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MORTALITY AND ASSOCIATED FACTORS AMONG NEONATES ADMITTED AT THE KARATINA SUB-COUNTY HOSPITAL NEWBORN UNIT, NYERI

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ABSTRACT

Background: **Neonatal mortality is death within the first four weeks of life. The developing world accounts for 99% of these deaths. Sub-Saharan Africa and Kenya's Neonatal Mortality Rate (NMR) in 2022 was 26.7 deaths and 21 deaths per 1000 live births, respectively. There is need for more data locally and regionally on neonatal mortality.**

Aim: **To determine the cases of mortality and associated factors at the hospital between January 1st, 2019, and December 31st, 2020.**

Methods: **A cross-sectional analytical design using data abstraction forms for data collection was used. The study included 108 neonates. Data analysis was done using the SPSS software version 23. Descriptive statistics, measures of association (*p*-values and odds ratios), and logistical regression were used to compare variables.**

Results: **The NMR at Karatina Sub-County Hospital (KSCH) Newborn Unit (NBU) was 78 deaths per 1000 neonates. Statistical significance was found between neonatal mortality and parity (*p*=0.025), gestational age at birth (*p*=0.039), 5th-minute Apgar score (*p*<0.0001), and need for resuscitation at birth (*p*<0.001). Respiratory**

distress (*p*=0.003) and respiratory distress syndrome (*p*=0.016) as morbidities during admission significantly correlated with neonatal mortality.

***Conclusion*: There is a statistical significance between maternal and neonatal factors with neonatal mortality. The Ministry of Health, the Nyeri County Government, and clinicians should undertake measures to minimise these risk factors.**

INTRODUCTION

The World Health Organization (WHO) defines neonatal mortality as death within the first four weeks of life[1]. 99% of these deaths happen in the developing world[1]. In 2022, the Neonatal Mortality Rate (NMR) in Kenya and Sub-Saharan Africa was 21 and 26.7 per 1000 live births, according to KDHS[2] and UNICEF[3], respectively.

On a global scale, neonatal deaths are mainly caused by infections, prematurity, and asphyxia[4]. Obstetric factors linked to neonatal mortality include preterm labour, intrapartum asphyxia, antepartum haemorrhage, infection, and intrauterine growth restriction (IUGR)[4]. Lack of records or inadequate documentation of neonatal mortality contributes to ineffective strategy formation in reducing this burden[3].

Addressing neonatal mortality is part of attaining sustainable development goal 3 (SDG-3) as stipulated by the United Nations (UN)[5]. According to SDG-3, the 2030 NMR goal is 12 for every 1000 live births, while, in Kenya, the NMR was 20.4 per 1000 live births in 2022[3]. Despite a decline from previous years, intervention is needed to attain the desired 2030 goal.

Currently, there are no studies conducted in Nyeri County investigating neonatal mortality. Also, studies conducted in the country are few and may not reflect the national burden. This study adds to the local data bank on neonatal mortality and its associated factors, giving comparative data for local and international use.

This study purposed to determine neonatal mortality at the Karatina Sub-County Hospital Newborn Unit (KSCH NBU) and investigate the risk factors associated with neonatal mortality in the study period. The study recommends measures to prevent and control neonatal mortality and its associated factors.

MATERIALS AND METHODS

Study design: A cross-sectional analytical design was used. The retrospective study period was from January 1st, 2019, to December 31st, 2020.

Setting: The study was conducted in Karatina Sub-County Hospital (KSCH), in Karatina town, Mathira Sub-County in Nyeri County, Kenya.

Data Collection: Data was collected using data abstraction forms. Data was collected by reviewing the existing medical records of NBU admissions from January 01st, 2019, to December 31st, 2020. Maternal and neonatal information extracted from files was filled into data abstraction forms.

Sampling techniques: Total enumerative sampling technique was used to select files of the deceased neonates within the study period. For comparative analysis, systematic random sampling was used to select an equal number of files belonging to neonates admitted to the NBU within the study period.

Sample size: There were 54 cases of neonatal deaths within the study period at the KSCH NBU. Systematic random sampling was used to obtain 54 files from the survivors for

comparative analysis bringing the total sample size for the retrospective study to 108.

Statistical analysis: A descriptive data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 23 software. Missing data was identified and handled using list-wise deletion to produce conservative results. The neonatal deaths during the study period were divided by the total number of admissions in the NBU during the study period to determine mortality. To determine cofactors associated with mortality, binary and multinomial logistic regression were used to determine the relationship between mortality and the predictor variables. Logistic regression gave *p*-values and Odds ratio (OR), used in interpretation. Statistical significance was established at $p<0.05$. There also was a cross-checking for uniformity, completeness, and accuracy of the information collected.

Ethical considerations: Ethical approval to conduct the research was obtained from the Kenyatta University Ethics Review Committee. The Approval number for the study is PKU/2279/I1421. The study's authorisation was obtained from The Nyeri County Government and KSCH administration, including permission to access the patients' past medical records from the records department. Data security and confidentiality were ensured by coding the specific patient files, not using identifiable criteria, and the information obtained was made available and accessible only to the researchers.

RESULTS

There were a total of 108 participants in the study on mortality. Of these, 42.6% were males, 46.3% were females, and 11.1% did not have the sex indicated. More than half (53.7%) were admitted on their birth day. The fraction that was premature was 34.2%.

Neonatal mortality: Out of the 689 neonates admitted at the KSCH NBU between January 2020 and December 2020, 54 died, translating to a mortality rate of 78 neonates per every 1000 neonates admitted at the KSCH NBU.

Neonatal factors: Many neonates at admission had multiple diagnoses. The admission diagnoses most commonly observed among the sample were low birth weight (LBW) (15.2%), prematurity (14.7%), respiratory distress syndrome (10.7%), meconium aspiration syndrome (10.7%), and neonatal jaundice (10.7%) (n=197). The neonates who died had more comorbidities than those who survived (58.9%) (n=197). Those with LBW constituted 38.9%, with deaths accounting for 23.2% and survivors 15.7% (n=108). Prematurity was documented in 34.2% of the sample, from which 21.3% were dead, and 11.1% (n=108) survived.

A majority of those who died had a 5th-minute Apgar score of 7 and below (25.9%) compared to the ones who survived (6.5%) (n=108). However, 16.7% of the sample had their 5th-minute Apgar score missing from their files. Almost half (49.0%) of the sample size were resuscitated in the delivery room, from which 33.3% died while 15.7% survived (n=108).

Table 1

Neonatal Factors Predicting Neonatal Mortality

Determinant	**n=107 OR[CI]***	***P*** **	**Cases(%) n=108**

Birth asphyxia (ref: yes)	3.709 [0.978 -14.070]	0.054	19(17.6%)
Congenital anomalies (ref: yes)	0.000	1.000	3(2.8%)
Sex (ref: male)	1.040 [0.422 – 2.563]	0.932	46(42.6%)
Birth weight		0.078	
Age at admission (ref: 0 days)	0.991 [0.892 -1.102]	0.870	58(53.7%)
Estimated gestational age at birth[ǫ]	1.139 [1.007-1.289]	0.039	
Apgar[ǫ]	1.786 [1.297 – 2.463]	<0.0001	80(74.1%)
Temperature at admission	0.868 [0.597-1.261]	0.456	
Need for resuscitation (ref: yes)	0.230 [0.103-0.514]	<0.001	53(49.1%)

**OR[CI] stands for the odds ratio and their confidence intervals*

*** Significance level at $p < 0.05$*

[ǫ] the outcome reference is alive

Binary logistic regression results show a statistically significant relationship between neonatal mortality and gestational age at birth (p = 0.039, OR = 1.139, CI 1.007 - 1.289), 5th minute Apgar score ($p < 0.0001$, OR = 1.786, CI 1.297 – 2.463), and need for resuscitation in the delivery room ($p < 0.001$, OR = 0.192, CI 0.103 - 0.514).

Table 2

Comorbidities Predicting Neonatal Mortality

Determinant	**n=107 RRR [CI]***	***P*****	**Cases (%) (n=108)**
Delayed feeding (ref: yes)	2.553 [0.352-18.533]	0.354	6(5.6%)
Perinatal asphyxia (ref: yes)	2.783 [0.765-10.127]	0.120	24(22.2%)
Convulsions (ref: yes)	6.126 [0.570-65.859]	0.135	7(6.4%)
Respiratory distress (ref: yes)	5.256 [1.739-15.888]	0.003	42(38.9%)
Temperature instability (ref: yes)	2.231 [0.280-17.749]	0.448	6(5.6%)
Respiratory Distress Syndrome (ref: yes)	6.310 [1.417-28.102]	0.016	15.7%
Transient Tachypnea of Newborn (ref: yes)	0.203 [0.187-2.204]	0.190	5(4.6%)
Hypoglycaemia (ref: yes)	1.692×10^{6} [0]	0.994	2(1.9%)
Jaundice (ref: yes)	0.306 [0.068-1.3656]	0.121	23(21.3%)
Neonatal sepsis (ref: yes)	2.350 [0.578-9.549]	0.232	14(13.0%)

**RRR[CI] stands for the relative risk ratio and their confidence intervals*

*** Significance level at $p < 0.05$*

Multinomial logistic regression results show that the presence of respiratory distress (p = 0.003, RRR = 5.256, CI 1.739-15.888) and respiratory distress syndrome (p = 0.016, RRR = 6.310, CI 1.417-28.102) positively predicted neonatal mortality.

Maternal factors: Mothers between the ages of 15-20 made up the largest proportion of the sample, 20.8% (n=108). The smallest proportion was of mothers aged 36-40 years which was 9.26% (n=108). 37.0% of mothers were multiparous, with primiparas and nulliparas being 26.9% and 21%, respectively (n=108). Delivery by spontaneous vertex delivery was 60.2%, and Caesarean Section 35.2% (n=108). Most (96.2%) mothers delivered at the health facility (n=108). Most of the mothers were HIV-negative; 64.8% (n=108). Of note is the high number of missing data, which was 28.7% (n=108). Obstetric complications were absent in 63.9% (n=108) of the mothers,

with 24.1%. However, missing data for obstetric complications was 24.1% (n=108)

Table 3

Maternal Factors Predicting Neonatal Mortality

Determinant	**n=107 OR[CI]***	***P*** **	**Cases(%) n=108**
Maternal age	1.025 [0.962-1.091]	0.447	
Parity (ref: high number)	1.444 [1.047-1.992]	0.025	6(5.6%)
Mode of delivery			
Spontaneous vertex delivery	3.789 [0.405-35.488]	0.243	65(60.7%)
Emergency caesarean section	8.143 [0.927-71.500]	0.059	31(29.0%)
Elective caesarean (ref)		0.055	7(6.5%)
Place of delivery (ref: health facility)	2.040 [0.179-23.217]	0.566	101(94.4%)
HIV Status (ref: positive)	1.869 [0.414-8.428]	0.416	7(6.5%)
Obstetric complications (ref: yes)	3.854 [0.975 – 15.232]	0.054	13(12.0%)

**OR[CI] stands for the odds ratio and their confidence intervals*

*** Significance level at $p < 0.05$*

Binary logistic regression analysis results show that among the maternal factors, only parity was a significant predictor of neonatal mortality. Mothers who had given birth to more children were 1.4 times more (OR = 1.444 CI [1.047-1.992] $p = 0.025$) likely to have their neonates die.

DISCUSSION

For the study period, the mortality rate was 78 per 1000 neonates admitted at KSCH NBU. This rate is comparable to the rates observed in Kenya and the region. A study across 16 purposively sampled Kenyan public hospital NBUs showed a crude mortality rate of 102/1000 live births[6]. A retrospective case-control study between January and December 2013 at an intensive neonatal care unit in the Eastern Democratic Republic of Congo reported a facility NMR of 197/1000[7] A retrospective cross-sectional study in the Specialized New Born Care Unit in Asmara, Eritrea, in the national referral hospital in 2016, reported a mortality rate of 65.6/1000 live births[8]. A prospective cohort study conducted between January 2016 and January 2017 in Mexico showed a mortality rate of 125.5/1000 hospitalised newborn infants in the neonatal care unit.[9].

Statistical significance was established between gestational age at birth and neonatal mortality. A high estimated gestational age at birth gave the neonates a higher chance of living, similar to several studies. A meta-analysis done in East Africa documented that babies born <34 weeks' gestation had the highest death odds compared to term babies, with the highest mortality rates in moderately preterm babies and small for gestational age[10]. A study in Ethiopia found a significant relationship between preterm birth and neonatal mortality[11]. Both studies showed the cause of death being primarily RDS and other comorbidities in babies born prematurely, such as sepsis, pneumonia, and asphyxia.

The need for resuscitation was statistically significant to neonatal mortality, a finding congruent to other studies. Untimely or ineffective resuscitation leads to mortality or

irreversible invalidity[12]. Even though most neonates do not need intervention to aid respiration after delivery, 10% need respiratory assistance, and 1% need elaborate resuscitation. Resuscitation aims to avert morbidity and mortality due to hypoxic-ischemic tissue injury and restore spontaneous cardiorespiratory activity[13]. A direct observational study showed a significant reduction in neonatal mortality in premature babies when resuscitation was performed[14]. Training in neonatal resuscitation decreases term neonatal mortality in the intrapartum stage by 30%. However, the intervention coverage is low in regions with high neonatal mortality[15].

Similar to other studies, this study found a statistically significant association between the 5th-minute Apgar score and mortality. A high 5th-minute Apgar score gave the neonates a 1.786 higher chance of living. The 5th-minute Apgar score is a more accurate marker of vitality in neonates[16]. A poor 5th-minute APGAR score is linked to perinatal asphyxia and respiratory distress syndrome at birth[17].

Respiratory distress and respiratory distress syndrome were the significant factors linked to neonates' mortality. Respiratory distress comprised a majority (29.8%), with RDS making up 13.5%. The findings are consistent with a study in Ethiopia, where respiratory distress was significantly associated with neonatal mortality.[11]

Our study found that maternal factors were not significant predictors of neonatal mortality except for parity. Mothers who had given birth to more children were 1.4 times more likely to have their neonates die. Grand multiparas have a considerably higher risk of neonatal mortality than women of lower parity[18]. The perinatal outcomes were attributed to a higher risk of placenta abruption, preterm deliveries, macrosomic babies, higher postpartum haemorrhage risks, and idiopathic neonatal deaths. Multiparous women require more screening and adequate monitoring during labour and delivery, even after the confounding factors are effectively controlled. In most third-world countries, the poor healthcare system and delivery make adequate prenatal screening and maternal monitoring harder. Grand multiparity remains a risk in pregnancy and is associated with an increased prevalence of maternal and neonatal complications[19].

Our study had several strengths. The findings are relatable to many Level 4 facilities in the country with similar resources. The sample was representative of the current situation in KSCH. The study used standardised measures and statistical analysis, making it reliable.

A significant limitation of our study was missing data in the files of neonates. Missing data was managed using stepwise deletion to obtain conservative results. Documentation improvement can aid future reference in research/audits/accounting to improve service delivery in the facility.

Another limitation is the assumption that the files presented were all needed for the study. The researchers scrutinised all the files for the year to ensure all appropriate files were selected. Future research should consider a prospective cohort study that limits omission errors in the record-keeping process.

Given that the study was done in a Sub-County facility, the results do not reflect neonatal mortality in Nyeri County or the country. Similar studies should be conducted in a larger referral facility and other counties for future comparison and analysis.

CONCLUSION

This study has demonstrated maternal and neonatal factors are associated with neonatal

mortality. Nevertheless, the study revealed a higher significance of neonatal factors than the maternal ones investigated. The study demonstrated that a mother's parity predicts neonatal mortality, with nulliparous women showing a lower risk for neonatal mortality.

Neonatal factors associated with neonatal mortality included estimated gestational age at birth, prematurity, 5th-minute Apgar score, need for resuscitation, respiratory distress, and respiratory distress syndrome.

RECOMMENDATIONS

The maternity clinicians and nurses at KSCH should ensure careful labour monitoring for all pregnant mothers, especially multiparous women.

Clinicians and nurses at the KSCH maternity department and NBU should effect meticulous documentation of diagnoses, progress, and care provided to neonates. With this done, a more comprehensive plan for at-risk neonates, timely interventions, and a rich database for reference purposes in the future would be possible.

Specialised treatment of sick neonates should be considered and implemented under the oversight of the Director of Health Services at KSCH and the County Health Office, including cardiorespiratory support in Neonatal Intensive Care Units (NICU), surfactant administration for those with Respiratory Distress Syndrome (RDS), neonatologists' reviews, and departmental ambulance services to other facilities for advanced care.

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