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Applying the ARIMA Model to Generate Expected Future Neonatal Mortality Trends in Burkina Faso

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***Abstract* - Addressing adverse neonatal outcomes should be a priority during this era of SDGs because the death of newborns has long lasting psychological impacts on mothers and entire families. Neonatal mortality levels indicate the quality of healthcare services during antenatal, delivery and postnatal periods. Therefore governments should strive to sufficiently reduce neonatal mortality by improving the quality of health care services at all levels of healthcare. This research uses annual time series data on neonatal mortality rate (NMR) for Burkina Faso from 1969 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 (4,1,5) model. The ARIMA model predictions indicate that neonatal mortality is likely going to decline from around 25 in 2020 to about 21 deaths per 1000 live births by the end of 2030. Hence, there is need to allocate more resources to maternal and child health programs especially to ensure availability of trained medical staff and medical supplies particularly in primary health care facilities. Priority should also be given to regular training of healthcare workers on basic & emergency obstetric and neonatal healthcare.**

Keywords: ARIMA, Forecasting, NMR.

I. INTRODUCTION

Burkina Faso has a population of about 20 million and total fertility rate of 5.2 births per woman (World Bank, 2019). The country has a high maternal mortality ratio (MMR) of 320 per 100 000 live births (World Bank, 2020). Child mortality is estimated to be 88 deaths per 1000 live births (World Bank, 2020). The government has made significant progress towards achieving sustainable development goal (SDG) 3 target 3.2 which aims to reduce neonatal mortality to at least 12 per 1000 live births by 2030 (Ouedraogo *et al*. 2020). The government is seriously committed to reduce maternal and under 5 mortality by subsidizing emergency obstetric and neonatal care in all health facilities since 2006 and availed the free care policy for under 5 children (Ouedraogo *et al*. 2015). However, authorities must invest more in maternal and child health (MNCH) in order to achieve set SDG-3 targets by the end of 2030.In this study we proposed the popular Box-Jenkins ARIMA methodology to project future trends of neonatal mortality rate (NMR) for Burkina Faso since it is an appropriate model for linear data (Nyoni, 2018; Box & Jenkins, 1970). The goal is to have an insight of the likely future trends of NMR to facilitate planning, decision making and allocation of resources to MNCH programs in the country. This will specifically inform neonatal policies and stimulate implementation of strategies to substantially reduce NMR by the end of 2030.

II. LITERATURE REVIEW

Olack *et al*. 2021 investigatedcauses of neonatal LBW and preterm mortality in Migori County, among participants of the PTBI-K (Preterm Birth Initiative-Kenya) study. Verbal and social autopsy (VASA) interviews were conducted with caregivers of deceased LBW and preterm neonates delivered within selected 17 health facilities in Migori County, Kenya. The probable cause of death was assigned using the WHO International Classification of Diseases (ICD-10). The researchers found out that Birth asphyxia (45.5%), neonatal sepsis (26.1%), respiratory distress syndrome (12.5%) and hypothermia (11.0%) were the leading causes of death. A retrospective cohort study in Kenya was carried out by Irimu *et al.* 2021 to find out the proportion of all admissions and deaths in the neonatal age group and examine morbidity and mortality patterns, stratified by birth weight, and their variation across hospitals. The results of the study revealed that the majority of newborns died of preventable causes (>95%). Ouedraogo *et al*. 2020 conducteda retrospective, descriptive and analytical study to investigate the risk factors for neonatal mortality in the Neonatology Department of Saint Camille Hospital of Ouagadougou (HOSCO - Hospital Saint Camille de Ouagadougou).The study included all newborns hospitalized in the neonatology department, at St Camille Hospital, in Burkina Faso from January 1 to December 31, 2017. Total of 710 records of hospitalized newborns in 2017 were analyzed and specifically focused on neonatal mortality. The study findings revealed that the leading cause of death was respiratory distress (89.8%). All the

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newborns had been hospitalized within 24 hours of life and the average time to death in the unit was 3 days and 54% of deaths occurred within 72 hours of hospitalization. Bitew *et al.* 2020 determined predictors and the incidence density rate (IDR) of neonatal mortalities in sub-Saharan countriesby utilizing electronic databases (Web of Science, PubMed, EMBASE (Elsevier), Scopus, CINAHL (EBSCOhost), World Cat, Google Scholar, and Google). The study concluded that the incidence density rate of neonatal mortality in Sub-Saharan Africa is significantly high. Multiple factors (neonatal and maternal) were found to be independent predictors. Noori *et al*. 2020 utilized Nanoro HDSS data from 2009 to 2013 to estimate the association between under-5 mortality and accessibility to inpatient and outpatient 38 health facilities in Burkina Faso, seasonality of death, and age group. The study found that significant predictors of under 5 mortality were seasonality of death (wet season greater than dry season) and time taken to reach the health facility. In another study Machio (2017) investigated the effects of antenatal and skilled delivery care services on neonatal and under-five mortality in Kenya using pooled Kenya demographic and health survey data for 1998, 2003, 2008/2009 and 2014. Two-stage residual inclusion estimation procedure and the control function approach were used to test and control for potential endogeneity of antenatal and skilled delivery care and for potential unobserved heterogeneity. Findings revealed that adequate use of antenatal care services reduced risk of neonatal and under-five mortality by 2.4 and 4.2 percentage points respectively.

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 Burkina Faso for the period 1969 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 2: Criteria Table

Model Selection Criteria Table			
Dependent Variable: DLOG(B)			
Date: 01/22/22 Time: 13:03			
Sample: 1969 2019			
Included observations: 50			
Model	LogL	AIC*	BIC
(4,5)(0,0)	224.606843	-8.544274	-8.123629
(2,4)(0,0)	221.519511	-8.540780	-8.234857
(2,3)(0,0)	220.310322	-8.532413	-8.264730
(2,2)(0,0)	219.304802	-8.532192	-8.302749
(5,5)(0,0)	224.626067	-8.505043	-8.046157
(3,2)(0,0)	219.611618	-8.504465	-8.236782
(2,5)(0,0)	221.530272	-8.501211	-8.157047
(3,4)(0,0)	221.525815	-8.501033	-8.156868

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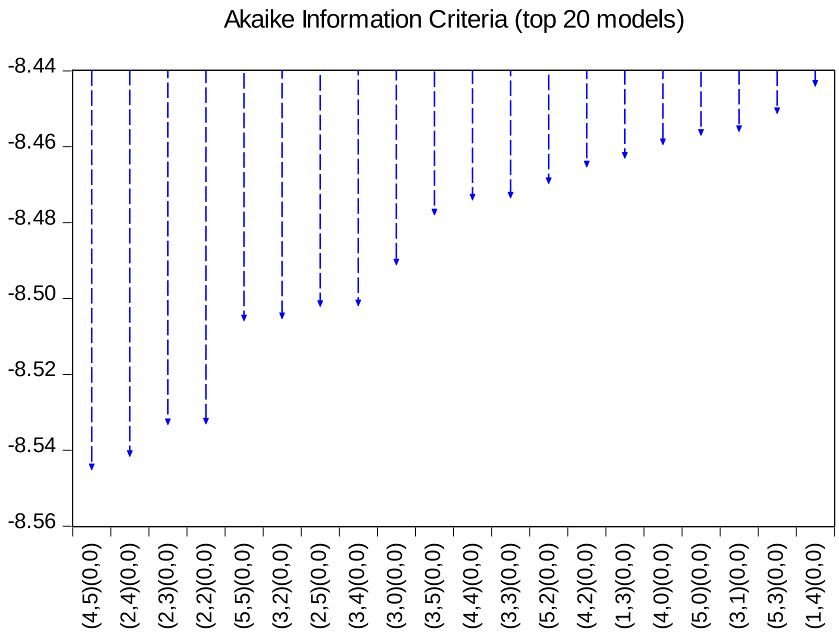
(3,0)(0,0)	217.256605	-8.490264	-8.299062
(3,5)(0,0)	221.927100	-8.477084	-8.094679
(4,4)(0,0)	221.829768	-8.473191	-8.090786
(3,3)(0,0)	219.816604	-8.472664	-8.166740
(5,2)(0,0)	220.721305	-8.468852	-8.124688
(4,2)(0,0)	219.611676	-8.464467	-8.158543
(1,3)(0,0)	217.553708	-8.462148	-8.232706
(4,0)(0,0)	217.464142	-8.458566	-8.229123
(5,0)(0,0)	218.402911	-8.456116	-8.188433
(3,1)(0,0)	217.378007	-8.455120	-8.225678
(5,3)(0,0)	221.259323	-8.450373	-8.067968
(1,4)(0,0)	218.079728	-8.443189	-8.175506

Criteria Graph

Figure 1: Criteria Graph



Forecast Comparison Graph

Figure 2: Forecast Comparison Graph

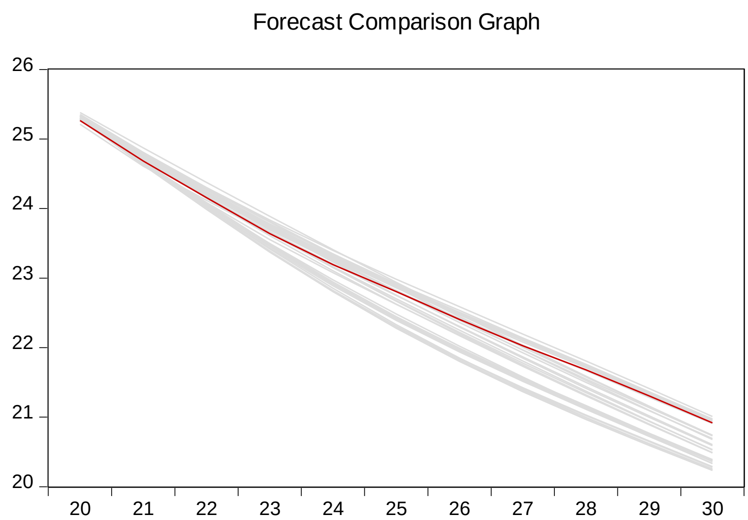


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Table 1 and Figure 1 indicate that the optimal model is the ARIMA (4,1,5) model. Figure 2 is a combined forecast comparison graph showing the out-of-sample forecasts of the top 25 models evaluated based on the AIC criterion. The red line shows the forecast line graph of the optimal model, the ARIMA (4,1,5) model.

IV. RESULTS

ARIMA () Model Forecast

Tabulated Out of Sample Forecasts

Table 2: Tabulated Out of Sample Forecasts

Year	Forecasts
2020	25.26666469383781
2021	24.68300701006108
2022	24.15696322779622
2023	23.63887143197877
2024	23.19494338732021
2025	22.8058438324737
2026	22.40309582172305
2027	22.02512709321431
2028	21.68081758651849
2029	21.3063607985679
2030	20.91798520537077

Table 5 and Figure 3 indicates that neonatal mortality is likely going to decline from around 25 in 2020 to about 21 deaths per 1000 live births by the end of 2030.

V. POLICY IMPLICATION & CONCLUSION

High maternal and child mortality rates in Burkina Faso are of great concern. Although the country has made some progress towards achieving SDG-3 targets, health authorities in the country should draft and implement strategies to substantially reduce neonatal mortality. This study forecasted NMR for Burkina Faso using the ARIMA model and the results showed that neonatal mortality is likely going to decline from around 25 in 2020 to about 21 deaths per 1000 live births by the end of 2030. Therefore there is need to allocate more resources to maternal and child health (MNCH) especially to ensure availability of trained medical staff and medical supplies particularly in primary health care facilities. Priority should also be given to regular training of healthcare workers on basic & emergency obstetric and neonatal care.

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