

# Highlighting Future Trends of Neonatal Mortality in Morocco Using Forecast Values Generated By the ARIMA Model

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**Abstract - This study uses annual time series data on neonatal mortality rate (NMR) for Morocco 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 (2) variable. The optimal model based on AIC is the ARIMA (5,2,4) model. The study findings indicate that neonatal mortality is expected to gradually decline to levels below the global SDG target of 12 deaths per 1000 live births by the end of 2030. Therefore, we implore the Moroccan health authorities to come up with country specific neonatal policies that will address the challenge of neonatal mortality with special attention being given to channeling more resources to primary healthcare, retention of healthcare workers and strengthening the referral system.**

**Keywords:** ARIMA, Forecasting, NMR.

## I. INTRODUCTION

Improving maternal health and child survival is one of the key components of sustainable development goals (SDGs). Ensuring that mothers get quality, affordable, accessible family planning services and essential newborn care is critical in the reduction of maternal and under 5 mortality (WHO, 2019; IOM, 2019; UNFPA, 2018; Scandall *et al.* 2016; Every woman every child, 2015; UNPA *et al.* 2014). The targets set by the Lancet commission on investing in Health and the sustainable development goals aimed at reducing neonatal mortality rate (NMR) to at least 12 per 1000 live births and maternal mortality should be reduced to less than 70 maternal deaths per 100 000 live births by 2030. This is achievable, however low-middle income countries will require financial and technical assistance in order to achieve the ambitious goals due to a variety of reasons which include poverty & hunger driven by climate change, political instability and mass exodus of qualified and experienced healthcare professionals. It is important to highlight that forecasting of NMR for Morocco is necessary to facilitate allocation of resources as well as tracking progress towards achieving sustainable development goal 3 target 3.2 by 2030. In this paper the widely applied Box-Jenkins ARIMA model is employed to forecast future trends of NMR in the country.

## II. LITERATURE REVIEW

Nove *et al.* (2020) estimated the potential impact of midwives on reducing maternal and neonatal deaths and stillbirths under several intervention coverage scenarios. The model used was the Lives Saved Tool 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 showed 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. Lahmini and Bourrous (2020) conducted a retrospective and descriptive study, over five years (1st January 2012 and 31st December 2016) including all children aged from 0 to 15 years old who died at the PED in the Mohamed VI Hospital in Marrakech. The aimed of the study was to examine pediatric mortality Makarrakech pediatric emergency department. It was found out that the most common causes of pediatric mortality were neonatal pathologies (62.3%), infections (7.7%), birth deformities (7.3%), and trauma (0.9%). Neonatal mortality was mainly due to infections (32.2%) and prematurity (24.4%). In a 2018 descriptive 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. Doukkali *et al.* (2016) examined the characteristics of pregnant women in the hospital center in the urban commune of Missouri as well as the morphological data of the newborn and identified the risk factors implicated in neonatal morbidity. A retrospective study collected data from records of women who gave birth in the Maternity of

Missouri during 2012. As well as a prospective study conducted at the maternity in 2013.. Neonatal mortality rate was found to be 0.6%. 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) and 11 (0.9%) had 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, including Tourism Economics. In this paper, hinged on this technique; the researcher will use automatic ARIMA modeling for estimating equation [10].

#### Data Issues

This study is based on annual NMR in Morocco for 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: DLOG(M, 2)  
 Date: 01/23/22 Time: 18:10  
 Sample: 1960 2019  
 Included observations: 58

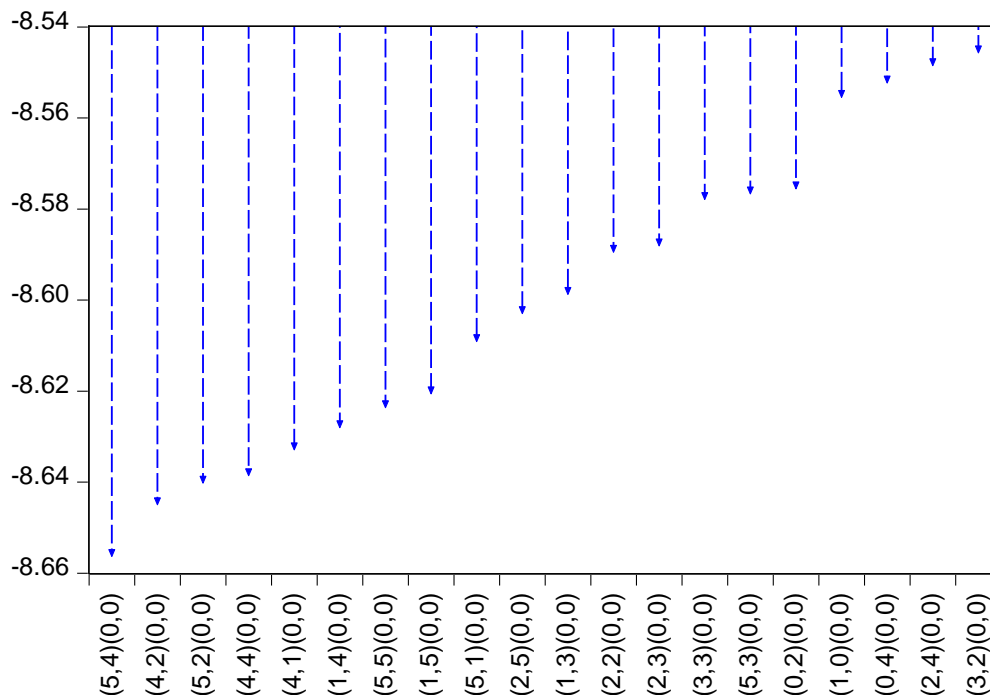
Model	LogL	AIC*	BIC	HQ
(5,4)(0,0)	262.008130	-8.655453	-8.264679	-8.503239
(4,2)(0,0)	258.678506	-8.644086	-8.359887	-8.533385
(5,2)(0,0)	259.542051	-8.639381	-8.319657	-8.514842
(4,4)(0,0)	260.493498	-8.637707	-8.282458	-8.499330
(4,1)(0,0)	257.328749	-8.632026	-8.383352	-8.535162
(1,4)(0,0)	257.187666	-8.627161	-8.378487	-8.530297
(5,5)(0,0)	262.060017	-8.622759	-8.196461	-8.456707
(1,5)(0,0)	257.972108	-8.619728	-8.335529	-8.509027
(5,1)(0,0)	257.639215	-8.608249	-8.324050	-8.497548
(2,5)(0,0)	258.461547	-8.602122	-8.282398	-8.477583
(1,3)(0,0)	255.338131	-8.597867	-8.384717	-8.514841
(2,2)(0,0)	255.070113	-8.588625	-8.375475	-8.505599
(2,3)(0,0)	256.030559	-8.587261	-8.338586	-8.490397
(3,3)(0,0)	256.733390	-8.577013	-8.292814	-8.466312
(5,3)(0,0)	258.698835	-8.575822	-8.220573	-8.437445
(0,2)(0,0)	252.665986	-8.574689	-8.432590	-8.519339

(1,0)(0,0)	251.083079	-8.554589	-8.448014	-8.513076
(0,4)(0,0)	253.991320	-8.551425	-8.338276	-8.468399
(2,4)(0,0)	255.882323	-8.547666	-8.263467	-8.436965
(3,2)(0,0)	254.800605	-8.544848	-8.296174	-8.447985
(0,3)(0,0)	252.791385	-8.544531	-8.366906	-8.475342
(3,4)(0,0)	256.772243	-8.543870	-8.224147	-8.419332
(1,2)(0,0)	252.718581	-8.542020	-8.364396	-8.472832
(0,1)(0,0)	250.647970	-8.539585	-8.433011	-8.498072
(3,0)(0,0)	252.402546	-8.531122	-8.353498	-8.461934
(2,0)(0,0)	251.367674	-8.529920	-8.387820	-8.474569
(1,1)(0,0)	251.183702	-8.523576	-8.381476	-8.468225
(4,3)(0,0)	256.148546	-8.522364	-8.202640	-8.397825
(0,0)(0,0)	249.081027	-8.520035	-8.448986	-8.492360
(4,0)(0,0)	253.046389	-8.518841	-8.305692	-8.435815
(0,5)(0,0)	254.013093	-8.517693	-8.269019	-8.420829
(3,5)(0,0)	256.906558	-8.514019	-8.158770	-8.375643
(4,5)(0,0)	257.835106	-8.511555	-8.120782	-8.359341
(5,0)(0,0)	253.777988	-8.509586	-8.260912	-8.412722
(3,1)(0,0)	252.679520	-8.506190	-8.293041	-8.423164
(2,1)(0,0)	251.576638	-8.502643	-8.325018	-8.433454

Criteria Graph

Figure 1: Criteria Graph

Akaike Information Criteria (top 20 models)



**Forecast Comparison Graph**

Figure 2: Forecast Comparison Graph

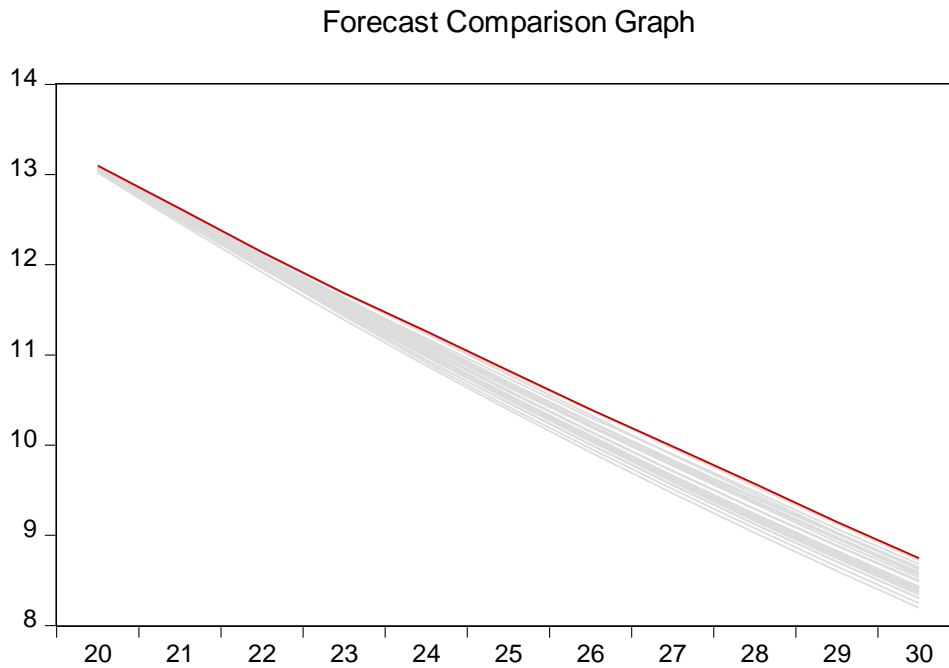


Table 2 and Figure 1 indicate that the optimal model is the ARIMA (5,2,4) model. Figure 2 is a combined forecast comparison graph showing the out-of-sample forecasts of the top 25 models evaluated based on the AIC criterion. The red line shows the forecast line graph of the optimal model, the ARIMA (5,2,4)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

**RESULTS**

**ARIMA () Model Forecast**

**Tabulated Out of Sample Forecasts**

Table 2: Tabulated Out of Sample Forecasts

Year	Forecasts
2020	13.09678848725735
2021	12.62009879221605
2022	12.139710691619
2023	11.68512202181447
2024	11.26249803396042
2025	10.82710054772715
2026	10.39436473691899
2027	9.985563179047745
2028	9.570373014068202
2029	9.148826346913595
2030	8.747737246475791

Table 2 clearly indicates that neonatal mortality is expected to gradually decline to levels below the global SDG target of 12 deaths per 1000 live births by the end of 2030.

## V. POLICY IMPLICATION & CONCLUSION

High quality Maternal and child health care (MNCH) is a key factor in the economic development of a country as this contributes to human development. Achieving a substantial scale-up of coverage of essential interventions that can be delivered by adequately trained health care workers (Doctors, Midwives, general nurses and other medical staff) will assist in the substantial reduction of maternal and child mortality especially in low-middle income countries. Mobilizing resources for the MNCH program is essential for its success. Furthermore, surveillance mechanisms should be in place to track progress towards achieving set targets. In this paper we applied the ARIMA model as an early surveillance tool to detect abnormal trends of NMR for Morocco and the findings suggest that neonatal mortality is expected to gradually decline to levels below the global SDG target of 12 deaths per 1000 live births by the end of 2030. Therefore, we implore the Moroccan health authorities to come up with country specific neonatal policies that will address the challenge of neonatal mortality with special attention being given to channeling more resources to primary healthcare, retention of healthcare workers and strengthening the referral system.

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