Western European Journal of Medicine and Medical Science
Volume 4, Issue 08, August 2026
https://westerneuropeanstudies.com/index.php/3
ISSN (E): 2942-1918 Open Access| Peer Reviewed
This article/work is licensed under CC Attribution-Non-Commercial 4.0

MATERNAL MORTALITY PREDICTION FOR TRINIDAD AND TOBAGO USING THE DOUBLE EXPONENTIAL SMOOTHING METHOD

Smartson. P. NYONI[1], Thabani NYONI[2]
[1]Independent Researcher & Medical Doctor, Harare, Zimbabwe
[2]Independent Researcher & Health Economist, Harare, Zimbabwe

Abstract
This study uses annual time series data on MMR for Trinidad and Tobago from 1985 to 2023 to predict future trends of MMR over the period 2024 to 2035. The study utilizes Holt's double exponential smoothing model. The optimal values of smoothing constants α and β are 0.4 and 0.1 respectively based on minimum MSE. The results of the study indicate that MMR will fall from around 44 in 2024 to about 34 deaths per 100 000 live births in 2035. Therefore, we encourage authorities to address local causes of maternal deaths.

Keyword(s): - *Exponential smoothing, Forecasting, Maternal Mortality Ratio*

Introduction

According to WH0, the twin-island Republic of Trinidad and Tobago is located to the southern end of the Caribbean, close to the continent of South America, northeast of Venezuela and northwest of Guyana. The economy is mainly dependent on oil and gas production, with the petroleum and petrochemical industries representing nearly 37% of gross domestic product (GDP) (WHO, 2018). In 2011, the Trinidad and Tobago Census revealed that the total population estimate was 1,328,019. In addition, the 2011 census indicated that close to 13% of the population was above 60 years of age with 13% of persons being 80 years and older and estimated to be 15.8% in 2015 and over 32.8% by 2025. Trinidad and Tobago has one of the highest NCD rates in the world. NCDs contribute around 60% of total deaths per annum. In 2015, heart disease was the number one cause of death, accounting for a quarter of all deaths, followed by diabetes accounting for 14%, cancer (13 %), and cerebrovascular disease 10 % (WHO, 2018). In 2015 maternal mortality ratio stood at 63 per 100 000 live births (Global Health Observatory, 2017). The objective of this paper is to model and forecast MMR for Trinidad and Tobago using the double exponential smoothing technique. The findings of this paper are expected to highlight likely future trends of MMR for this country. This will inform policy making, planning and allocation of resources to the maternal and child health program so that there will be further reduction in preventable maternal deaths.

Literature Review

Author(s)	Objective(s)	Methodology	Key finding(s)
Becerra et al. (2026)	to identify and analyze maternal complications	qualitative and descriptive approach	adolescent pregnancy in Latin America and the

Western European Journal of Medicine and Medical Science
Volume 4, Issue 08, August 2026
https://westerneuropeanstudies.com/index.php/3
ISSN (E): 2942-1918 Open Access| Peer Reviewed
This article/work is licensed under CC Attribution-Non-Commercial 4.0

	associated with adolescent pregnancy, with a particular focus on the Latin American context		Caribbean entails significant medical risks and negatively affects the integral development of adolescents, a situation that is aggravated by the lack of access to health services, education and by factors such as poverty
Marks & Castro (2026)	To examine how MWHs have been implemented across Latin America, analyzing their evolution, the specific needs they address in different countries, and their impact on maternal and neonatal health outcomes throughout the region	Systematic review	The evolution of MWHs suggests that they address a spectrum of needs beyond their original purposes, such as providing culturally responsive maternal support and psychosocial and early childhood support
Tsushima et al. (2026)	To determine the long-term incidence of dysglycemia and dyslipidemia after GDM and evaluated whether postpartum changes in body mass index (BMI) independently predicted these outcomes	Prospective cohort study	postpartum weight change may help identify women at higher risk of subsequent metabolic abnormalities, particularly dysglycemia, in this high-risk population, although causal relationships cannot be inferred from this observational study
Yue et al. (2026)	to perform an umbrella review to summarize the current evidence to	Systematic literature review	This review offers a thorough overview of the current evidence linking SLE, SS and

Western European Journal of Medicine and Medical Science
Volume 4, Issue 08, August 2026
https://westerneuropeanstudies.com/index.php/3
ISSN (E): 2942-1918 Open Access| Peer Reviewed
This article/work is licensed under CC Attribution-Non-Commercial 4.0

	provide a reference for clinicians and future research		APS to pregnancy and assisted reproductive outcomes. It identifies existing gaps and proposes future research directions
Cresswell et al. (2025)	To obtain updated evidence on causes of maternal death is needed to accelerate progress	Systematic review	Globally, the most common cause of maternal death was hemorrhage (27%; 80% uncertainty interval 22–32), followed by indirect obstetric deaths (23%, 18–30), and hypertensive disorders (16%, 14–19). The proportion of hemorrhage deaths varied substantially by region and was highest in sub-Saharan Africa and Western Asia and Northern Africa.
Quiroz-Acuña et al. (2025)	To assess maternal mortality trends in LAC women from 1997 to 2019, providing key insights to address this issue.	ecological observational time-series study	Despite overall progress, regional differences in maternal mortality persist across Latin America and the Caribbean. These variations highlight the importance of strengthening maternal health systems, improving access to skilled birth attendance, and ensuring quality prenatal and postnatal care

Western European Journal of Medicine and Medical Science
Volume 4, Issue 08, August 2026
https://westerneuropeanstudies.com/index.php/3
ISSN (E): 2942-1918 Open Access| Peer Reviewed
This article/work is licensed under CC Attribution-Non-Commercial 4.0

Silvana et al. (2025)	To describe the factors influencing the reduction of maternal mortality during the 2022–2024 management period at Tartagal Hospital (HT)	Participatory Action Research (PAR) with a qualitative-quantitative analysis. Twelve meetings and interviews were conducted with the healthcare team, along with 10 validated surveys administered to obstetric inpatients (10/12/24), and an analysis of hospital databases	intercultural, comprehensive, and territory-based management of pregnancy and childbirth led to a reduction in maternal mortality beginning in 2022. Teamwork and intersectoral collaboration optimized available resources, consolidating a sustainable and effective model for maternal health. However, the greatest challenge lies in maintaining and increasing funding to ensure the continuity of this policy
Nigenda and Serván-Mori (2024)	To discuss the relationship between the availability of human resources for health and the maternal mortality ratio for the period 1990–2021 in Latin America	used secondary data from a global source to show patterns in the relationship between these two aspects and identify gaps in the Latin American and Caribbean regions	Although variations in maternal mortality rate cannot be explained solely through the provision of health personnel, it is important to consider that it is critical to find new modalities on how human resources for health could integrate and create synergies with other resources to increase systems capacity to deliver care according to conditions in each country

Western European Journal of Medicine and Medical Science
Volume 4, Issue 08, August 2026
https://westerneuropeanstudies.com/index.php/3
ISSN (E): 2942-1918 Open Access| Peer Reviewed
This article/work is licensed under CC Attribution-Non-Commercial 4.0

Critto et al. (2022)	To examine the effects of a pandemic influenza virus on cause-specific maternal mortality time series, using Argentinian vital statistics	-conducted a population-based natural experiment from national vital records of maternal deaths between 1980 and 2017 -applied Join-point regression models	Over this 38-year study, the MMR decreased by 58.6% (69.5 to 28.8 deaths/100,000 live births), transitioning from direct obstetric causes (67.0 to 21.1/100,000 live births; 68.4% decrease) to indirect causes (2.6 to 7.7/ 100,000 live births; 196.2% increase)

Methodology

This study utilizes an exponential smoothing technique to model and forecast future trends of MMR for Trinidad and Tobago. In exponential smoothing forecasts are generated from the smoothed original series with the most recent historical values having more influence than those in the more distant past as more recent values are allocated more weights than those in the distant past. This study uses the Holt's linear method (Double exponential smoothing) because it is an appropriate technique for modeling linear data.

Holt's linear method is specified as follows:

Model equation

$X_t=\mu_t + \rho_t \mathbf{t} + \varepsilon_t$

Smoothing equation

$S_t= \alpha X_t + (1-\alpha) (S_{t-1} + b_{t-1})$

$0<\propto<1$

Trend estimation equation

$b_t= \beta (S_t-S_{t-1}) + (1-\beta) b_{t-1}$

$0<\beta<1$

Forecasting equation

$f_{t+h}= S_t + hb_t$

X_t is the actual value of MMR at time t

ε_t is the time varying **error term**

Western European Journal of Medicine and Medical Science
Volume 4, Issue 08, August 2026
https://westerneuropeanstudies.com/index.php/3
ISSN (E): 2942-1918 Open Access| Peer Reviewed
This article/work is licensed under CC Attribution-Non-Commercial 4.0

μ_t is the time varying mean (**level**) term

ρ_t is the time varying **slope term**

t is the trend component of the time series

S_t is the exponentially smoothed value of MMR at time t

α is the exponential smoothing constant for the data

β is the smoothing constant for trend

f_{t+h} is the h step ahead forecast

b_t is the trend estimate (slope of the trend) at time t

b_{t-1} is the trend estimate at time t-1

Data Issues

This study is based on annual MMR in Trinidad and Tobago 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

Exponential smoothing Model Summary

Table 1: ES model summary

Variable	X
Included Observations	39
Smoothing constants	
Alpha (α) for data	0.400
Beta (β) for trend	0.100
Forecast performance measures	
Mean Absolute Error (MAE)	3.731167
Sum Square Error (SSE)	1159.936132
Mean Square Error (MSE)	29.741952
Mean Percentage Error (MPE)	-0.342376
Mean Absolute Percentage Error (MAPE)	7.235866

Residual Analysis for the Applied Model

Western European Journal of Medicine and Medical Science
Volume 4, Issue 08, August 2026
https://westerneuropeanstudies.com/index.php/3
ISSN (E): 2942-1918 Open Access| Peer Reviewed
This article/work is licensed under CC Attribution-Non-Commercial 4.0

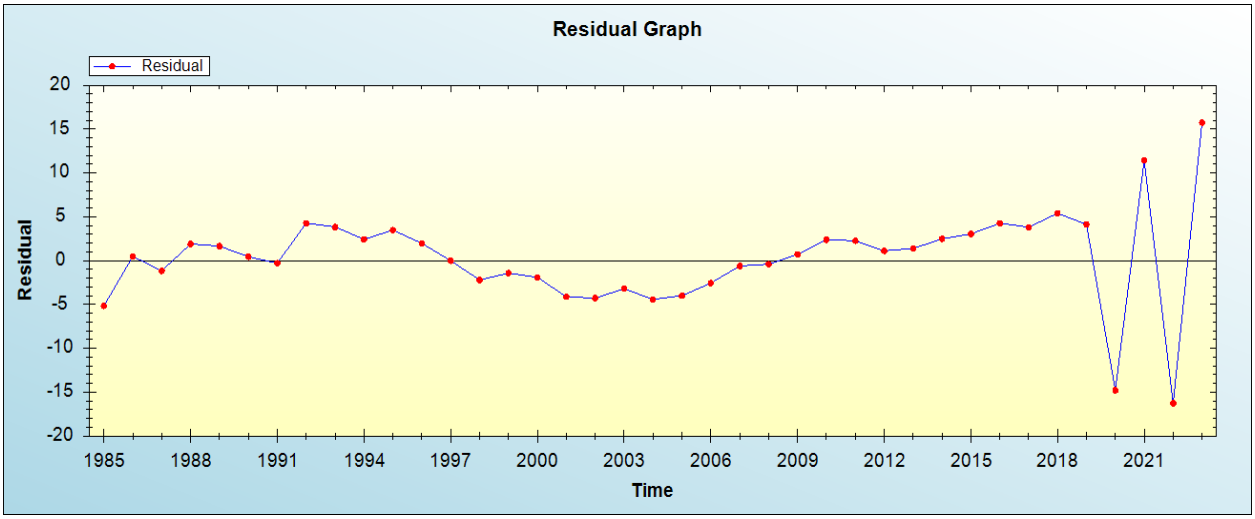


Figure 1: Residual analysis

In-sample Forecast for X

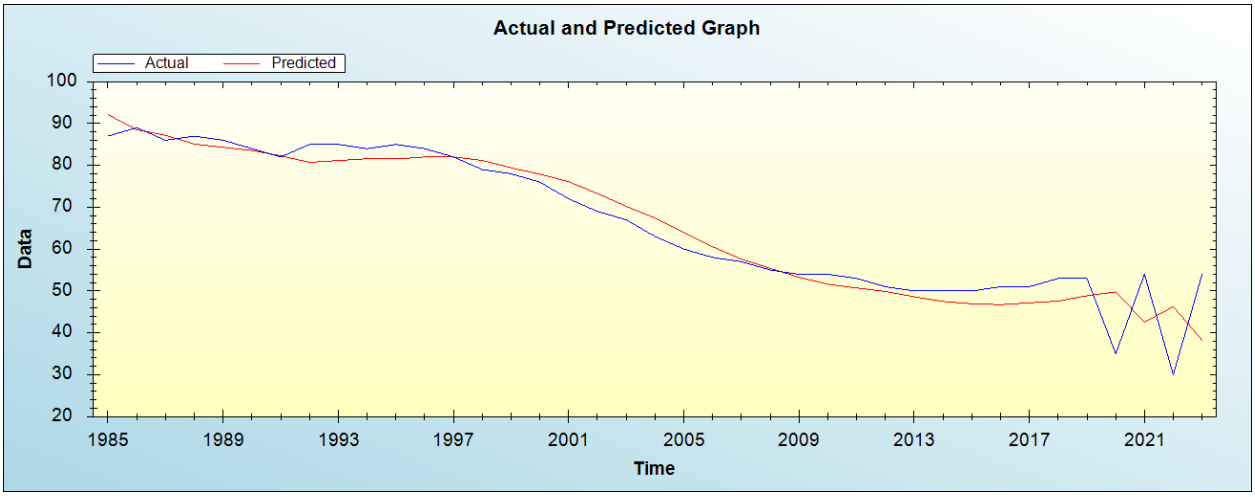


Figure 2: In-sample forecast for the X series

Actual and Smoothed graph for X series

Western European Journal of Medicine and Medical Science
Volume 4, Issue 08, August 2026
https://westerneuropeanstudies.com/index.php/3
ISSN (E): 2942-1918 Open Access| Peer Reviewed
This article/work is licensed under CC Attribution-Non-Commercial 4.0

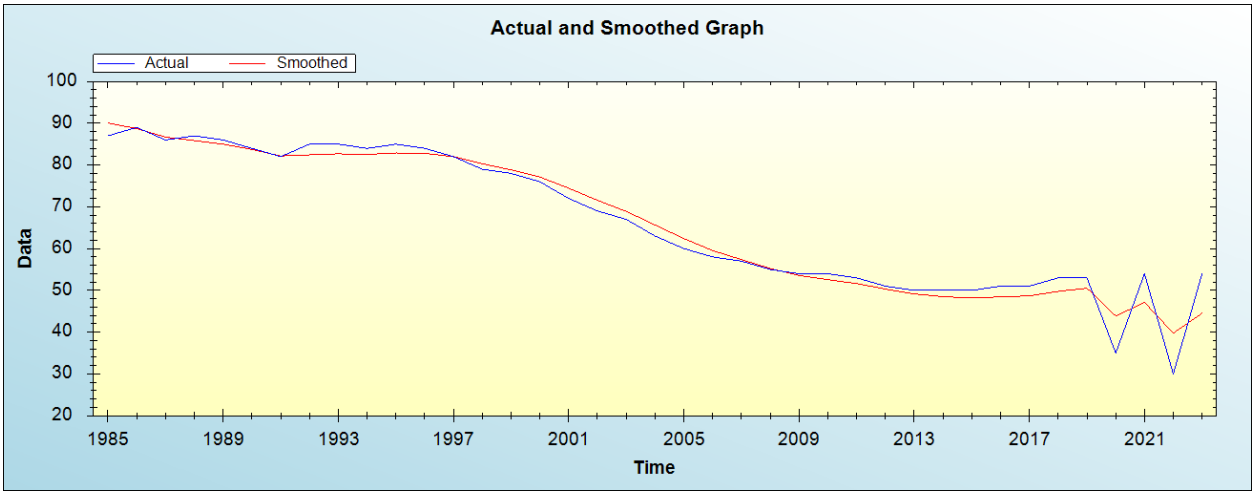


Figure 3: Actual and smoothed graph for X series

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

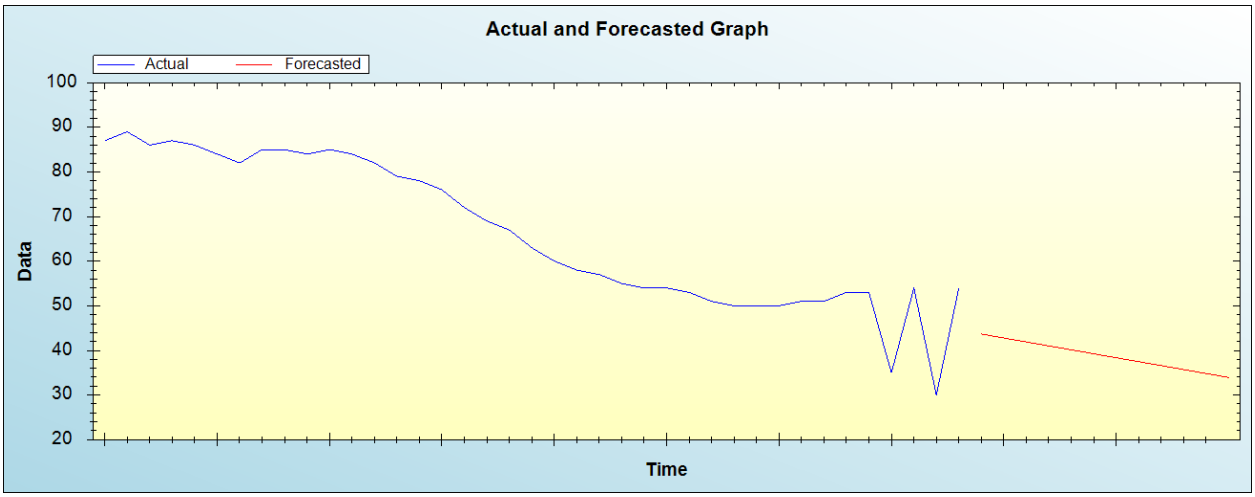


Figure 4: Out-of-sample forecast for X: actual and forecasted graph

Out-of-Sample Forecast for X: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted MMR
2024	43.6641
2025	42.7802
2026	41.8964
2027	41.0126

Western European Journal of Medicine and Medical Science
Volume 4, Issue 08, August 2026
https://westerneuropeanstudies.com/index.php/3
ISSN (E): 2942-1918 Open Access| Peer Reviewed
This article/work is licensed under CC Attribution-Non-Commercial 4.0

2028	40.1288
2029	39.2450
2030	38.3611
2031	37.4773
2032	36.5935
2033	35.7097
2034	34.8259
2035	33.9421

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 fall from around 44 in 2024 to about 34 deaths per 100 000 live births in 2035.

Conclusion

This study applied Holt's double exponential smoothing technique to analyze and project maternal mortality trends in Trinidad and Tobago. The model forecasts a gradual decline in the Maternal Mortality Ratio (MMR), decreasing from approximately 44 deaths per 100,000 live births in 2024 to 34 by 2035. While this downward trajectory reflects positive momentum, sustained progress will require healthcare authorities to proactively address key local drivers of maternal mortality, particularly non-communicable diseases and systemic barriers to high-quality emergency obstetric care.

References

[1] Becerra, A. M., Gómez, C. A., & Torres, L. M. (2026). Adolescent pregnancy and associated maternal complications in Latin America and the Caribbean: A narrative review. *Revista Panamericana de Salud Pública*, 50.
[2] Cresswell, J. A., Campbell, O. M. R., Bohlikkeri, A., Filipovic-Pierucci, A., & Chou, D. (2025). Global, regional, and national causes of maternal mortality: A systematic analysis. *The Lancet Global Health*, 13(2), e215–e226.
[3] Critto, A., Rossi, M., & Fernandez, P. (2022). Impact of pandemic influenza on direct and indirect causes of maternal mortality in Argentina: A 38-year time-series analysis (1980–2017). *BMC Public Health*, 22(1).
[4] Global Health Observatory. (2017). *Maternal mortality ratio (modeled estimate, per 100 000 live births) - Trinidad and Tobago*. World Health Organization.
[5] Marks, F., & Castro, A. (2026). Evolution and impact of maternity waiting homes in Latin America: A systematic review. *International Journal of Gynecology & Obstetrics*, 172(2), 210–222.

Western European Journal of Medicine and Medical Science
Volume 4, Issue 08, August 2026
https://westerneuropeanstudies.com/index.php/3
ISSN (E): 2942-1918 Open Access| Peer Reviewed
This article/work is licensed under CC Attribution-Non-Commercial 4.0

[6] Nigenda, G., & Serván-Mori, E. (2024). Human resources for health and maternal mortality in Latin America and the Caribbean (1990–2021): Progress, challenges, and regional disparities. *Human Resources for Health*, 22(1).
[7] Quiroz-Acuña, R., Morales, J., & Silva, C. (2025). Trends in maternal mortality ratios in Latin America and the Caribbean (1997–2019): An ecological time-series analysis. *Bulletin of the World Health Organization*, 103(3), 180–191.
[8] Silvana, M., Juarez, G., & Romero, E. (2025). Strategies for reducing maternal mortality through intercultural and territory-based care in Argentina: A participatory action research study. *Salud Colectiva*, 21, Article e4521.
[9] Tsushima, T., Takahashi, K., & Sato, Y. (2026). Postpartum body mass index changes and long-term risk of dysglycemia and dyslipidemia after gestational diabetes mellitus: A prospective cohort study. *Diabetes Care*, 49(3), 512–520.
[10] World Health Organization. (2018). *Country cooperation strategy at a glance: Trinidad and Tobago*. World Health Organization.
[11] Yue, L., Zhang, Y., Wang, X., Liu, H., & Chen, Z. (2026). Systemic lupus erythematosus, Sjögren's syndrome, and antiphospholipid syndrome in pregnancy and assisted reproduction: An umbrella review. *Human Reproduction Update*, 32(1), 88–104.