MAKERERE UNIVERSITY

A MULTI-LEVEL STATISTICAL MODELING OF THE DETERMINANTS OF NEONATAL MORTALITY IN UGANDA

BY

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DECLARATION

I Karungi Bonitah hereby declare that this dissertation entitled: "A MULTI-LEVEL STATISTICAL MODELING OF THE DETERMINANTS OF NEONATAL MORTALITY IN UGANDA" is my original work and has not been submitted to Makerere University or any other institution for the award of any academic qualification. The information presented in this dissertation has been obtained from authentic sources and all materials used from other authors have been duly acknowledged through citations and references.

Signature: _____ Date: 9/07/2026.

Name: Karungi Bonitah

APPROVAL

This is to certify that this dissertation has directly been under my supervision and is ready for submission to the Department of Statistical Methods and Actuarial Science of the College of Business and Management Sciences of Makerere University.

Signature: _____ Date: 09.07.2026

DR. WANDIEMBE SYMON PETER

DEDICATION

I dedicate this dissertation first and foremost to Almighty God for his guidance, wisdom and strength throughout my studies. I also dedicate it to my parents and family for their unwavering love, prayers, encouragement and sacrifices which have enabled me to reach this milestone. I also dedicate it to my lecturer Dr. Wandiembe Symon Peter who has assisted and guided me while compiling my dissertation. I appreciate all the work done to enable me reach this far.

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LIST OF ABBREVIATIONS

AOR	Adjusted Odds Ratio
CHWs	Community Health Workers
CI	Confidence Interval
ICC	Intra-Class Correlation Coefficient
LRT	Likelihood Ratio Test
UBOS	Uganda Bureau of Statistics
UDHS	Uganda Demographic and Health Survey
VHTs	Village Health Teams
MOH	Ministry of Health
WHO	World Health Organization
SDG	Sustainable Development Goal

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ABSTRACT

Neonatal mortality remains a major public health challenge in Uganda despite improvements in maternal and newborn healthcare services. This study aimed to determine the maternal socioeconomic, neonatal, household environmental and community-level factors associated with neonatal mortality in Uganda using a multilevel logistic regression approach. The study employed a cross-sectional analytical design using secondary data from the 2022 Uganda Demographic and Health Survey (UDHS). A total of 18,178 live births nested within 680 community clusters were included in the analysis among which 118 neonatal deaths were recorded. Data were analyzed using Stata version 16. Descriptive statistics were used to summarize the study variables, chi-square tests examined bivariate associations and multilevel logistic regression models were fitted to account for the hierarchical structure of the data. The empty model revealed significant community-level clustering of neonatal mortality (ICC = 14.23%, LR test, p = 0.035) justifying the use of multilevel modelling. At the bivariate level, household wealth index ($\chi^2 = 11.203$, p = 0.024) and place of residence ($\chi^2 = 6.429$, p = 0.011) were significantly associated with neonatal mortality. In the intermediate multilevel model, neonates from households in the second wealth quintile had significantly higher odds of neonatal mortality than those from the poorest households (AOR = 2.159, p = 0.010). In the final multilevel model, after adjusting for maternal socioeconomic, neonatal, household environmental and community-level factors, household toilet facility remained the only statistically significant determinant of neonatal mortality with households having improved toilet facilities exhibiting higher odds of neonatal mortality than those with unimproved facilities (AOR = 5.480, p = 0.020). Although this association was contrary to expectations it should be interpreted cautiously because it may reflect residual confounding or unmeasured factors not captured in the dataset. The study concludes that neonatal mortality in Uganda is influenced by household socioeconomic conditions, household environmental characteristics and community-level factors. The findings highlight the importance of strengthening socioeconomic support, improving maternal and newborn healthcare services, addressing contextual community differences and conducting further research to better understand the unexpected association between household sanitation and neonatal mortality

CHAPTER ONE: INTRODUCTION

1.0 Introduction

This chapter presents the background of the study, the statement of the problem, the objectives, the research questions, the hypotheses, the justification, and the scope of the study on the determinants of neonatal mortality in Uganda. Neonatal mortality remains a major public health concern globally, regionally and in Uganda, despite ongoing interventions to improve maternal and newborn health outcomes.

1.1 Background

Globally, neonatal mortality remains a major contributor to deaths among children under five years of age. According to the World Health Organization, approximately 45% of deaths among children under five occur during the neonatal period, which is the first 28 days of life(Organization, 2014).

Although developed countries have significantly reduced neonatal deaths through improved healthcare systems, low-income countries continue to experience high neonatal mortality rates due to inadequate maternal and newborn healthcare services. In Europe, only 5.9 babies per 1,000 live births fail to survive beyond 28 days, whereas in Africa and parts of Asia, the neonatal mortality rate is four to five times higher(Merab, 2017).

Sub-Saharan Africa bears the greatest burden of neonatal mortality worldwide. It is estimated that about 1.2 million newborns die every year within the region(Moges et al., 2024), translating to approximately 13,000 deaths every day or almost nine deaths every minute . The high neonatal mortality burden in sub-Saharan Africa has been attributed to poverty, inadequate health infrastructure, shortage of skilled health personnel, poor maternal healthcare utilization, and preventable neonatal complications such as infections and birth asphyxia(Jena & Jaldo, 2025).

Uganda is among the ten countries globally contributing the highest neonatal mortality rates in the world(Merab, 2017). A review conducted at Nsambya Hospital involving 173 audited perinatal deaths revealed that 99 deaths, representing 57.2%, were neonatal deaths(Kirabira et al., 2020). Reports from the Uganda Ministry of Health indicate that at least 45,000 neonatal deaths and an equal number of stillbirths occur annually in Uganda. Uganda’s neonatal mortality

rate has remained persistently high at approximately 28 deaths per 1,000 live births over many years, despite interventions aimed at improving maternal and child health service(Rwashana et al., 2014).

The major causes of neonatal mortality in Uganda are similar to those reported in other sub-Saharan African countries and include birth asphyxia, neonatal infections, prematurity, tetanus, pneumonia, diarrhea, and complications related to low birth weight (Merab, 2017). Underlying factors contributing to these deaths include poor access to healthcare services during pregnancy and childbirth, low utilization of antenatal and postnatal care services, poverty, inadequate skilled birth attendance, and delayed healthcare-seeking behavior among mothers.

As a result, many neonatal deaths occur among rural poor communities and vulnerable populations with limited access to quality healthcare services. According to the Uganda Bureau of Statistics, Uganda's neonatal mortality rate stood at 27 deaths per 1,000 live births by 2016(Ssekamatte-Ssebuliba). Neonatal deaths account for approximately 41% of all under-five deaths, emphasizing the importance of interventions targeting neonatal survival(Lawn et al., 2014). In low-income countries, nearly half of mothers and newborns do not receive skilled care during childbirth and immediately after delivery, yet studies suggest that about two-thirds of neonatal deaths can be prevented through effective healthcare interventions provided during pregnancy, delivery, and the first week of life(Lassi & Bhutta, 2015).

In Uganda, approximately 141,000 children die before reaching their fifth birthday every year, and 26% of these deaths occur during the neonatal period(Prisca et al., 2024). Between 2000 and 2010, Uganda's neonatal mortality rate declined by only 2.2% annually, which was insufficient to create a significant reduction in child mortality statistics(Kananura et al., 2016). This slow decline indicates persistent challenges in maternal and neonatal healthcare service delivery despite national and international interventions aimed at reducing child mortality(Boerma et al., 2018).

To reduce neonatal mortality, several interventions have been implemented in Uganda, including promoting antenatal care attendance, improving skilled birth attendance, strengthening immunization services, encouraging exclusive breastfeeding and utilizing Community Health Workers (CHWs), locally known as Village Health Teams (VHTs), to sensitize communities on newborn care practices. Community Health Workers have played an important role in mobilizing

pregnant women to attend antenatal clinics, deliver from health facilities, attend postnatal care services, and recognize neonatal danger signs for timely healthcare seeking(Wafula et al., 2024).

Despite these interventions, neonatal mortality in Uganda has remained persistently high over the years(Rwashana et al., 2014). Although national reports indicate slight improvements in neonatal survival, the mortality rate remains above the global targets for child survival. This situation calls for further analysis of the factors associated with neonatal mortality, particularly within healthcare institutions that manage high-risk pregnancies and neonatal complications. Therefore, this study is important in identifying the factors associated with neonatal mortality at the hospital so as to provide evidence that can guide interventions aimed at improving neonatal survival outcomes.

1.2 Problem Statement

According to Sustainable Development Goal 3.2, all countries are expected to reduce neonatal mortality to at least 12 deaths per 1,000 live births by the year 2030(Lawn et al., 2023). Despite global and national interventions aimed at improving maternal and newborn health, neonatal mortality remains a significant public health challenge in Uganda. Although Uganda has registered slight improvements in child survival over the years, neonatal mortality has remained persistently high at about 22–27 deaths per 1,000 live births, which is still above the global target.

Several interventions have been put in place to boost newborn survival in Uganda including strengthening antenatal care services, promoting skilled birth attendance, improving emergency obstetric care and utilizing Community Health Workers (CHWs) also known as Village Health Teams (VHTs) to raise awareness in communities about maternal and newborn care practice(Merab, 2017). These CHWs have played a role in encouraging pregnant women to attend antenatal care, deliver at health facilities, seek postnatal care, and recognize neonatal danger signs for prompt healthcare action(Merab, 2017).

Although clinical causes such as birth asphyxia, prematurity, neonatal sepsis and low birth weight remain common contributors to neonatal deaths there is still limited statistical evidence explaining how maternal socioeconomic conditions, neonatal biological factors and household environmental factors collectively influence neonatal mortality. Even with specialized maternal

and neonatal healthcare facilities available in parts of the country such as national referral hospitals, neonatal mortality remains a concern nationally due to delayed referrals, congestion in public health facilities and disparities in healthcare access between different regions and between urban and rural populations. Furthermore, there is limited published research that comprehensively models the determinants of neonatal mortality across Uganda using secondary datasets and advanced statistical approaches.

Therefore, this study seeks to analyze the maternal, neonatal, socioeconomic, household environmental and community-level factors associated with neonatal mortality in Uganda. The findings of this study provide evidence-based information that can support policymakers, health planners and healthcare providers in designing targeted interventions aimed at reducing neonatal mortality and improving newborn survival outcomes across the country.

1.3 Research Objectives

1.3.1 General Objective

To analyze the maternal, neonatal, socioeconomic and household environmental factors associated with neonatal mortality in Uganda .

1.3.2 Specific Objectives

1. To examine the distribution of neonatal mortality across different maternal socioeconomic demographic and community level characteristics in Uganda.
2. To determine the association between neonatal characteristics such as sex, birth order and neonatal survival outcomes.
3. To assess the influence of household environmental factors such as source of drinking water, type of toilet facility on neonatal mortality in Uganda.

1.4 Null Hypotheses

H_{o1}**:** Maternal education level has no significant relationship with neonatal mortality in Uganda.
H_{o2}: Household wealth index has no significant relationship with neonatal mortality in Uganda.
H_{o3}: Maternal age has no significant relationship with neonatal mortality in Uganda

H_{04}: The sex of the newborn does not significantly affect neonatal mortality in Uganda.
H_{05}: Birth order does not significantly affect neonatal mortality in Uganda.
H_{06}: The source of drinking water used by a household is not significantly associated with neonatal mortality in Uganda.

H_{07}: The type of toilet facility used by a household is not significantly associated with neonatal mortality in Uganda.

H_{08}: Place of residence (urban/rural) and region have no significant relationship with neonatal mortality in Uganda.

1.5 Justification of the Study

This study provides a rigorous, data-driven analytical approach to understanding neonatal survival across Uganda. Neonatal mortality remains a persistent public health challenge despite improvements in maternal and child health programs and the expansion of healthcare infrastructure in Uganda. Therefore, there is a need to move beyond descriptive assessments and apply advanced statistical modeling techniques to identify the underlying determinants of neonatal deaths.

By utilizing secondary data sources such as the Uganda Demographic and Health Survey (UDHS)2022, this study achieves broader population coverage, improved statistical power and cost effectiveness compared to primary data collection. This approach also avoids ethical and logistical challenges associated with collecting sensitive neonatal outcome data directly from affected families.

The findings from this study generate evidence-based insights that can support the Ministry of Health, district health authorities, and other stakeholders in designing targeted maternal and newborn health interventions. These include promoting maternal education and economic empowerment programs, strengthening support for mothers based on neonatal risk characteristics such as birth order and improving household access to clean drinking water and proper sanitation facilities to address the environmental conditions that influence neonatal survival outcomes across the country.

1.6 Scope of the Study

1.6.1 Content Scope

The study focused on identifying and analyzing maternal, neonatal, socioeconomic and household environmental factors associated with neonatal mortality. Key variables included maternal education, wealth status, sex of the newborn, birth order, source of drinking water, type of toilet facility.

1.6.2 Geographical Scope

The study covered Uganda as a whole drawing on data from all regions captured in the 2022 Uganda Demographic and Health Survey. This national coverage allowed the findings to reflect variations in neonatal mortality between both urban and rural areas as well as across different regions of the country.

1.6.3 Data Scope

The study relied on secondary data particularly nationally representative datasets that is the Uganda Demographic and Health Survey (UDHS)2022.

1.6.4 Time Scope

The study used data from the 2022 Uganda Demographic and Health Survey conducted at a single point in time though the birth and death information used covers the five years before the survey.

1.7 Conceptual framework

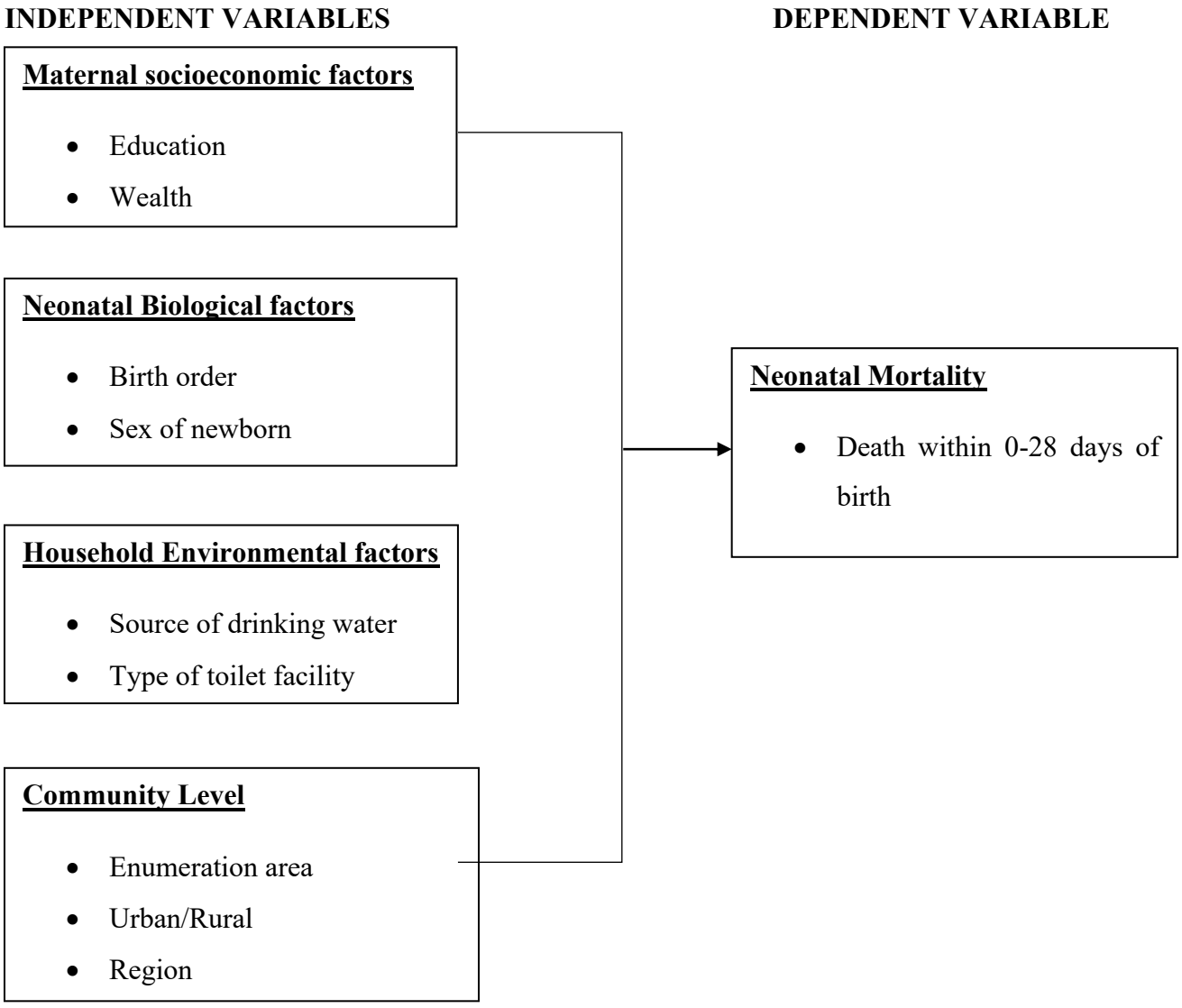

Figure 1: Conceptual framework

The conceptual framework above shows the relationship between the independent variables (maternal socioeconomic factors, neonatal characteristics, household environmental factors and community-level factors) and the dependent variable (neonatal mortality). It shows how maternal education and wealth, the biological characteristics of the newborn, household sanitation and water conditions and the cluster and regional environment in which a mother and child live directly affect the likelihood of neonatal mortality in Uganda. This framework guided the selection of study variables and provided a structured approach for the multilevel statistical modeling and analysis used in this study.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter reviews existing literature on the factors that affect neonatal mortality in Uganda. It is structured around the study's specific objectives, focusing on how maternal socioeconomic factors, neonatal characteristics, household environmental factors and community-level factors affect neonatal mortality. The chapter also identifies key gaps in previous research and combines scholarly arguments to support the current study.

2.1 Theoretical Review

This study was guided by the Mosley and Chen Framework for Child Survival which explains how social, economic and environmental factors influence child survival through biological and health-related pathways. The framework was developed to bridge social science and medical approaches in understanding child mortality. According to the framework, socioeconomic determinants such as maternal education, household wealth and place of residence affect child survival indirectly through proximate determinants including maternal health status, environmental contamination, nutrient deficiency, injuries, and access to healthcare services. The theory is relevant to this study because neonatal mortality is influenced by both individual-level factors and contextual factors. Maternal education and wealth may determine healthcare utilization and newborn care practices(Bobo et al., 2017). While household environmental conditions such as water source and sanitation may increase exposure to infections(Budge et al., 2022). Community-level factors including region and residential setting may further influence access to health services and neonatal survival(Huda et al., 2016).Therefore, the Mosley and Chen Framework provides a suitable foundation for understanding the pathways through which maternal socioeconomic, neonatal, household environmental and community factors influence neonatal mortality in Uganda.

2.2 Conceptual Review

2.2.1 Neonatal Mortality

Neonatal mortality refers to the death of a live-born infant within the first 28 days of life. It is one of the most important indicators of maternal and child health and reflects the quality of healthcare services available during pregnancy, childbirth and the postnatal period. Neonatal deaths are classified into early neonatal deaths (0–7 days) and late neonatal deaths (8–28 days).

2.2.2 Maternal Socioeconomic Factors

Maternal socioeconomic factors refer to social and economic characteristics of the mother that influence health-seeking behavior and access to healthcare services. In this study, they include maternal education level and household wealth index. Higher maternal education and better household economic status are associated with improved utilization of maternal health services and better newborn care practices.

2.2.3 Neonatal Characteristics

Neonatal characteristics are biological attributes of the newborn that may affect survival. These include sex of the child and birth order. Male newborns are generally more vulnerable to neonatal complications than females while first births and high-order births have been associated with increased neonatal mortality risks.

2.2.4 Household Environmental Factors

Household environmental factors refer to conditions within the home environment that affect health outcomes. This study focuses on source of drinking water and type of toilet facility. Poor water quality and inadequate sanitation increase the risk of infections, which can indirectly affect neonatal survival.

2.2.5 Community-Level Factors

Community-level factors are characteristics of the broader environment in which mothers and newborns live. These include region, place of residence, and enumeration area characteristics. Such factors influence healthcare accessibility, availability of health facilities and socioeconomic opportunities that affect neonatal survival.

2.3 Empirical review

2.3.1 Maternal socioeconomic factors and neonatal mortality

Socioeconomic and demographic conditions play a significant role in determining neonatal survival outcomes. Studies show that maternal education, household wealth, and decision-making power strongly influence health-seeking behavior and access to maternal and newborn healthcare services (Ministry of Health [MOH], 2010). In contexts where women have limited autonomy, delays in seeking care during pregnancy and delivery increase the risk of neonatal death.(Gautam et al., 2026) reports that neonatal mortality is disproportionately higher among

poor households compared to wealthy households. For example, in India, neonatal mortality is 24 per 1,000 live births among the poorest households compared to 12 per 1,000 among the wealthiest. Similarly, in Sierra Leone, mortality is 42 per 1,000 among the poorest compared to 30 per 1,000 among the richest households. Maternal education is found to be a strong predictor of neonatal survival. Educated mothers are more likely to utilize antenatal care services, practice proper newborn care, and seek timely medical attention (Alem et al., 2022). In Ethiopia, Neonates born to mothers with secondary or higher education have significantly lower mortality risk compared to those born to mothers with no formal education(Aynalem et al., 2021).In Uganda, the Uganda Bureau of Statistics [UBOS] (2007) reports that neonatal mortality is significantly higher among mothers with no formal education compared to those with secondary education(Merab, 2017). Education improves awareness of maternal health services, family planning, and newborn care practices thereby reducing the risk of neonatal death (UNICEF, 2008). Rural-urban disparities also influence neonatal outcomes with rural populations generally experiencing higher mortality rates due to limited access to skilled healthcare services (Lassi et al., 2019).

2.3.2 Neonatal characteristics and neonatal mortality

Neonatal biological characteristics significantly affect survival outcomes. Sex of the newborn is associated with survival differences. UBOS (2007) reports that male neonates in Uganda have approximately 1.8 times higher mortality risk than female neonates during the neonatal period(Merab, 2017). This vulnerability among male newborns has been attributed to biological factors including differences in lung maturity and immune system development at birth. Birth order is also an important predictor of survival. First births have higher mortality risk compared to subsequent births due to maternal inexperience and biological factors during the first pregnancy and delivery (UBOS, 2007). High order births particularly the 5th or later are also associated with increased neonatal mortality risk, largely due to maternal exhaustion and competing household resources by the time later children are born.

2.3.3 Household environmental factors and neonatal mortality

The cleanliness of a household's environment especially its drinking water source and sanitation facilities is closely linked to child health outcomes. In Uganda specifically, unsafe drinking water, poor sanitation and limited hygiene practices remain major contributors to diarrhea

related child deaths (Auma et al., 2024). Although this risk is most strongly documented for diarrheal disease broadly, it points to how household conditions shape a child's exposure to infection from the earliest days of life. A mixed-methods study conducted in Amuru District, Uganda finds that maternity units with poor water supply and sanitation are linked to higher rates of neonatal sepsis and infection among newborns(Hajra Mukasa et al., 2023) and that improving water access and hygiene practices in these facilities contributes to a reduction in neonatal sepsis . This suggests that the environment surrounding childbirth, not just the home itself plays an important role in a newborn's risk of infection during the most vulnerable period of life. Evidence from South Asia further supports this pattern at a broader scale. A study using Demographic and Health Survey data from five South Asian countries finds that access to improved water and sanitation significantly reduces child mortality, although this effect is strongest during the post-neonatal period rather than the first 28 days of life specifically (Ly et al., 2022). This suggests that while household environmental conditions matter for overall child survival their effect on neonatal mortality specifically is less direct than factors closer to the birth itself such as the cleanliness of the delivery setting. Although the relationship is stronger for post-neonatal mortality, household environmental factors remain an important part of the broader living conditions that shape a newborn's chances of survival in Uganda.

2.3.4 Community-Level Factors and Neonatal Mortality

Community and regional differences influence neonatal mortality through variations in healthcare access, socioeconomic development and public health infrastructure. A 2025 pooled analysis of recent Demographic and Health Survey data from sub-Saharan Africa finds that 5.2% of the total variation in neonatal mortality occurs between communities and that the odds of neonatal death are 1.80 times higher in high-risk enumeration areas compared to low-risk enumeration areas in the null model (Akombi, Ghimire, & Renzaho, 2025). The same study finds that individual-level factors alone explain about 35.2% of the total variation in neonatal mortality, but once community-level factors are added alongside individual factors, this rises to 59.6% of the variation explained showing that a model which leaves out community-level factors misses a large part of the picture. This pattern is also observed specifically in East Africa, where Uganda forms part of the region studied. A 2025 multilevel analysis covering eleven East African countries finds that babies born in Uganda have a significantly higher risk of mortality

compared to babies born in Ethiopia, even after individual factors are accounted for, showing that the country and community context itself adds real risk beyond personal characteristics (Zegeye et al., 2025). Studies using multilevel models therefore consistently demonstrate significant grouping of neonatal deaths within communities highlighting the importance of accounting for community-level influences when studying neonatal mortality.

2.4 Research Gap

Although numerous studies have examined determinants of neonatal mortality in Uganda and other Sub-Saharan African countries, several gaps remain. First, many studies have focused on a single district or a small geographic area with limited evidence drawn from a nationally representative sample covering all regions of Uganda. For example, a systems-thinking study of neonatal mortality dynamics in Uganda is limited specifically to Kampala district and explicitly notes that factors found elsewhere in Uganda, such as terrain, extreme poverty, and rural conditions, are not captured in that research. This shows that findings from one part of Uganda cannot simply be assumed to apply nationally, pointing to the need for a study that examines determinants across the whole country. Second, many previous studies have concentrated primarily on clinical and maternal healthcare factors while giving less attention to household environmental conditions and community-level socioeconomic inequalities considered together in a single analytical model. Furthermore, most existing studies have applied conventional logistic regression models that assume independence of observations. However, neonatal outcomes are often clustered within communities and regions violating this assumption. A recent multilevel study of perinatal mortality in East Africa notes that the limited knowledge of the multifaceted factors influencing newborn outcomes in low-resource settings continues to hinder the development of targeted, evidence-based interventions and calls for more comprehensive analyses of individual, socioeconomic and health systems-level drivers within the region. Consequently, there is limited evidence specifically modeling Uganda's own national-level individual and community-level determinants of neonatal mortality using a multilevel statistical framework that simultaneously examines maternal socioeconomic factors, neonatal characteristics, household environmental factors, and community-level influences. Therefore, this study seeks to fill this gap by applying multilevel logistic regression techniques to analyze the determinants of neonatal mortality across Uganda using UDHS 2022 data providing updated

nationally relevant evidence on how much of the variation in neonatal mortality is attributable to community and regional differences.

CHAPTER THREE: METHODOLOGY

3.0 Introduction

This chapter presents the methodology that was used to statistically model the determinants of neonatal mortality in Uganda. It outlines the research design and rationale, data source, study variables and analytical techniques to be employed in the study. The chapter further explains the procedures for data processing, multilevel model estimation and presentation of the study results.

3.1 Research Design and Rationale

This study employed a cross-sectional analytical study design using secondary quantitative data. A cross-sectional design involves analysis of data collected at a single point in time and is appropriate for estimating prevalence and identifying associations between variables.

3.2 Data source

This study relied entirely on secondary data obtained from the Uganda Demographic and Health Survey (UDHS)2022. The UDHS is a nationally representative household survey conducted under the coordination of the Uganda Bureau of Statistics which collects comprehensive information on population, health and nutrition indicators including birth histories, maternal characteristics, household environmental conditions and survival outcomes of children.

All available birth records across Uganda contained in the dataset were used for this study comprising 18178 birth records nested within 680 clusters across 14 regions of which 118 were recorded as neonatal deaths. Data extraction focused on variables relating to maternal socioeconomic characteristics, neonatal characteristics, household environmental factors and community and regional identifiers. No primary data collection was undertaken and the dataset was obtained in Stata format for direct analysis.

3.3 Variables and measurements

Neonatal mortality was found out by asking mothers to talk about all the children they had ever given birth to including whether each child was still alive and if not, how old the child was when it died and a baby was counted as a neonatal death if it died within the first 28 days after birth.

Maternal education was collected by simply asking the mother the highest level of school she had reached then grouping her answer into one of four groups no education, primary, secondary, or higher. Household wealth index was not asked as a direct question but instead UBOS looked at what things a household owned like a TV, radio or bicycle and also looked at things like the floor of the house and where they get water from combining all this information into a score and then dividing households into five wealth groups from poorest to richest. Sex of the newborn was recorded by the interviewer asking the mother whether each child she gave birth to was a boy or a girl. Birth order was found by counting where each child falls among all the children the mother has given birth to for example whether the child was her first, second or seventh born. Source of drinking water was collected by asking the household what they normally use for drinking water which was then grouped into "improved" sources like piped water or boreholes, and "unimproved" sources like rivers or unprotected wells. Type of toilet facility was collected by asking the household what kind of toilet they use which was grouped into "improved" facilities like flush toilets or covered pit latrines and "unimproved" facilities like open or shared pits. Region refers to which of Uganda's regions the household is located in and was used to group the data by area in the analysis. Enumeration area refers to the specific community where each household was found during and was used to group babies from the same community together for multilevel analysis.

3.4 Data Management and Analysis

3.4.1 Data Management

Data obtained from the UDHS 2022 dataset was coded and checked for completeness prior to analysis. Records with missing or incomplete information on key study variables were excluded from the analysis. Each record was assigned a unique identification code to ensure anonymity and the dataset was stored securely in password protected files to prevent unauthorized access. All analysis was conducted using Stata version 16.

3.4.2 Data Analysis

Data analysis was conducted using Stata version 16 in three stages.

Stage 1: Univariate Analysis. Frequencies and percentages were computed for all categorical study variables including maternal education level, household wealth index, sex of the newborn,

birth order, source of drinking water, type of toilet facility, place of residence and region to describe the distribution of the study population and the overall neonatal mortality rate.

Stage 2: Bivariate Analysis. Chi-square tests of independence were conducted to assess the association between neonatal mortality and each independent variable. The chi-square statistic was computed as:

$$\chi^2_{cal} = \sum_{i=1}^{r}\sum_{j=1}^{c}\frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

Where O is the observed frequency, E is the expected frequency in each cell and Σ denotes summation across all cells. A p-value less than 0.05 was considered statistically significant. All variables were considered for inclusion in the multilevel model based on their theoretical importance established in existing literature.

Stage 3: Multilevel Logistic Regression Analysis. Since individual births (Level 1) are nested within community clusters (Level 2), multilevel logistic regression was used to account for the hierarchical structure of the data. Four sequential models were fitted.

Null Model (Model 0)

An empty model with no predictors was fitted first to test for the presence of community-level variation in neonatal mortality. The null model took the form:

$$\ln\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = \beta_{0j} \text{ , where } \beta_{0j} = \gamma_{00} + \mu_{0j}$$

The Intraclass Correlation Coefficient (ICC) was estimated as:

$$ICC = \frac{\sigma^2_\mu}{\sigma^2_\mu + \frac{\pi^2}{3}}$$

Where $\sigma^2 u$ is the between-cluster variance and $\pi^2/3 = 3.29$ is the Level 1 logistic variance. An ICC greater than 5% confirmed that significant community-level clustering existed and that

multilevel modeling was justified. The Likelihood Ratio Test was used to compare the multilevel null model to a conventional logistic regression model.

Random Intercept Models (Models 1, 2, and 3)

Three sequential random intercept models were fitted using the general model:

$$ln\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = \beta_0 + \beta_1 X_{1ij} + \cdots + +\beta_1 X_{kij} + u_j$$

Where π_{ij} is the probability of neonatal death for individual i in cluster j, $\beta_1 \ldots \beta_k$ are fixed effect coefficients for predictors $X_1 \ldots X_k$, and $u_j \sim N\ (0, \sigma_u^2)$ is the community-level random effect.

Model 1 included maternal education level and household wealth index as fixed effects. Model 2 added sex of the newborn and birth order to Model 1. Model 3 (Full Model) added source of drinking water, type of toilet facility, place of residence, and region.

Model fit between nested models was assessed using the Likelihood Ratio Test:

$LRT = -2(\log L_0 - \log L_1)$

Where $\log L_0$ and $\log L_1$ are the log-likelihoods of the simpler and more complex models respectively. Results were reported as adjusted odds ratios (aOR) with 95% confidence intervals (CI), presented in tables and graphs.

3.5 Ethical Considerations

Ethical approval was obtained from the relevant academic and institutional review bodies of Makerere University. Permission was also sought from the custodians of the secondary datasets used in the study.

Since the study used secondary data, no direct interaction with human participants was conducted. However, confidentiality and data protection principles were strictly observed. The dataset was made anonymous and no personal identifiers were disclosed.

3.6 Dissemination of Findings

The findings of this study were disseminated through:

Submission of the final dissertation to Makerere University, College of Business and Management Sciences

Presentation to the School of Statistics and Planning

Sharing results with health policymakers such as the Ministry of Health.

Possible publication in academic journals or conferences

3.7 Limitations of the Study

This study is limited by its reliance on secondary data which restricts control over variable selection and data quality. Key clinical variables such as birth weight, gestational age, antenatal care attendance, place of delivery and skilled birth attendance were not available in the dataset used which limits the depth of biological and healthcare utilization factors that can be examined. However, the available variables are well supported in the literature as determinants of neonatal mortality and provide meaningful socioeconomic, demographic and community-level context to the findings. Additionally, the cross-sectional design limits the ability to establish causal relationships between variables and missing data on certain variables may slightly affect the precision of the estimates.

CHAPTER FOUR: PRESENTATION AND INTERPRETATION OF FINDINGS

4.0 Introduction

This chapter highlights and analyzes the results of the study on the determinants of neonatal mortality in Uganda. The analysis of the results is carried out using data obtained from the Uganda Demographic and Health Survey (UDHS) 2022. The results are analyzed and interpreted in relation to the objectives of the study.

The results were categorized according to the research objectives. First, there were descriptive statistics that show the distribution of neonatal mortality in relation to maternal socio-economic status, neonatal factors, household environment and community level factors. Secondly, bivariate analysis was carried out in order to analyze the association between neonatal mortality and the selected independent variables. Lastly, the analysis of multilevel logistic regression was conducted in order to determine the significant determinants of neonatal mortality.

4.1 Descriptive Characteristics of the Study Population

Descriptive statistics was used to describe the characteristics of the study population. Frequencies and percentages were calculated for all the study variables such as maternal socio-economic characteristics, neonatal characteristics, household environment characteristics and community-level variables. This analysis gives us an idea about the distribution of the sample respondents and the incidence of neonatal deaths in various categories of the explanatory variables. Variables analyzed in this section are the maternal level of education, household wealth index, sex of the child, birth order, drinking water source, type of toilet facility, type of residence, and region.

Table 4. 1: Distribution of Neonatal Mortality

Neonatal Mortality	Frequency	Percentage (%)
Alive	18,060	99.35
Neonatal Death	118	0.65

In the 18,178 live births, 18,060 (99.35%) survived the neonatal period. Neonatal mortality was 0.65 deaths per 100 live births or equivalently 6.5 deaths per 1000 live births.

It is evident from the results that there was low neonatal mortality among the children in the study. Nevertheless, the neonatal deaths recorded during the study signify the presence of some odd factors for neonatal death in Uganda.

Table 4. 2: Sample socio-demographic characteristics and Association Between Neonatal Mortality and Explanatory Variables

Variable	**n**	**Neonatal mortality (1000 live births)**	**χ^2 value**	**p-value**
Maternal Education Level			2.155	0.541
No education	1,062	5.84		
Primary	10,207	56.15		
Secondary	5,690	31.30		
Higher	1,219	6.71		
Wealth Index			11.203	0.024
Lowest	3,241	17.83		
Second	3,402	18.71		
Middle	3,155	17.36		
Fourth	3,508	19.30		
Highest	4,872	26.80		
Sex of Child			0.543	0.461
Male	2,325	50.04		
Female	2,321	49.96		
Place of Residence			6.429	0.011
Urban	6,494	35.72		
Rural	11,684	64.28		

Region			10.453	0.657
Kampala	1,407	7.74		
Buganda	2,736	15.05		
Busoga	1,499	8.25		
Bukedi	1,171	6.44		
Bugisu	1,010	5.56		
Teso	1,334	7.34		
Karamoja	648	3.56		
Lango	1,247	6.86		
Acholi	1,182	6.50		
West Nile	1,525	8.39		
Bunyoro	1,270	6.99		
Tooro	1,283	7.06		
Ankole	1,030	5.67		
Kigezi	836	4.60		

The majority of mothers (56.2%) were from the primary education category while those without any form of education were 5.8%. In terms of household wealth, the highest proportion of the study participants (26.80%) was from the highest wealth quintile. On gender proportions of the children, there was almost an even distribution with 50.04% males and 49.96% being female. The majority of respondents (64.28%) were from the rural areas while the rest (35.72%) were from the urban areas. Buganda region had the highest respondents while Karamoja region had the lowest.

4.2 Bivariate Analysis of Neonatal Mortality and Explanatory Variables

Tests for independence through chi-square test were performed in order to assess the association between neonatal mortality and the chosen socio-economic factors of the mother, neonate, household environment, and community-level factors. The outcomes are shown in Table 4.2.

From the results obtained, it can be noted that wealth index of the households was significantly associated with neonatal mortality (χ^2 = 11.203, p = 0.024) implying that the economic differences in the household settings affect neonatal mortality. In addition, place of residence was significantly associated with neonatal mortality (χ^2 = 6.429, p = 0.011).

For a multilevel logistic model:

$$ICC = \frac{\sigma_u^2}{\sigma_u^2 + 3.29}$$

where:

$\sigma_u^2 = 0.5458312$(community-level variance)

3.29 is the level-1 logistic variance.

$$ICC = \frac{0.5458312}{0.5458312 + 3.29}$$
$$ICC = \frac{0.5458312}{3.8358312}$$
$$ICC = 0.1423$$
$$ICC = 14.23\%$$

Table 4. 3: Empty Multilevel Logistic Regression Model

Parameter	**Estimate**
Community-level variance	0.546
Log likelihood	-710.378
LR test (chibar^2)	3.28
p-value	0.035
ICC (%)	14.23

4.3 Multilevel Logistic Regression Analysis

4.3.1 Empty Model (Model 0)

In order to find out whether there is a significant variability in neonatal mortality among different communities, an empty multilevel logistic regression model without any explanatory

variables was fitted. Random intercept at the community level was used in the model to consider the hierarchy of data. There is evidence of a community-level variance of 0.546, which indicates variability of neonatal mortality in communities. The difference between the fitted multilevel model and the conventional logistic regression model was statistically significant (LR test = 3.28, p = 0.035), showing that the multilevel model fits the data better. Intra-class correlation coefficient was estimated at 14.23%. It shows that 14.23% of total variation in neonatal mortality is explained by the differences between communities and 85.77% by the differences between individuals. These results show that there is clustering of neonatal mortality and that a multilevel logistic regression analysis is needed in this case.

Table 4. 4: Multilevel Logistic Regression of Maternal Socioeconomic Factors on Neonatal Mortality (Model 1)

Variable	**AOR**		**95% CI**	**p-value**
Maternal Education Level		SE		
None	Ref			
Primary	0.657	0.232	0.329, 1.312	0.234
Secondary	0.687	0.267	0.321, 1.470	0.333
Higher	0.671	0.370	0.228 ,1.979	0.470
Wealth Index				
First	ref			
Second	1.776	0.525	0.995, 3.169	0.052
Middle	1.126	0.375	0.586, 2.164	0.721
Fourth	1.271	0.412	0.673, 2.397	0.460
Highest	0.739	0.264	0.367, 1.488	0.397
Community Variance	0.452			
Log Likelihood	-704.728			

4.3.2 Model 1: Effects of Maternal Socioeconomic Factors on Neonatal Mortality

Model 1 examined the association between maternal socioeconomic factors and neonatal mortality while accounting for community-level clustering. The results showed that neither maternal education level nor household wealth index was significantly associated with neonatal

mortality at the 5% level of significance. Community-level variance reduced from 0.546 in the empty model to 0.452 in Model 1, showing that there is some variation among the odds of neonatal mortality at the community level caused by socioeconomic status of mothers. There still exists however significant unexplained community-level variance indicating that other neonatal and household environmental factors might influence the neonatal mortality rates in Uganda.

Table 4. 5: Multilevel Logistic Regression Results for Maternal Socioeconomic and Neonatal Factors (Model 2)

Variable	AOR	p-value
Maternal Education		
Primary	0.828	0.606
Secondary	0.878	0.751
Higher	0.872	0.811
Wealth Index		
Second	2.159	0.010
Middle	1.516	0.218
Fourth	1.886	0.053
Highest	1.431	0.322
Sex of Child		
Female	0.859	0.422
Birth Order		
Birth Order 2–3	0.861	0.609
Birth Order 4–5	0.808	0.498
Birth Order 6+	0.926	0.815
Community-Level Effects		
Community Variance	0.323	
Log Likelihood	-539.964	

4.3.3 Model 2: Effects of Maternal Socioeconomic and Neonatal Factors on Neonatal Mortality

Model 2 incorporated neonatal characteristics in addition to maternal socioeconomic factors in order to assess their influence on neonatal mortality while accounting for community-level clustering. With respect to household wealth status, children from households in the second wealth quintile were significantly more likely to experience neonatal mortality compared to those from households in the lowest wealth quintile (AOR = 2.159, p = 0.010). This implies that the odds of neonatal mortality among children in the second wealth category were approximately 2.2 times higher than those in the poorest households. The community-level variance further declined from 0.452 in Model 1 to 0.323 in Model 2 indicating that the inclusion of neonatal characteristics explained additional variation in neonatal mortality across communities. Overall, Model 2 suggests that among the variables included, only household wealth status particularly the second wealth quintile was significantly associated with neonatal mortality after controlling for maternal socioeconomic and neonatal characteristics.

Table 4. 6: Final Multilevel Logistic Regression Model for Determinants of Neonatal Mortality

Variable	AOR	p-value
Maternal Education		
Primary	0.538	0.093
Secondary	0.633	0.270
Higher	0.714	0.566
Wealth Index		
Second	1.477	0.200
Middle	0.999	0.998
Fourth	1.247	0.540
Highest	1.356	0.521
Sex of Child (Female)	0.837	0.351
Birth order		
Birth Order 2–3	0.847	0.519
Birth Order 4–5	0.758	0.353

Birth Order 6+	1.037	0.898
Household Environment		
Water source(improved)	0.720	0.172
Toilet facility (improved)	5.480	0.020
Place of residence		
Rural Residence	1.283	0.370

4.3.4 Model 3: Full Multilevel Logistic Regression Model

Model 3 included factors about the mother's socioeconomic status, neonatal, household environment and community-level factors which were used to find out the overall effect of these factors on neonatal mortality in Uganda. Household toilet facility was significantly associated with neonatal mortality in the full model. Households with an improved toilet facility had significantly higher odds of neonatal mortality compared to those with an unimproved facility (AOR = 5.480, p = 0.020). The community-level variance reduced from 0.323 in Model 2 to 0.198 in Model 3 indicating that household environmental and community-level factors accounted for further variation in neonatal mortality across communities. Overall, the full model shows that after controlling for maternal, neonatal, household and community-level factors, household toilet facility remained the only significant determinant of neonatal mortality in Uganda.

4.4 Chapter Summary

In this chapter, the results from the analysis of the determinants of neonatal mortality in Uganda based on Uganda Demographic and Health Survey data (2022) are presented. From the descriptive statistics, neonatal mortality was found to constitute a small percentage of the total births within the dataset at 0.65% equivalent to 6.5 deaths per 1,000 live births. Bivariate analysis confirmed the presence of significant associations between neonatal mortality and household wealth index ($\chi^2 = 11.203$, p = 0.024) and place of residence ($\chi^2 = 6.429$, p = 0.011). A multilevel logistic regression model was used to control for the possible clustering effect at the community level. The empty model confirmed significant community-level variation in neonatal mortality (ICC = 14.23%, LR test p = 0.035) justifying the use of a multilevel approach. In Model 2, the second wealth quintile was significantly associated with neonatal mortality (AOR = 2.159, p = 0.010). In the final model, household toilet facility emerged as the only significant

determinant of neonatal mortality after controlling for maternal, neonatal, household and community-level factors (AOR = 5.480, p = 0.020).

CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the discussion of the findings, conclusions, recommendations and areas for further research based on the results presented in Chapter Four. The discussion focuses on the statistically important findings obtained from the descriptive, bivariate and multilevel logistic regression analyses. The findings are interpreted in relation to the study objectives and compared with existing literature on neonatal mortality. The chapter concludes by highlighting the implications of the findings for policy and practice and suggesting areas that require further research.

5.2 Discussion of Findings

5.2.1 Household Wealth Index and Neonatal Mortality

Household wealth index was significantly associated with neonatal mortality both at the bivariate level ($\chi^2 = 11.203$, $p = 0.024$) and in the adjusted multilevel logistic regression model. Neonates from households in the second wealth quintile had significantly higher odds of neonatal mortality compared to those from the lowest wealth quintile (AOR = 2.159, $p = 0.010$).

This finding confirms the importance of socioeconomic conditions in determining neonatal survival outcomes. Households with limited economic resources often face challenges in accessing quality maternal healthcare services, skilled birth attendance, essential newborn care and timely treatment of neonatal complications. The finding is consistent with (Gautam et al., 2026) who reported that neonatal mortality is disproportionately higher among poorer households than wealthier households. Their study found substantial differences in neonatal mortality rates between the poorest and wealthiest households in countries such as India and Sierra Leone highlighting the role of household economic status in shaping neonatal survival. The results also support the observations of the Ministry of Health (2010) which noted that socioeconomic disadvantage limits healthcare utilization and contributes to poor maternal and newborn health outcomes.

The odds were highest in the second wealth quintile rather than the poorest group a pattern that may reflect a non-linear relationship between wealth and neonatal survival in Uganda. Households just above the poorest category may still face substantial barriers to maternal and newborn healthcare while lacking the targeted support sometimes directed at the poorest households a pattern that justifies further investigation.

5.2.2 Place of Residence and Neonatal Mortality

Place of residence was significantly associated with neonatal mortality ($\chi^2 = 6.429$, $p = 0.011$) with a higher proportion of neonatal deaths recorded among rural residents than urban residents pointing to a meaningful rural-urban disparity in neonatal survival in Uganda. This finding is consistent with (Lassi et al., 2019) who reported higher neonatal mortality in rural areas due to limited access to healthcare services. Rural communities in Uganda often face longer distances to health facilities, fewer skilled birth attendants and limited access to emergency obstetric and newborn care all of which can elevate neonatal mortality risk among rural newborns.

5.2.3 Household Toilet Facility and Neonatal Mortality

Household toilet facility was significantly associated with neonatal mortality in the full model. Households with an improved toilet facility had significantly higher odds of neonatal mortality than those with an unimproved facility (AOR = 5.480, $p = 0.020$). This result is surprising because most existing studies show that better sanitation protects newborns not the opposite. (Auma et al., 2024) found that unsafe water, poor sanitation and poor hygiene contribute to child illness and death in Uganda. (Hajra Mukasa et al., 2023) found that poor water and sanitation in maternity facilities raise the risk of newborn infections. (Ly et al., 2022) also found that better water and sanitation reduce child deaths in South Asia. This unexpected result does not necessarily mean that improved toilets cause neonatal deaths. It is more likely that other factors not captured in this study explain the pattern. For example, households with improved toilets may also be located in communities that recently received extra health support because they previously had poor newborn survival. Other differences between households such as recent migration or how close they live to a health facility could also be responsible for the result. Because of this, the finding should be treated with caution and future studies with more detailed data are needed to better understand it.

5.2.4 Community-Level Variation in Neonatal Mortality

Neonatal deaths in Uganda were not spread evenly across communities. The empty model showed that about 14.2% of the differences in neonatal mortality were due to differences between communities and this variation was statistically significant. This indicates that a baby's chances of surviving the first 28 days of life are influenced by more than just individual or household factors.

This finding is supported by (Akombi, Ghimire, & Renzaho, 2025) who found that community-level differences explain a meaningful share of neonatal mortality across sub-Saharan Africa and that ignoring these differences can hide a large part of the picture. Zegeye et al. (2025) also found that babies born in Uganda had significantly higher odds of death than babies born in some neighboring East African countries even after accounting for individual factors showing that the community and country context itself adds to the odds of death beyond personal characteristics. This significant clustering confirms that a multilevel approach was the right choice for this study. It also suggests that efforts to reduce neonatal mortality in Uganda should not focus on individual mothers and babies alone. Programs that strengthen health services and infrastructure at the community level are also needed to close the survival gap between communities

5.3 Conclusions

In conclusion, Neonatal survival in Uganda is significantly shaped by household wealth index, place of residence, household toilet facility and community-level variation. Household wealth index was significantly associated with neonatal mortality both at the bivariate level and after adjusting for other factors in the multilevel model with neonates in the second wealth quintile facing significantly higher odds of mortality than those in the poorest households (AOR = 2.159, $p = 0.010$). This confirms that household economic status remains an important determinant of neonatal survival in Uganda. Place of residence was significantly associated with neonatal mortality ($\chi^2 = 6.429$, $p = 0.011$) with rural residents facing a higher burden of neonatal deaths. Household toilet facility was significantly associated with neonatal mortality in the fully adjusted model (AOR = 5.480, $p = 0.020$). However, the direction of this association with improved facilities linked to higher rather than lower odds of mortality, this was unexpected and justifies careful interpretation and further research before it is used to inform policy.

Neonatal deaths in Uganda also varied significantly by community with about 14.2 % of the variation in neonatal mortality occurring between communities (ICC = 14.23%). This confirms that community-level factors not just individual or household characteristics play an important role in neonatal survival and justifies the use of a multilevel statistical approach in this study. Overall, the study confirms that neonatal mortality in Uganda is a multifactorial outcome shaped by household economic and community-level conditions.

5.4 Recommendations

The Ministry of Health and development partners should strengthen interventions aimed at reducing socioeconomic inequalities by improving access to quality antenatal care, skilled birth attendance, emergency obstetric care and essential newborn care among households with limited economic resources.

Government should continue investing in maternal and newborn healthcare services in rural communities through expansion of health facilities, deployment of skilled healthcare workers and improvement of referral systems in order to reduce rural-urban disparities in neonatal survival.

The unexpected association observed between household toilet facility and neonatal mortality should be investigated further before being used to inform public health policy. Future studies should explore whether this finding reflects residual confounding, measurement limitations or other contextual factors not captured in the present analysis.

Policymakers should continue designing maternal and newborn health programs that address both household-level and community-level determinants of neonatal mortality. Community-based interventions should complement household-level strategies in order to reduce the observed clustering of neonatal deaths across communities

5.5 Areas for Further Research

Future studies should include important clinical variables that were unavailable in the present study including birth weight, gestational age, antenatal care attendance, place of delivery, mode of delivery, birth complications and postnatal care utilization.

Longitudinal studies are recommended to establish causal relationships between household socioeconomic conditions, environmental characteristics and neonatal mortality.

Further research should investigate the unexpected association between household toilet facilities and neonatal mortality using more comprehensive datasets that include additional maternal, clinical and health system variables.

Future multilevel studies should also examine community and health system characteristics including quality of maternal healthcare services, availability of skilled birth attendants, accessibility of health facilities and referral systems to explain the remaining community-level variation in neonatal mortality.

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