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Employing ARIMA Model Forecasts to Inform Maternal and Neonatal Healthcare Initiatives in Egypt

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***Abstract* - The success of maternal and child health programs is dependent on political commitment, availability of resources and an enabling environment with peace and security. In addition sustainable agricultural practices, poverty reduction, sustainable governance and prevention of environmental degradation are key elements to achieve universal health coverage. Focusing on the reduction of neonatal mortality is crucial at this juncture as evidence indicates that the decline of neonatal deaths especially in low-middle income countries is not sufficient enough to reach the desired target by the end of 2030.This study uses annual time series data on neonatal mortality rate (NMR) for Egypt from 1960 to 2019 to predict future trends of NMR over the period 2020 to 2030. Unit root tests have shown that the series under consideration is an I (1) variable. The optimal model based on AIC is the ARIMA (3,1,0) model. The ARIMA model predictions indicate that neonatal mortality will gradually decline from around 11 to around 4 deaths per 1000 live births in the out of sample period. Therefore, we encourage Egyptian authorities to address local factors that contribute to deaths among neonates. Particular attention should be given to regular training of healthcare workers on essential newborn care, health education among communities to address various issues which contribute to neonatal mortality, and medical staff retention at all levels of healthcare.**

Keywords: ARIMA, Forecasting, NMR.

I. INTRODUCTION

A neonatal death is defined as the death of a newborn during the first 28 days of life after birth. The common causes of mortality during this critical period include asphyxia, prematurity, infections, respiratory distress syndrome and congenital anomalies. Global neonatal mortality rate (NMR) dropped from 37 per 1000 live births in 1990 to 19 per 1000 live births in 2016 (Alkema *et al.* 2014; UNIGME report, 2014). Neonatal mortality has been found to vary by region with Sub-Saharan Africa and Southern Asia reporting the highest NMR (UNIGME report, 2017). Egypt's maternal mortality ratio (MMR) declined from 174 per 100 000 in 1992 to 37 in 2017 (WHO *et al*. 2019; Campbell *et al*. 2005). During the same period NMR dropped from 31 per 1000 live births to 12 per 1000 live births (UNICEF, 2019). This shows that Egypt has done very well in improving maternal and child health. This paper aims to model and project future trends of NMR for Egypt using the popular Box-Jenkins ARIMA technique which is a useful tool for modelling linear data (Nyoni, 2018, Box & Jenkins, 1970). This is envisioned to be used as a surveillance tool for the early detection of abnormal trends of NMR so that appropriate measures can be put into place to keep the country on track of achieving the set SDG3 target 3.2 of at least 12 neonatal deaths per 1000 live births by 2030.

II. LITERATURE REVIEW

Tesema & Worku (2021) investigated the individual and community-level determinants of neonatal mortality in the Emerging regions of Ethiopia. Secondary analysis of the data from the 2016 Ethiopian Demographic and Health Survey (EDHS) was carried out and the findings indicated that Neonatal mortality in Emerging regions of Ethiopia was unacceptably high.Garcia *et al*.(2020)described changes over time in the use of childbirth care in Egypt, focusing on location and sector of provision (public versus private) and the content of immediate postpartum care. The authors used five Demographic and Health Surveys conducted in Egypt between 1995 and 2014 to explore national and regional trends in childbirth care. The study findings suggested that Egypt achieved large increases in the percentage of women delivering in facilities and with skilled birth attendants. However, most women and newborns did not receive essential elements of high quality immediate postpartum care. A cross-sectional study was conducted by Weddih *et al.*(2019)to examine factors associated with neonatal mortality at the Referral Hospital in Nouakchott, Mauritania between January 2013 and December 2013 and included neonatal patients hospitalized at the National Referral Hospital (NRH). Data were collected by reviewing the medical charts and through questionnaires administered to the parents and logistic regression was used for analysis. The findings of this study revealed that low birth weight, hypothermia, and

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birth outside the NRH were independently associated with neonatal deaths. Merabet *et al*.(2018) described neonatal deaths and identified their risk factors at the Al Hoceima Provincial Hospital. The findings revealed 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. In another study in Morocco, Doukkali *et al*.(2016) examined the characteristics of pregnant women in the hospital center in the urban commune of Missour as well as the morphological data of the newborn and identified the risk factors implicated in neonatal morbidity. The retrospective study collected data from records of women who gave birth in the Maternity of Missour during 2012. The study concluded that the risk factors associated to neonatal morbidity are gestational age and weight birth (in 50% of the cases, 85.7% of deaths are premature infants less than 1500 g). 14 (1.2%) were referred and 11 (0.9%) congenital malformations.

III. METHODOLOGY

The Box – Jenkins Approach

The first step towards model selection is to difference the series in order to achieve stationarity. Once this process is over, the researcher will then examine the correlogram in order to decide on the appropriate orders of the AR and MA components. It is important to highlight the fact that this procedure (of choosing the AR and MA components) is biased towards the use of personal judgement because there are no clear – cut rules on how to decide on the appropriate AR and MA components. Therefore, experience plays a pivotal role in this regard. The next step is the estimation of the tentative model, after which diagnostic testing shall follow. Diagnostic checking is usually done by generating the set of residuals and testing whether they satisfy the characteristics of a white noise process. If not, there would be need for model re – specification and repetition of the same process; this time from the second stage. The process may go on and on until an appropriate model is identified (Nyoni, 2018). The Box – Jenkins technique was proposed by Box & Jenkins (1970) and is widely used in many forecasting contexts.

Data Issues

This study is based on annual NMR in Egyptfor the period 1960 to 2019. The out-of-sample forecast covers the period 2020 to 2030. All the data employed in this research paper was gathered from the World Bank online database.

Evaluation of ARIMA Models

Criteria Table

Table 1: Criteria Table

Model Selection Criteria Table			
Dependent Variable: D(X)			
Date: 01/22/22 Time: 13:42			
Sample: 1960 2019			
Included observations: 59			
Model	LogL	AIC*	BIC
(3,0)(0,0)	41.916082	-1.251393	-1.075330
(2,2)(0,0)	42.275749	-1.229686	-1.018411
(2,1)(0,0)	41.040953	-1.221727	-1.045665
(4,1)(0,0)	43.003764	-1.220467	-0.973979
(4,0)(0,0)	41.958850	-1.218944	-1.007669
(3,1)(0,0)	41.941486	-1.218355	-1.007080
(5,0)(0,0)	42.412877	-1.200437	-0.953949
(5,3)(0,0)	45.383813	-1.199451	-0.847326
(3,2)(0,0)	42.345003	-1.198136	-0.951648
(2,3)(0,0)	42.313838	-1.197079	-0.950592
(1,5)(0,0)	42.964260	-1.185229	-0.903529

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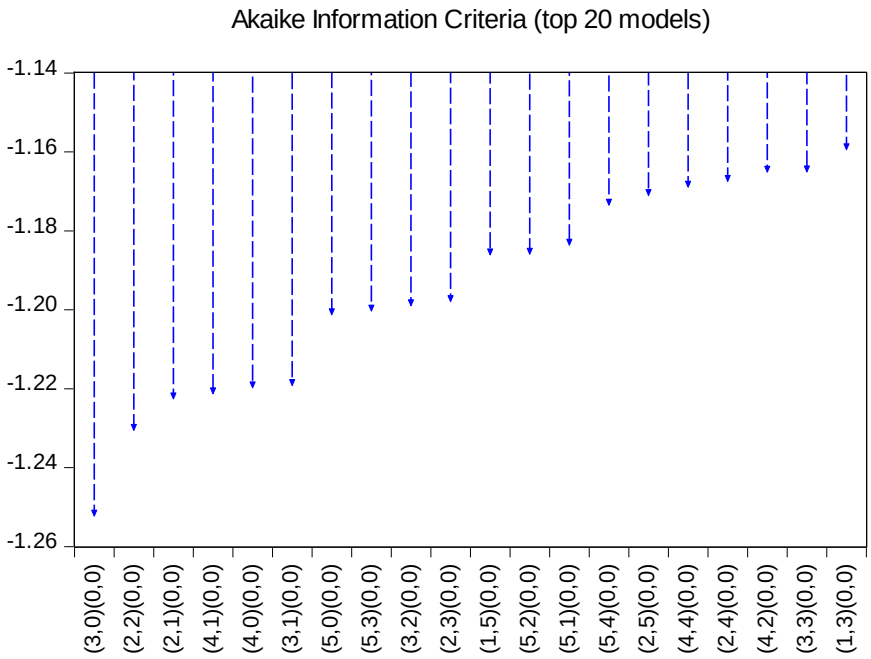
(5,2)(0,0)	43.958799	-1.185044	-0.868132
(5,1)(0,0)	42.891376	-1.182759	-0.901059
(5,4)(0,0)	45.592957	-1.172643	-0.785305
(2,5)(0,0)	43.520789	-1.170196	-0.853284
(4,4)(0,0)	44.458403	-1.168081	-0.815956
(2,4)(0,0)	42.415920	-1.166641	-0.884941
(4,2)(0,0)	42.345331	-1.164249	-0.882549
(3,3)(0,0)	42.345167	-1.164243	-0.882543
(1,3)(0,0)	40.178062	-1.158578	-0.947303

Criteria Graph

Figure 1: Criteria Graph



Forecast Comparison Graph

Figure 2: Forecast Comparison Graph

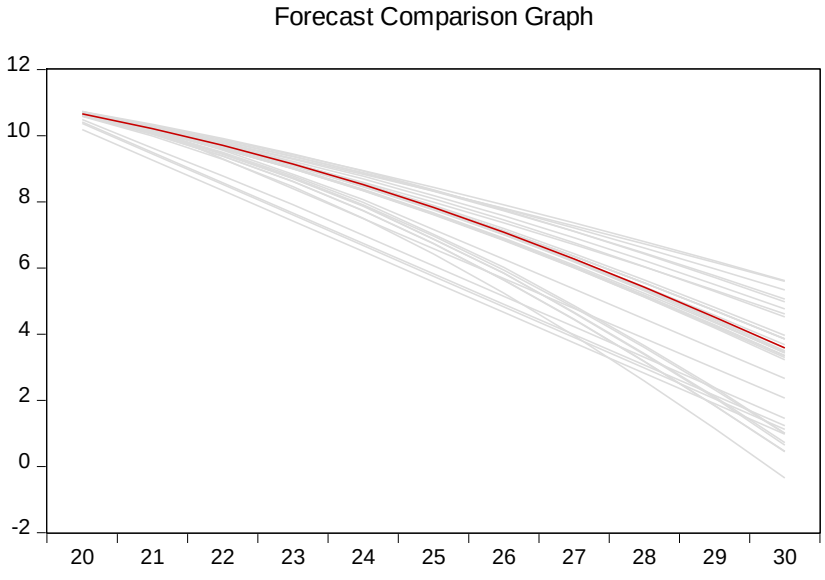


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Table 1 and Figure 1 indicate that the optimal model is the ARIMA (3,1,0) model. Figure 2 is a combined forecast comparison graph showing the out-of-sample forecasts of the top 25 models evaluated based on the AIC criterion. The red line shows the forecast line graph of the optimal model, the ARIMA (3,1,0) model.

IV. RESULTS

ARIMA () Model Forecast

Tabulated Out of Sample Forecasts

Table 2: Tabulated Out of Sample Forecasts

Year	Forecasts
2020	10.66173419232669
2021	10.20941935648921
2022	9.70397538087197
2023	9.144055055488908
2024	8.519520911168274
2025	7.83118190590826
2026	7.080582092047592
2027	6.273270909330265
2028	5.416062616391462
2029	4.517118353484059
2030	3.584906808692534

Table 2 clearly indicates that neonatal mortality will gradually decline from around 11 to around 4 deaths per 1000 live births in the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Early surveillance tools are designed to detect abnormal trends of diseases and other health related problems to facilitate planning, decision making and resource mobilization in order to address a specific public health problem at a particular point in time. It is important to mention that public health programming should be informed by research evidence so that effective and appropriate interventions are implemented. Modelling techniques have been shown to be useful surveillance tools although they are being underutilized in low-middle income countries. In this study we proposed the Box-Jenkins ARIMA technique to model and project future trends of neonatal mortality rate in Egypt. The model projections suggest that neonatal mortality will gradually decline from around 11 to around 4 deaths per 1000 live births in the out of sample period. Therefore, we encourage the Egyptian authorities to address local factors that contribute to deaths among neonates. Particular attention should be given to regular training of healthcare workers on essential newborn care, health education among communities to address various issues which contribute to neonatal mortality, and medical staff retention at all levels of healthcare.

REFERENCES

[1] Box, D. E., and Jenkins, G. M. (1970). Time Series Analysis, Forecasting and Control, Holden Day, London.

[2] Nyoni, T. (2018). Box-Jenkins ARIMA Approach to Predicting net FDI Inflows in Zimbabwe, *University Library of Munich*, MPRA Paper No. 87737.

[3] United Nations Inter-agency Group for Child Mortality Estimation (UN IGME), 'Levels & Trends in Child Mortality. Report 2014', United Nations Children's Fund, New York, 2014.

[4] United Nations Inter-agency Group for Child Mortality Estimation (UN IGME) (2017). 'Levels & Trends in Child Mortality. Report 2017', United Nations Children's Fund, New York.

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[5] Campbell O., Gipson R., Issa AH., Matta N., El Deeb B., and El Mohandes A (2005). National maternal mortality ratio in Egypt halved between 1992–93 and 2000. Bull World Health Organ, 83(6):462–71 Available from: https:// www.ncbi.nlm.nih.gov/pmc/articles/PMC2626255/pdf/15976898.pdf.

[6] WHO, UNICEF, UNFPA, World Bank Group, United Nations Population Division (2019). Trends in Maternal Mortality: 2000 To 2017 [Internet]. WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. Available from: https://www.unfpa.org/featured-publication/ trends-maternal-mortality-2000-2017

[7] UNICEF (2019). Neonatal mortality - UNICEF DATA. Available from: https://data.unicef. org/topic/child-survival/neonatal-mortality.

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