

# Trends in the Under-five Mortality and Disparities between Regions in Kenya

Shikuku, Eric Odongo<sup>1</sup>

<sup>1</sup>Institute of Mathematical Sciences, Strathmore University, Nairobi, Kenya

# Outline

## Table of Contents

- ▶ Introduction
- ▶ Literature review
- ▶ Methodology
- ▶ Results and interpretation
- ▶ Discussions, Conclusions and Recommendations

# Background of the Study

- ▶ Time-to-event analysis or survival analysis is widely used when the outcome/dependent variable relates to the time taken until the occurrence of a pre-specified event. These methods consider censoring mechanisms to ensure accurate analysis without discarding information on participants who fail to experience the event of interest within the study period.
- ▶ This study focused on analyzing the time taken until the death of an infant due to the top five major causes, which include preterm birth complications, low birth weight, intrapartum growth restrictions, neonatal infections, and congenital malformations (Imbo et al., 2021).

# Statement of the Problem

- ▶ Despite various public health interventions aimed at reducing the mortality of children below five years, under-five mortality remains a significant public health challenge in Kenya. Numerous studies have analyzed the determinants of mortality for children under five years of age, but still there is a gap in understanding regional disparities in these mortality rates between regions and trends since 2000.
- ▶ This research sought to fill this gap by looking at the disparities between regions and trends by reconstructing Demographic Health Surveys from 2000 to 2022. These findings aimed to inform policy and improve public health interventions to reduce mortality rates of under-five years of age.

# Research Objectives

The study's main objective was to examine the disparity between regions and the yearly trends in the mortality rates of the under-fives since 2000.

## Specific Objectives

- ▶ i) To examine the extent of regional disparities in the trends in child mortality in Kenya using data from the DHS survey.
- ▶ ii) To identify key socio-economic, demographic, and healthcare-related determinants contributing to regional differences in child mortality trends.

## Research Questions

- ▶ i) What is the extent of regional disparities in trends in child mortality rates?
- ▶ ii) What are the key socio-economic, demographic, and healthcare-related determinants that contribute to regional differences in child mortality trends?

# Justification of the Study

This study was helpful because it highlighted how various regions of the country are performing in terms of reducing the national burden of under-five mortality. Variations in known factors associated with mortality among children aged five years and under in regions will help to develop appropriate public health intervention mechanisms. The yearly trends were useful in knowing whether these rates are declining or increasing over time and whether these trends are significant or not.

# Literature Review

- ▶ Kimani-Murage et al. (2014) analyzed trends in child mortality in Kenya and found a general decline over three decades. However, disparities between rural and urban areas persisted, with rural regions experiencing slower mortality reductions.
- ▶ Similar studies in Uganda and East Africa (Nasejje et al., 2015) and (Tesema et al., 2021) confirmed these patterns, indicating that socioeconomic and healthcare access differences drive regional disparities.
- ▶ Macharia et al. (2019) examined under-five mortality trends in Kenya since 1965 and found a 61.6% national decline. However, county-level variations were significant, with some regions showing mortality rates nearly four times higher than others.



# Literature Review

- ▶ Macharia et al. (2019) examined under-five mortality trends in Kenya since 1965 and found a 61.6% national decline.
- ▶ The current study built upon those findings by reconstructing yearly trends from 2000 to 2022 to understand regional disparities better.
- ▶ Victora et al. (2003) emphasized the role of poverty in child mortality, noting that children from low-income families experience higher mortality rates due to inadequate nutrition and healthcare access.
- ▶ Tesema et al. (2021) used a multilevel Weibull regression model to identify key determinants of under-five mortality in East Africa. Their findings highlighted the importance of maternal education, wealth index, and antenatal care in reducing mortality rates.

# Methodology

- ▶ This research was based on cross-sectional data collected under the Kenya Demographics Health Survey (KDHS) program between 2003 and 2022. The sample size included all children born in the last five years before the data collection dates.
- ▶ The outcome variable measured the duration from birth to the death of a child under the age of five. If a child passed away within the first five years of life, it was classified as an event. Meanwhile, children who remained alive throughout the study period were treated as censored observations.

# Methodology

## Research Approach

- ▶ A quantitative research approach using secondary data for analysis. The research utilized data from the KDHS (2003 - 2022) to analyze trends and disparities in under-five mortality across different regions in Kenya.

## Research Design

- ▶ A longitudinal study design was used to examine historical trends and regional disparities in under-five mortality over time. This design was appropriate as it allowed for an in-depth analysis of time-based trends and their associated determinants.

# Methodology

## Study Population and Sample

- ▶ The study population comprises children under five years whose information is captured in the KDHS datasets from 2003 to 2022. The sample included all singleton births occurring within one to five years before each survey period.

## Data Collection and Sources

- ▶ Secondary data was sourced from KDHS surveys conducted between 2003 and 2022. The datasets contained demographic, socioeconomic, maternal health, and child health indicators

# Methodology

## Dependent variable

- ▶ Time (in months) until the death of an infant before celebrating their fifth birthday.

## Independent variables

- ▶ The independent variables considered in the Cox regression models are sex of the child, mother's level of education, analysis period, region, smoking status of the mother, wealth index, age of the mother, type of residence, and preceding birth interval in months.

# Methodology

## Conceptual Framework and Research Gap

- ▶ The conceptual framework - A multi-variable determinant model that incorporated demographic, socioeconomic, healthcare, and environmental factors that influence mortality among under-fives. The framework hypothesized that socioeconomic disparities, accessibility to healthcare care, and maternal characteristics collectively influence the survival of children under five years of age.
- ▶ The research gap addressed in this study is the limited focus on regional disparities and the temporal trends in mortality among under-fives in Kenya. Although previous studies have analyzed national mortality trends, fewer studies have explored how these determinants vary between regions over time.

## The statistical model

- ▶ The main survival method - The Cox regression model.
- ▶ The Cox model does not impose a specific probability distribution model on the survival times, the only assumption it imposes is that of proportional hazard.
- ▶ The general form of this model is;

$$h_i(t) = \exp(\beta_1 x_{1i} + \beta_2 x_{2i} + \dots + \beta_p x_{pi}) h_0(t), \quad (1)$$

where  $h_0(t)$  is the baseline hazard function at time  $t$  while  $h_i(t)$  is the hazard function for the  $i^{th}$  individual at time  $t$ .

$\beta = (\beta_1, \beta_2, \dots, \beta_p)'$  is the vector of coefficients of the  $p$  independent variables in the model.

# Methodology

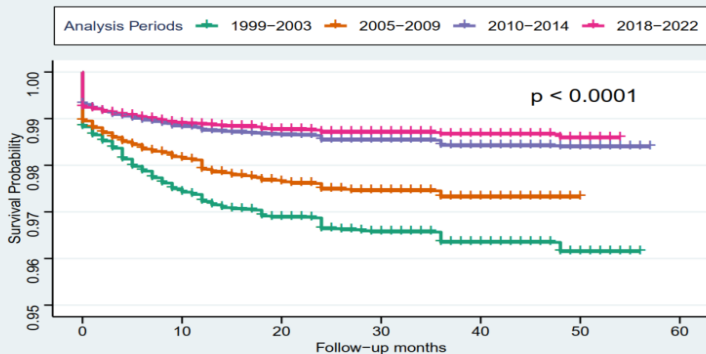
## Specific Statistical Methods

- ▶ To compare survival experience among categorical variables.
  - ▶ Stratified Kaplan-Meier curves for visual comparison.
  - ▶ Stratified log-rank test to statistically compare differences.
- ▶ To identify the key socio-economic, demographic, and healthcare-related determinants that contribute to the regional differences in child mortality trends.
  - ▶ Cox Proportional Hazards regression model was employed. This model is chosen for its effectiveness in estimating the hazard ratio for each determinant while accounting for censoring in the data.



# Results and Interpretation

## Survival Experience stratified by Period



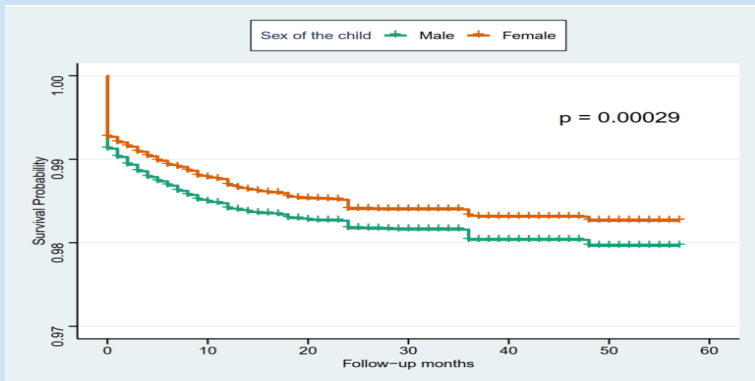
# Results and Interpretation

## Interpretation

- ▶ The 1999 - 2003 cohort (green) has the lowest survival probability throughout the follow-up period.
- ▶ The 2005 - 2009 cohort (orange) performs slightly better but still has lower survival than later periods.
- ▶ The 2010 - 2014 cohort (purple) shows further improvement in survival.
- ▶ The 2018 - 2022 cohort (pink) has the highest survival probability, indicating significant progress in survival outcomes over time.
- ▶ The p-value suggests that the observed differences are statistically significant.

# Results and Interpretation

## Survival Experience stratified by gender



# Results and Interpretation

## Interpretation

- ▶ Female children (orange) have consistently higher survival probabilities than male children (green) throughout the follow-up period.
- ▶ Male children have a steeper decline in survival, indicating a higher risk of mortality.
- ▶ The p-value suggests that the observed differences are statistically significant.

# Results and Interpretation

## Distribution of mortality rates across regions

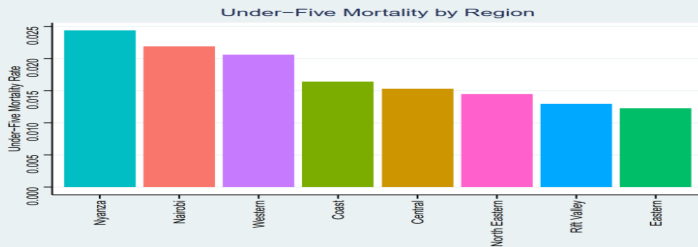


Table 2: Under-five mortality by region

	region	u5m	se
Nairobi	Nairobi	0.0202769	0.0027486
Central	Central	0.0131560	0.0013016
Coast	Coast	0.0167918	0.0014267
Eastern	Eastern	0.0140185	0.0012690
Nyanza	Nyanza	0.02275774	0.0015989
Rift Valley	Rift Valley	0.0136017	0.0007869
Western	Western	0.0191450	0.0015399
North Eastern	North Eastern	0.0149772	0.0014206

# Results and Interpretation

## Interpretation

- ▶ The highest under-five mortality rate is observed in Nyanza (0.0276 or 27.6 deaths per 1,000 live births), followed by Nairobi (0.0203 or 20.3 per 1,000).
- ▶ The lowest mortality rates are in the central (0.0132 or 13.2 per 1,000) and Rift Valley (0.0136 or 13.6 per 1,000).
- ▶ There are significant regional disparities in under-five mortality rates, with Nyanza and Nairobi facing the highest child mortality burdens, while Central and Rift Valley have the lowest.

# Results and Interpretation

## Adjusted Cox Regression Model

Table 4.12: Results for the adjusted model

Characteristic	HR	95% CI	p-value
<b>Wealth Index</b>			
Poorest	—	—	—
Poorer	1.13	(0.95, 1.35)	0.2
Middle	1.09	(0.91, 1.32)	0.4
Richer	0.99	(0.80, 1.22)	>0.9
Richest	1.41	(1.12, 1.79)	0.004
<b>Age of the mother</b>	1.00	(0.99, 1.01)	0.8
<b>Sex of the child</b>			
Male	—	—	—
Female	0.81	(0.72, 0.92)	<0.001
<b>Smoking Status</b>			
No	—	—	—
Yes	1.21	(0.54, 2.74)	0.6
<b>Type of residence</b>			
Urban	—	—	—
Rural	1.13	(0.95, 1.35)	0.2
<b>Preced-birth-interval-months</b>	1.00	(1.00, 1.00)	0.070

Abbreviations: CI = Confidence Interval, HR = Hazard Ratio

# Results and Interpretation

## Interpretation

- ▶ **Wealth Index:** Richest category associated with a 41% higher hazard. ( $p = 0.004$ ).
- ▶ **Age of the mother:** Does not significantly impact survival in this model.
- ▶ **Sex of the child:** Female children have significantly better survival compared to males ( $HR = 0.81$ ,  $p = 0.001$ ).
- ▶ **Smoking status:** Does not significantly impact survival in this model ( $p = 0.6$ ).
- ▶ **Type of residence:** There are no significant differences.
- ▶ **Preceding birth interval:** It may have a small impact but is not strongly significant.



# Results and Interpretation

## Assessing the PH assumptions

Table: PH assumptions for the adjusted model

	Chisq	df	p
Wealth Index	5.7	4	0.2
Age of the mother	2.1	1	0.2
Sex of the child	0.1	1	0.7
Smoking Status	1.0	1	0.3
Type of residence	0.0	1	0.8
Preceding-birth-interval	0.1	1	0.8
Global	10.9	9	0.3

# Discussions, Conclusions and Recommendations

## Addressing Research Questions

The specific research questions were:

- ▶ 1. What is the extent of regional disparities in under-five mortality trends in Kenya between 2003 and 2022?
- ▶ 2. What are the key socio-economic, demographic, and healthcare determinants influencing these regional disparities?

# Discussions, Conclusions and Recommendations

Based on the results:

- ▶ **Regional Disparities:** The study confirmed significant regional disparities in child mortality rates. Regions such as Nyanza and Western exhibited higher mortality risks compared to Nairobi and Central Kenya.
- ▶ **Key Determinants:** The adjusted Cox regression model identified maternal education, wealth index, and sex of the child as key determinants.
- ▶ **Trends Over Time:** Child survival has improved over time, with later periods (2010 - 2014 and 2018 - 2022) showing significantly higher survival probabilities than earlier periods (1999 - 2003).

# Discussions, Conclusions and Recommendations

## Interpretation of Findings

- ▶ These findings align with existing literature that highlights disparities in healthcare access, maternal education, and economic inequalities as primary drivers of child mortality variations.
- ▶ The survival improvement over time suggests that national and global initiatives, including immunization programs and maternal health interventions, have contributed to reduced under-five mortality.
- ▶ The unexpected increase in hazard for the wealthiest households warrants further investigation. It may indicate under-utilization of healthcare services, or differences in reporting child deaths.

# Discussions, Conclusions and Recommendations

## Limitations of the Study

- ▶ **Data Quality:** The study relied on secondary data, which may be subject to reporting biases and misclassification errors.
- ▶ **Unmeasured Confounders:** Some potential determinants of child mortality, such as environmental factors and healthcare infrastructure quality, were not included in the KDHS datasets.
- ▶ **Censoring Issues:** Survival analysis methods require assumptions about censoring, which may affect the interpretation of results.

# Discussions, Conclusions and Recommendations

## Conclusions

- ▶ The study concludes that regional disparities in child mortality persist in Kenya, with significant differences in survival rates between regions.
- ▶ Maternal education, household wealth index, and the sex of the child are key determinants influencing child survival outcomes.
- ▶ Over the years, mortality rates have declined, suggesting that public health interventions have had a positive impact.
- ▶ As a country we are on track for achieving the 2030 target for reducing mortality rates to 25 deaths per 1000 live births, because according to the results as of the 2022 survey, the mortality rate was 11.6.

# Discussions, Conclusions and Recommendations

## Policy recommendations

- ▶ To Strengthen maternal education programs to empower women with knowledge on child health and nutrition.
- ▶ Expand healthcare access in high-mortality regions, particularly Nyanza and Western Kenya, through targeted investments.
- ▶ To improve data collection and reporting mechanisms to address inconsistencies in mortality estimates across different economic groups.

# Discussions, Conclusions and Recommendations

## Recommendations for future research

- ▶ To conduct qualitative studies to understand healthcare-seeking behaviors among different socio-economic groups.
- ▶ To explore the role of environmental factors and healthcare infrastructure in child mortality disparities.
- ▶ To apply machine learning techniques to enhance predictive modeling of child mortality trends.



# QA session