



PROJECTION OF MATERNAL MORTALITY FOR THE UNITED ARAB EMIRATES USING ARTIFICIAL NEURAL NETWORKS

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Abstract

This research article employs annual time series data on MMR for the United Arab Emirates (UAE) from 1985 to 2023 to predict future trends of MMR over the period 2024 to 2035. The forecast evaluation criteria of the applied model indicate that the ANN (12, 12, 1) model is stable. The neural network model projections revealed that MMR will remain low throughout the out of sample period. Therefore, we encourage the government to relentlessly address local causes of maternal mortality.

Keywords: ANN, Forecasting, Maternal Mortality Ratio.

Introduction

Nearly 830 women die every day from avoidable causes linked to pregnancy or childbirth globally (WHO, 2018). The majority of maternal deaths are reported in low-middle income countries (WHO, 2018), and 65% of these deaths are reported in sub-Saharan Africa (WHO, 2019). WHO data indicates that maternal mortality ratios are highest where skilled birth attendance is the lowest (WHO, 2019). Most maternal deaths are reported during the intrapartum and peripartum periods (Ahmed et al. 2018; Merdad et a. 2018) highlighting the significance of early access to quality health services for birth and postpartum care. In addition, complications during childbirth and postpartum periods are best attended to in well-resourced and staffed medical facilities. This paper models forecasts MMR for the UAE using a machine learning technique. The study findings are expected



to guide policy making, planning and allocation of resources to the health sector so that preventable maternal deaths are eliminated.

Literature Review

Author (s)	Objective(s)	Methodology	Main finding(s)
Mackin et al. (2026)	to understand how levels of MNH care are organized in different country contexts	Scoping review	Three or four levels of MNH facility care were most commonly reported. Linking maternal and newborn facility care to community connections is an important consideration to ensure equitable access to routine and emergency care
Al-Taïar et al. (2025)	to assess the prevalence of anemia in pregnant women and its associated factors in the Kuwait Birth Cohort study	Prospective cohort study	-The prevalence of anemia was 28.16% (95% CI:25.53–30.91%), with 8.75% of women experiencing moderate anemia and 19.40% mild anemia. No cases of severe anemia were observed -Multivariable analysis identified current iron supplement use, (Adjusted Odds Ratio [AOR] 0.52, 95%CI:0.28–0.99; $p = 0.049$), vitamin D status (sufficient vs. insufficient/deficient), (AOR 0.63, 95%CI:0.43–0.92; $p = 0.018$), iron levels ($p < 0.001$), and ferritin levels ($p < 0.001$) as factors significantly associated with anemia
Cresswell et al. (2025)	To obtain updated evidence on causes of maternal death to accelerate SDG progress	conducted a multi-strategy systematic review to identify causes of maternal deaths occurring in 2009–20	Hemorrhage remains the leading cause of death, despite the existence of effective clinical interventions, emphasizing the need for improved access to quality health care
Hamdan et al. (2025)	To describe postpartum Hemorrhage Burden, Management and	Scoping review	the review identified critical gaps in blood loss estimation methods, with visual estimation being unreliable and leading to



	Challenges in Malaysia		underdiagnosis, while patient intrinsic factors such as uterine atony, retained placenta, and placenta accreta spectrum disorders contribute to treatment complexity.
Kama et al. (2025)	to establish the period prevalence of MNM and mortality index, and to compare near-miss cases with maternal mortality and to identify their risk factors and causes	Cross-sectional study	The leading causes of MNM were eclampsia (47.8%), abruptio placentae (19.7%) and postpartum hemorrhage (8.3%), and the leading causes of maternal death were eclampsia (29.2%), puerperal sepsis (25%) and postpartum hemorrhage (12.5%)
Bhalotra & Clarke (2024)	to investigate the association of women's education with maternal and child mortality	Panel regression	moving an additional 1 percentage point of women into primary education reduces rates of maternal death by 4.6%, and reduces the rate of infant deaths by 1.9%
Hanach et al. (2024)	to delve into the digital experiences of postpartum women in the UAE by exploring the types of resources they navigate and the purposes those resources serve. In addition, it seeks to identify their perspectives and needs regarding digital resources that support their postpartum journey	Qualitative study	This study revealed the multifaceted role of digital resources in supporting mothers during the postpartum period, highlighting unmet needs that present opportunities for advancing postpartum care in the UAE
Hegazy et al. (2024)	to investigate the nature and extent of studies evaluating the prevalence of preeclampsia within	Scoping review	there is a significant scarcity of research in this area, especially within the Middle East, and notably an absence of studies specifically pertaining to the UAE



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	the Middle East region		
Duka et al. (2024)	to quantify the inequalities in the distribution of nurses in Albania, analyzing the nurse-to-population ratio and its impact on the quality of healthcare	Descriptive analytic study	The average nurse-to-population ratio in Albania is 28 nurses per 10,000 inhabitants, with significant variations between regions. Tirana has the highest ratio (60 nurses per 10,000 inhabitants), while Kukës and Dibër have the lowest values (10 per 10,000 inhabitants)
Chin et al. (2023)	to understand the demography, case characteristics and causes of maternal mortality in Sabah from 2015 through 2020	Retrospective study	Majority of deceased women, 56.7%, never attended antenatal visits prior to their death in the latest pregnancy. Overall, 63.88% deaths were due to direct obstetric causes, postpartum hemorrhage was the leading direct cause of death (24.53%), and most of the maternal deaths (65.5%) were preventable
Diguisto et al. (2022)	to compare maternal mortality in eight countries with enhanced surveillance systems	Descriptive multi-country population-based study.	Variations in maternal mortality ratios exist between high income European countries with enhanced surveillance systems. In-depth analyses of differences in the quality of care and health system performance at national levels are needed to reduce maternal mortality further by learning from best practices and each other
Pouyanfar et al. (2022)	to investigate the factors affecting the maternal mortality ratio (MMR) in different regions of Iran	Systematic review	The leading causes of maternal death were hemorrhage (43.7%), preeclampsia/eclampsia (24.5%), other hypertensive disorders (24%), and embolism (22.8%)
Hazari et al. (2021)	to examine the impact of Covid-19 infection on pregnant women	A case-control study was carried out to compare the clinical course and	Pregnant women presented with fewer Covid-19 symptoms but ran a much more severe course of ill



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	in the United Arab Emirates population	outcome of pregnancy in 79 pregnant women with Covid-19 and 85 non-pregnant women with Covid-19 admitted to Latifa Hospital in Dubai between March and June 2020	ness compared to non-pregnant women with the disease
Gabrani et al. (2020)	to identify key factors influencing the utilization of governmental and private primary healthcare services in Albania	cross-sectional health facility survey using a 4-point Likert scale questionnaire to rank the importance of factors driving services utilization.	The use of primary healthcare is strongly influenced by geographical and financial access for public facility users and availability of equipment for private users. This study found that aspects of acceptability and adequacy of services are equally valued
Norhayati et al. (2016)	to study severe maternal morbidity and maternal near miss among women in two tertiary hospitals in Kota Bharu, Kelantan, Malaysia	A cross-sectional study with record review was conducted in 2014. Severe maternal morbidity and maternal near miss were classified using the new World Health Organization criteria. Health indicators for obstetric care were calculated and descriptive analyses were performed using SPSS version 22.0	The maternal near miss mortality ratio was 23.5 and the mortality index was 4.1 %. The process indicators for essential interventions were almost 100.0 %. Hemorrhagic disorders were the most common event for severe maternal morbidity (68.6 %) and maternal near miss (80.9 %) and management-based criteria accounted for 85.1 %



Methodology

The Artificial Neural Network (ANN) approach, which is flexible and capable of nonlinear modelling; will be applied in this study. The ANN is a data processing system consisting of a large number of highly interconnected processing elements in architecture inspired by the way biological nervous systems of the brain appear like. Since no explicit guidelines exist for the determination of the ANN structure, the study applies the popular ANN (12, 12, 1) model based on the hyperbolic tangent activation function. This paper applies the Artificial Neural Network (ANN) approach in predicting annual maternal mortality ratio (MMR) for the UAE.

Data Issues

This study is based on annual MMR in the UAE for the period 1985 – 2023. The out-of-sample forecast covers the period 2024 – 2035. All the data employed in this research paper was gathered from the World Bank online database.

Findings of the study

ANN Model Summary

Table 1: ANN model summary

Variable	U
Observations	27 (after adjusting endpoints)
Neural Network Architecture:	
Input Layer Neurons	12
Hidden Layer Neurons	12
Output Layer Neurons	1
Activation Function	Hyperbolic Tangent Function
Back Propagation Learning	
Learning Rate	0.005
Momentum	0.05
Criteria:	
Error	0.052032
MSE	0.297303
MAE	0.396524



Residual Analysis for the Applied Model

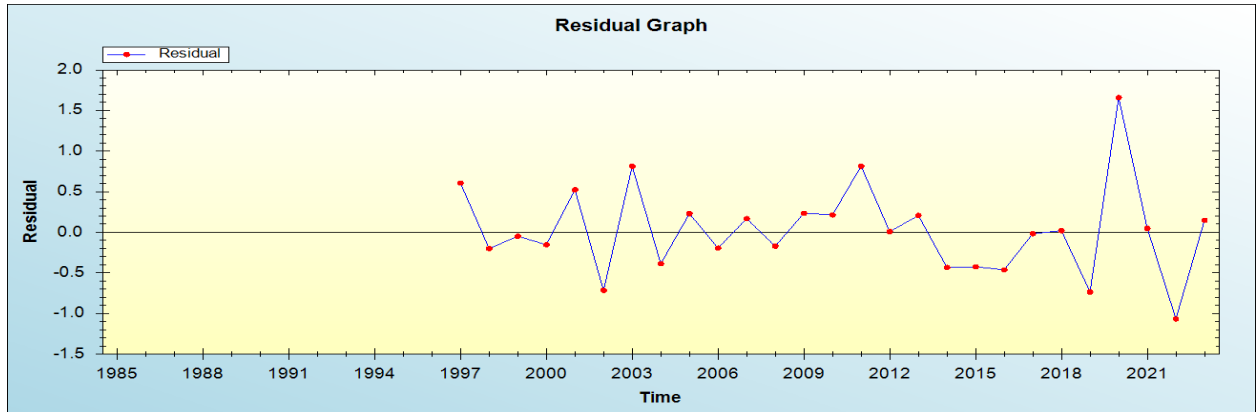


Figure 1: Residual analysis

In-sample Forecast for U

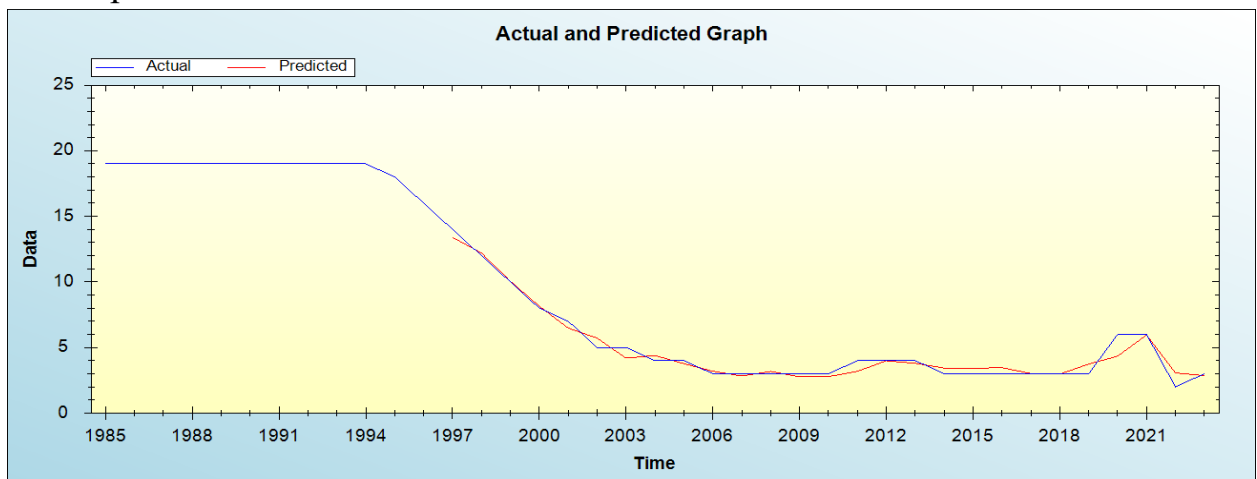


Figure 2: In-sample forecast for the U series

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

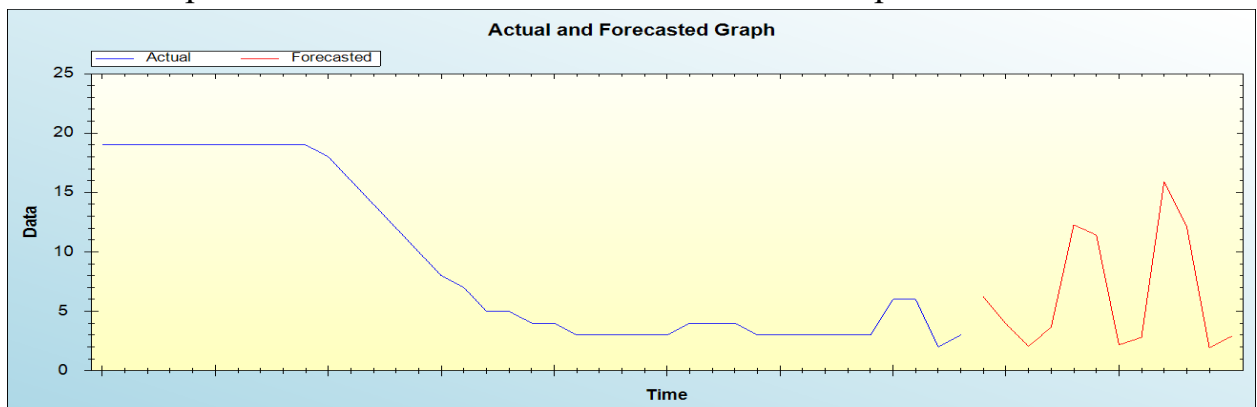


Figure 3: Out-of-sample forecast for U: actual and forecasted graph



Out-of-Sample Forecast for U: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted MMR
2024	6.1987
2025	3.9411
2026	2.0431
2027	3.6562
2028	12.2588
2029	11.4154
2030	2.1700
2031	2.8052
2032	15.9001
2033	12.1295
2034	1.9279
2035	2.9130

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 MMR will remain low over the out of sample period.

Conclusion

In this study we applied a machine learning technique to model and project MMR for the UAE and findings indicate that MMR will remain low in the forecast period. Hence, we implore authorities in the UAE to persistently address local factors associated with maternal mortality.

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