



DETECTION OF FUTURE TRENDS OF MATERNAL MORTALITY FOR BELGIUM USING A MACHINE LEARNING TECHNIQUE

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Article history:	Abstract:
Received: November 24 th 2025 Accepted: 20 th February 2026	<i>This research article employs annual time series data on MMR for Belgium 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 preventable maternal deaths and continue reporting severe maternal morbidities.</i>
Keywords: ANN, Forecasting, Maternal Mortality Ratio	

INTRODUCTION

A maternal death is the demise of a woman while pregnant or within 6 weeks of pregnancy termination, regardless of the duration and pregnancy site, from any cause related to or worsened by the pregnancy or its management, but not from accidental or incidental causes (WHO, 2012). The maternal mortality ratio (MMR) reflects the quality of healthcare services and, the position and importance accorded to women in the society (Verma et al. 2022; Sitaula et al. 2021; Zalvand et al. 2019). The global MMR has declined drastically from 342 in 2000 to 211 in 2017 (Meh et al. 2022). However, the burden of maternal mortality remains high therefore new ideas are needed to further reduce maternal morbidity and mortality (Kolleh et al. 2021). WHO statistics in 2017 highlighted that approximately

810 women died every day from avoidable causes related to pregnancy and childbirth, with 94% of these deaths being reported in low and lower-middle-income countries. In developing countries in Sub-Saharan Africa, South East and central Asia and, Latin America and the Caribbean, MMR hovers around 415 per 100,000 live births, which is unacceptably high compared to Europe, North America, Australia and New Zea land (WHO et al. 2019). The purpose of this study is to model and forecast MMR for Belgium using a machine learning technique. The results of the study will highlight likely future trends of MMR. This is expected to trigger an appropriate national health response in order to keep maternal mortality under control.

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.
Tsushima et al. (2026)	To determine the long-term incidence of dysglycemia and	Prospective cohort study	Postpartum BMI increase was independently



	dyslipidemia after GDM and evaluated whether postpartum changes in body mass index (BMI) independently predicted these outcomes.		associated with new-onset dysglycemia. No independent predictor of T2DM progression was identified. Dyslipidemia was independently associated with higher pre-pregnancy BMI and multiparity, whereas postpartum BMI change was not independently associated after multivariable adjustment
Yue et al. (2026)	to perform an umbrella review to summarize the current evidence to provide a reference for clinicians and future research	Systematic review	Positive aPLs significantly increased the risk of miscarriage rate in assisted reproductive technology (ART) and were also associated with total fetal loss, PE, intrauterine growth retardation and placental abruption
Nunn et al. (2025)	To explore whether changes in key characteristics among Victorian Aboriginal and/or Torres Strait Islander women contributed to reduced perinatal death rates	Retrospective population-based cohort study of all births in Victoria from 2000–2019	Changes in key maternal characteristics may have contributed to improved perinatal death rates among babies of Victorian Aboriginal and/or Torres Strait Islander women
Haninger-Vacariu et al. (2024)	To describe pregnancy and delivery outcomes in women with Fabry disease	Retrospective cohort-study of women with Fabry disease in Austria using a specific questionnaire and the Austrian Mother–Child Health Passport	The cohort-study in women with Fabry disease showed an increase of pain burden during pregnancies and clearly points to an increased risk for preeclampsia, prematurity, and neonates small for gestational age. With a substantial number of high-risk pregnancies, neonatal outcomes are somewhat worse in Fabry disease than in the general public



Alipour et al. (2023)	to estimate the global prevalence of maternal death causes through a systematic review and meta-analysis	Systematic review	The most prevalent causes of maternal deaths, listed in descending order from highest to lowest prevalence, were non-obstetric complications (48.32%), obstetric hemorrhage (17.63%), hypertensive disorders of pregnancy, childbirth, and the puerperium (14.01%), other obstetric complications (7.11%), pregnancy with abortive outcome (5.41%), pregnancy-related infection (5.26%), unanticipated complications of management (2.25%), unknown/undetermined causes (2.01%), and coincidental causes (1.59%), respectively
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
Schoenborn et al. (2021)	-to describe the sociodemographic profiles of women who are not legally residing in Belgium -to analyze the associations of registration status with pregnancy outcomes according to socioeconomic status and nationality.	-analyzed data from birth and death certificates taken from the Belgian civil registration system, linked with the National Population Registry (NPR). The data relates to all singleton babies born between 2010 and 2016 (n = 871,283), independent of their mother's NPR registration status -applied logistic regression	Overall, unregistered women have increased risks of adverse perinatal outcomes, but it is likely that the causal mechanisms differ starkly between Belgian, European and non-European women
Morong et al. (2017)	This study was a retrospective cohort study of cases of in-hospital maternal	-to determine if American and Australian women have a similar rate of	Women from Louisiana, United States and Queensland, Australia have similar rates of



	deaths in the Ochsner Health System (Louisiana, United States) and the Queensland Health System (Australia) from 1995 to 2013	preventable maternal death and if the deaths were attributable to the same factors	preventable maternal death. No statistically significant factors explained trends in Australian maternal death; American maternal mortality was significantly associated with point of entry into prenatal care, likely influenced by insurance status
Nahidi & Hajifoghaha (2017)	To provide the current situation and trend of MMR in the Eastern Mediterranean region between 1990 and 2015	Systematic review	Based on the collected data, 36 out of 66 studies met the required criteria and were chosen for analysis. All countries of this region showed a downward trend between 1990 and 2015, and this change varied from 16.30% in Yemen to 76.56% in Lebanon. The maternal mortality reduction was 69.88% in Iran in the same time
Schildberger et al. (2017)	-To investigate the personal meanings and experiences of women with disabilities in regard to pregnancy, childbirth and the puerperium	Conducted semi-structured interviews	Participants reported limited acceptance of their life decisions and experienced an environment of discriminatory attitudes. They experienced a lack of support and lack of confidence in their parenting abilities, which negatively influenced their self-efficacy and self-awareness. Violations of personal borders and a feeling of being watched and controlled were reported
Bouvier-Colle et al. (2012)	To assess capacity to develop routine monitoring of maternal health in the European Union using indicators	Analysis of aggregate data from routine statistical systems compiled by the EURO-PERISTAT project and	Currently available data on maternal mortality and morbidity are insufficient for monitoring trends over time in Europe and for



	of maternal mortality and severe morbidity	comparison with data from national enquiries	comparison between countries
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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 Belgium.

DATA ISSUES

This study is based on annual MMR in Belgium 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.

Finding of the Study

ANN Model Summary

Table 1: ANN model summary

Variable	B
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	0.085982
MSE	0.086282
MAE	0.226825

Residual Analysis for the Applied Model

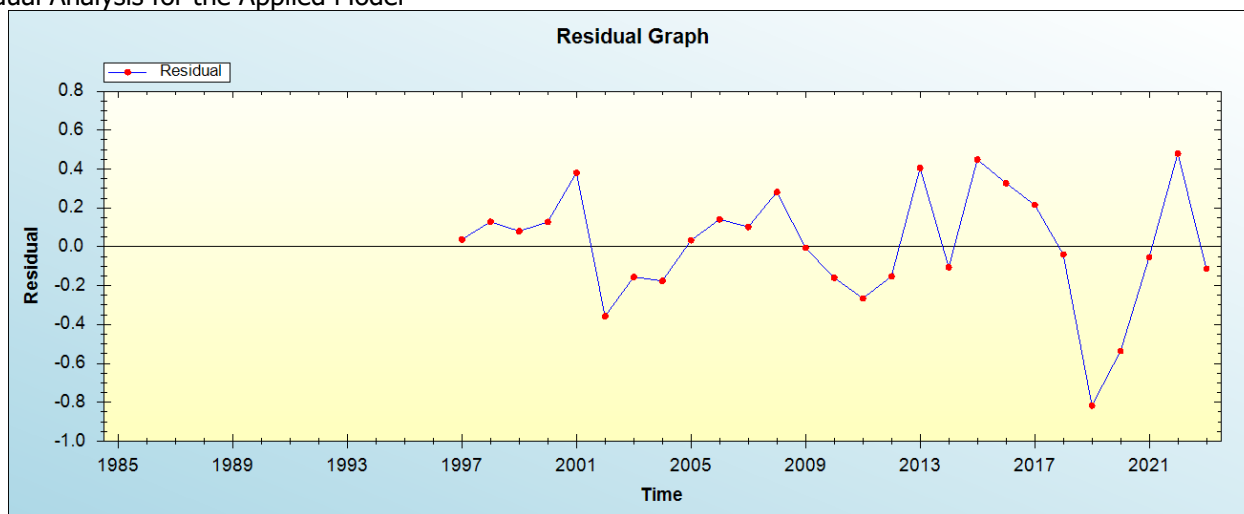


Figure 1: Residual analysis

In-sample Forecast for B

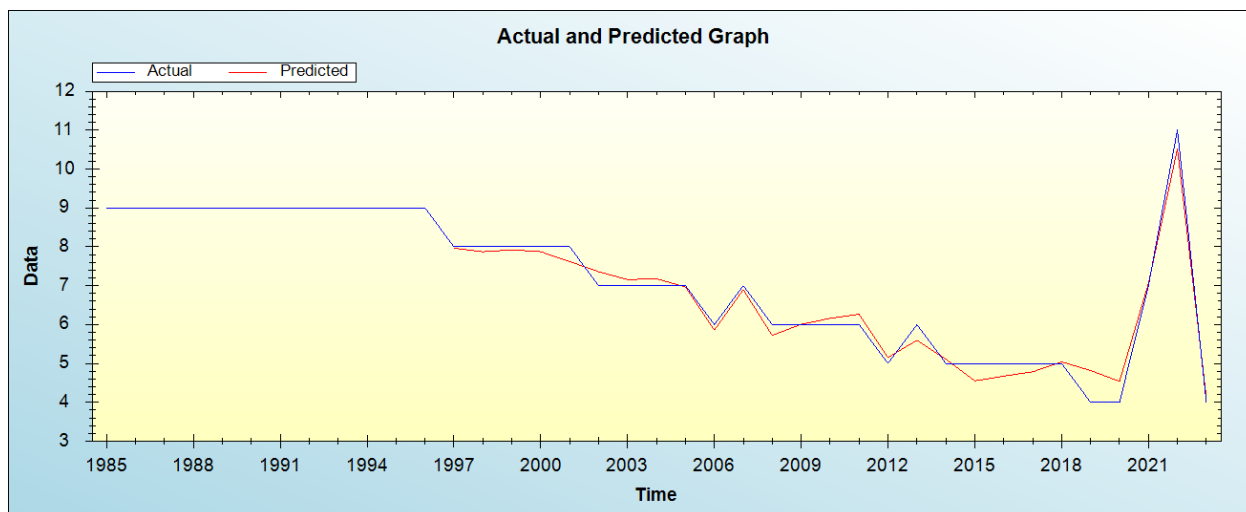


Figure 2: In-sample forecast for the B series

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

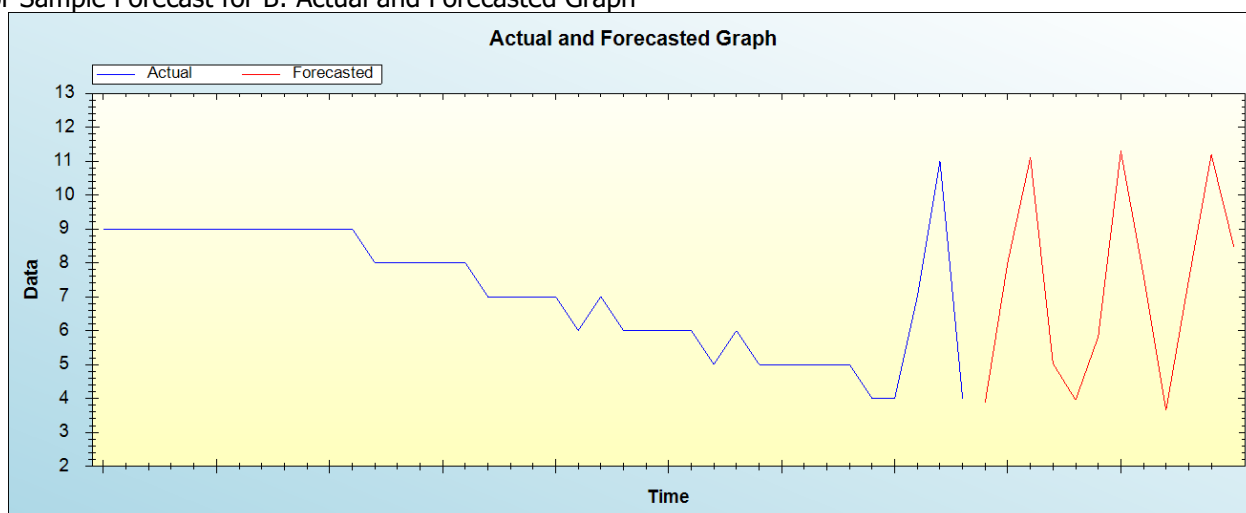


Figure 3: Out-of-sample forecast for B: actual and forecasted graph

Out-of-Sample Forecast for B: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted MMR
2024	3.8814
2025	8.0159
2026	11.1052
2027	5.0295
2028	3.9549
2029	5.8208
2030	11.2875
2031	7.6468
2032	3.6476
2033	7.4893
2034	11.1861
2035	8.4622

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 throughout the out of sample period.

CONCLUSION

This paper utilized a machine learning technique to project MMR for Belgium and results indicate that MMR will remain low in the forecast period. Authorities in Belgium are encouraged to address local causes of maternal deaths and continuous surveillance of severe maternal morbidities (SMM) to keep maternal mortality under control.

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