traditional midwives to expand access to care and improve referrals.

III. METHODOLOGY

This study employs an exponential smoothing technique to model and forecast future trends of neonatal mortality rate in Libya. 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

$$Y_t = \mu_t + \rho_t \mathbf{t} + \varepsilon_t \dots \dots \quad [1]$$

Smoothing equation

$$L_t = \alpha Y_t + (1-\alpha)(L_{t-1} + b_{t-1}) \dots \dots \quad [2]$$

$0 < \alpha < 1$

Trend estimation equation

$$b_t = \beta (L_t - L_{t-1}) + (1-\beta)b_{t-1} \dots \dots \quad [3]$$

$0 < \beta < 1$

Forecasting equation

$$f_{t+h} = L_t + h b_t \dots \dots \quad [4]$$

Y_t is the actual neonatal mortality 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**

$\mathbf{t}$ is the trend component of the time series

L_t is the exponentially smoothed value of neonatal mortality rate 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 at time t

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

Data Issues

This study is based on annual neonatal mortality rate in Libya for the period 1972 – 2021. The out-of-sample forecast covers the period 2022 – 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	Y
Included Observations	50
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.100
Forecast performance measures	
Mean Absolute Error (MAE)	0.303071
Sum Square Error (SSE)	19.614958
Mean Square Error (MSE)	0.392299
Mean Percentage Error (MPE)	0.838826
Mean Absolute Percentage Error (MAPE)	1.796242

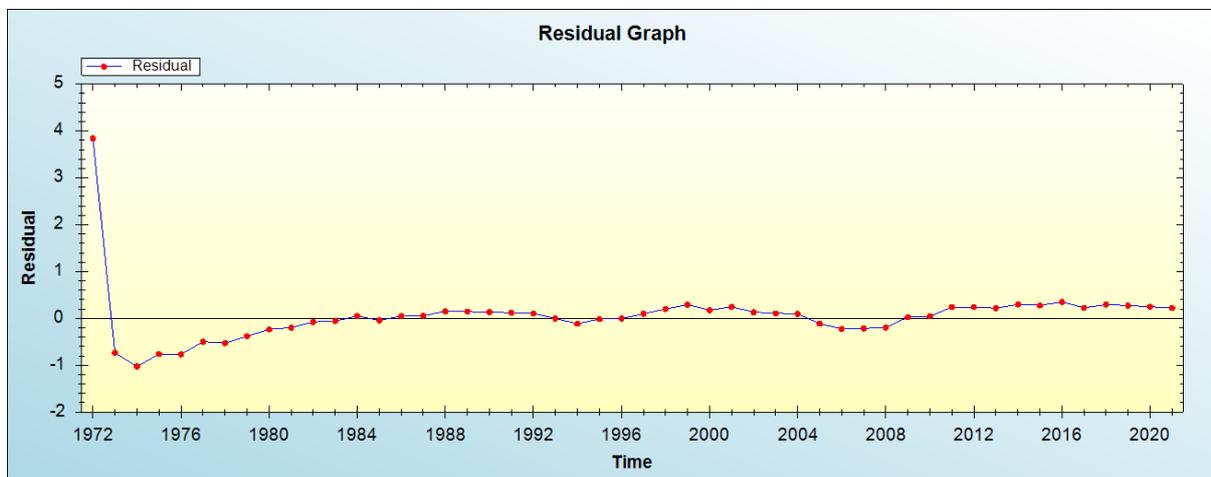Residual Analysis for the Applied Model

Figure 1: Residual analysis

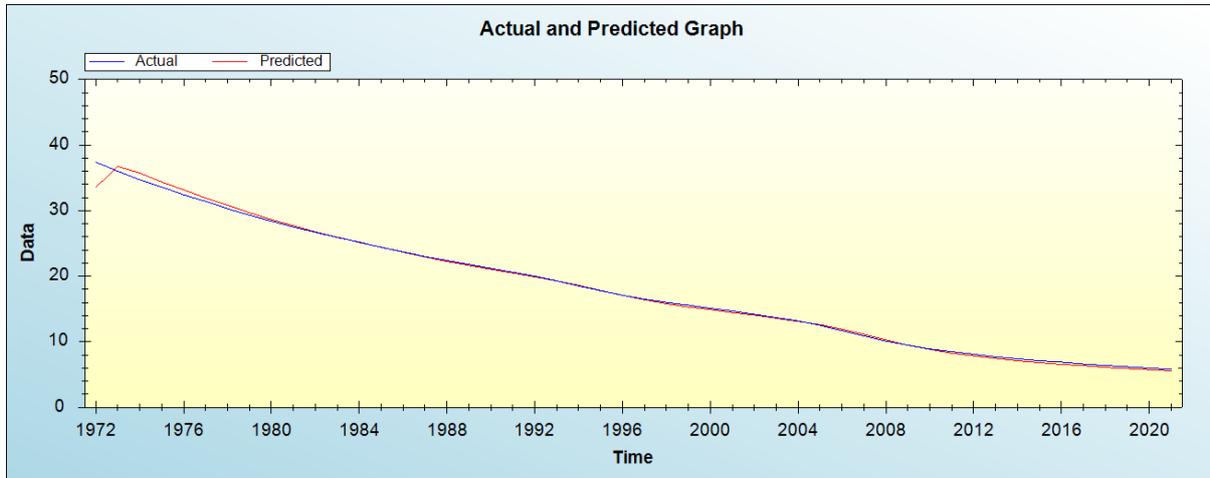In-sample Forecast for Y

Figure 2: In-sample forecast for the Y series

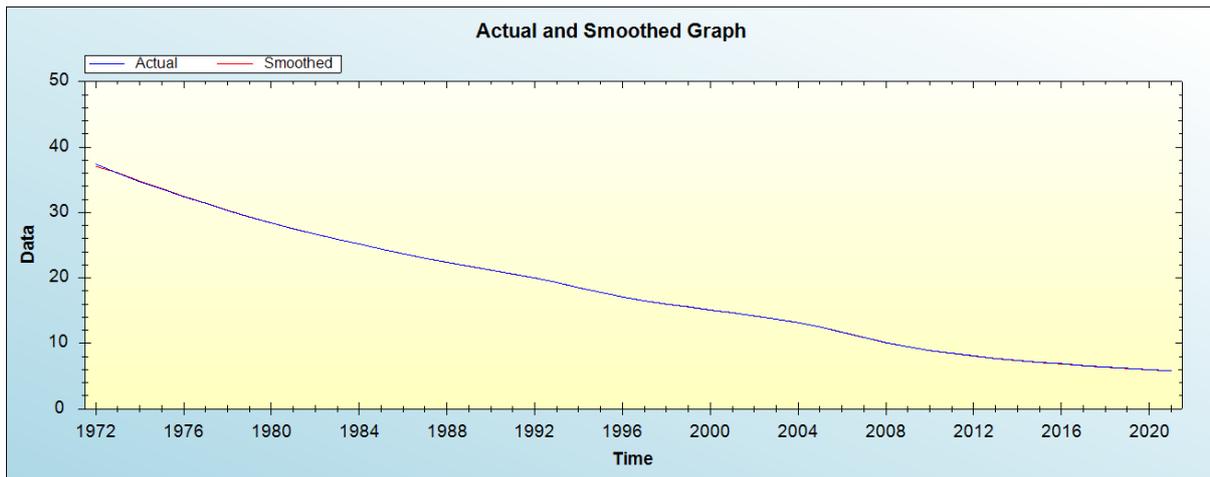Actual and Smoothed graph for Y series

Figure 3: Actual and smoothed graph for Y series

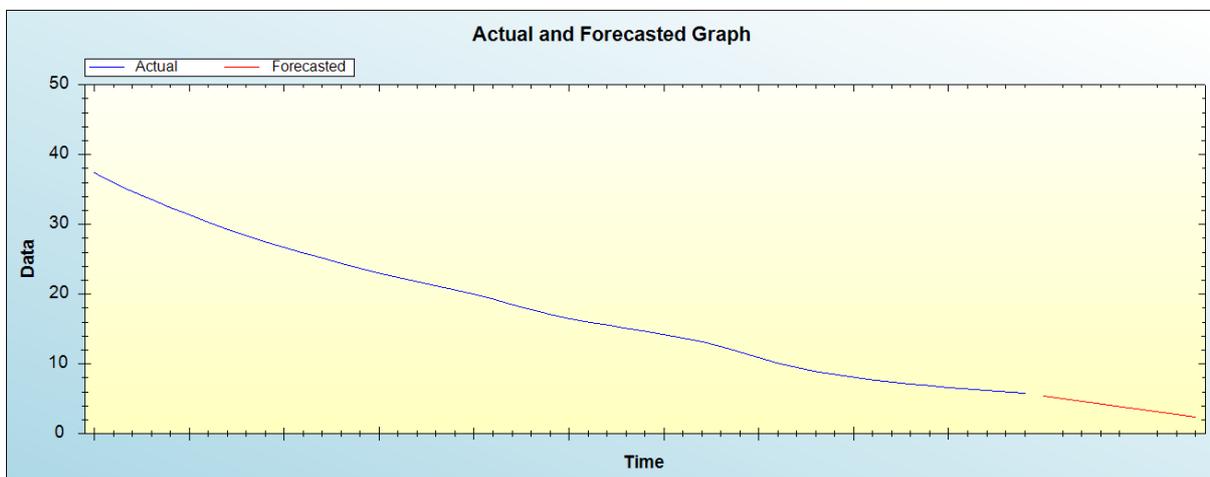Out-of-Sample Forecast for Y: Actual and Forecasted Graph

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

Out-of-Sample Forecast for Y: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted neonatal mortality rate
2022	5.4000
2023	5.0222
2024	4.6444
2025	4.2667
2026	3.8889
2027	3.5111
2028	3.1334
2029	2.7556
2030	2.3778

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 neonatal mortality will continue to decline to reach levels below 5 deaths per 1000 live births by the end of 2030.

V. POLICY IMPLICATION & CONCLUSION

Libya may reverse the gains made so far in achieving set SDG-3 targets if the civil conflict persists in the war tone country. It is high time for the authorities to prioritize maternal and child health issues to effectively reduce maternal and neonatal deaths. Nation building and restoration is the foundation for achieving all SDG targets including SDG-3 target 3.1 and 3.2 that aim to reduce maternal mortality to less 70 maternal deaths per 100 000 live births and neonatal mortality to at least 12 per 1000 live births by the end of 2030. This paper predicts future trends of NMR for Libya using **HLM** and the findings indicate that neonatal mortality will continue to decline to reach levels below 5 deaths per 1000 live births by the end of 2030. Therefore it is important for the Libyan authorities to focus on rebuilding health infrastructure and capacitating primary healthcare facilities so that they can offer basic & emergency obstetric and essential neonatal care.

REFERENCES

[1] UNICEF. Child Mortality 2019. New York: United Nations Children's Fund; 2019

[2] Yaya S., Zegeye B., Ahinkorah B O., Ameyaw E K., Seidu A and Shibre G (2020). Time trends, geographical, socio-economic, and gender disparities in neonatal mortality in Burundi: evidence from the demographic and health surveys, 2010–2016,Archives of Public Health, 78, 115, 1-10.

[3] UN Population Fund (2018). UNFPA Midwifery Programme strategy. New York: UN Population Fund.

[4] WHO (2019). Strengthening quality midwifery education for universal health coverage 2030: framework for action. Geneva: World Health Organization.

[5] International Confederation of Midwives (IOM) (2019). Essential competencies for midwifery practice: 2018 update. The Hague: International Confederation of Midwives.

[6] UN (2020) sustainable development goals. https://www.un.org/sustainabl development/development-agenda

[7] United Nation (2016). Transforming our world: The 2030 agenda for sustainable development.

[8] United Nations. (2015). transforming our world: The 2030 agenda for sustainable development, A/RES/70/1. New York: UN General Assembly.