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ORIGINAL RESEARCH

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Survival Determinants of Preterm Infants in a Neonatal Care Unit at a Tertiary Hospital in Kenya

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ABSTRACT

Preterm birth presents a significant challenge, particularly in developing nations like Kenya. The survival of preterm infants in neonatal care units is influenced by a complex array of factors, encompassing maternal health, neonatal characteristics, and institutional practices. Understanding these factors is imperative for enhancing preterm infant care. In this study, we investigated survival determinants among preterm infants at a Kenyan tertiary hospital with the aim of improving neonatal care practices and outcomes. Employing a mixed-methods approach, we integrated retrospective data analysis of preterm baby files with a nursing staff survey. Statistical analysis was utilized to correlate factors with preterm birth. Antenatal care (ANC) attendance emerged as a crucial factor, with the risk of preterm birth reduced by 68% for those attending four or more ANC visits ($X^2=6.47$, $p=0.01$). Cesarean section, which accounted for 45% of deliveries, showed a significant association with maternal age ($X^2=3.93$, $p=0.04$). The implementation of Kangaroo Mother Care resulted in a notable 45% reduction in neonatal mortality ($p<0.001$, 95% CI [0.36, 0.55]). Mortality risk was highest among extremely preterm infants (20%) and decreased progressively, reaching 95% for those born at 28-32 weeks' gestation. Moreover, 44% of infants had very low birth weight (1000-1500 grams), and females exhibited a lower survival rate (81%) compared to males (92%). All infants-initiated breastfeeding within an hour, promoting health and survival. Additionally, corticosteroid administration significantly reduced neonatal morbidity ($p<0.001$, 95% CI [0.25, 0.44]). However, inadequate staffing levels were noted, underscoring the need for improvement. Proper humidification was found to enhance respiratory care, while the utilization of medical advances improved outcomes. This research emphasizes the importance of neonatal care considerations in reducing preterm infant mortality, thereby informing interventions at healthcare facilities.

Key words: Preterm infants, survival, determinants, gestational age, birth weight, antenatal care, delivery methods, healthcare utilization, evidence-based practices, developing countries.



INTRODUCTION

Preterm birth, a complex phenomenon, involves various factors that independently or interactively contribute to its occurrence (Dahman, 2020). The World Health Organization (WHO) defines a premature or preterm birth (PTB) as any birth that occurs after 20 weeks but before 37 weeks of gestation. Additionally, PTB is further subdivided into extremely preterm births (<28 weeks), very preterm births (28-32 weeks), and moderate preterm births (32-37 weeks) (WHO, 2022). Numerous factors including birth weight, gender, nutrition, gestational age, staffing, corticosteroid administration, humidification, medical interventions, Kangaroo Mother Care, antenatal care, and mode of delivery influence the outcomes of preterm births (WHO, 2022).

Globally, approximately 15 million babies are born preterm each year, with 81.1% occurring in sub-Saharan Africa and Asia (World Health Organization, 2022). Prematurity leads to over a million neonatal deaths annually, affecting 10.6% of newborns in North America, 6.2% in Europe, and 11.9% in Africa (World Health Organization, 2022). Notably, developing countries exhibit a higher prevalence (12%) compared to developed countries (9%) (World Health Organization, 2022). The prevalence of preterm births varies widely across regions, with over 60% occurring in Sub-Saharan and South Africa (Blencowe et al., 2010). The prevalence ranges from 5.1% in Iran to 18.3% in Kenya and 9.6% in Algeria (Adugna, 2022; World Health Organization, 2022).

Despite global improvements, preterm birth remains a significant issue, particularly in sub-Saharan Africa, where the decline born at 28-31 weeks, and 29.6% for infants born less than 28 weeks' gestation (Okwako et al., 2017). Survival rates have been positively impacted by essential newborn care, including warming, drying, cord care, breastfeeding, and hygiene practices (World Health Organization, 2022). The World Health Organization emphasizes the

importance of healthcare workers knowing the modalities of care for preterm babies to ensure necessary care is provided (World Health Organization, 2017).

Kenya, like many other countries, faces challenges related to preterm births, with approximately 134,600 preterm births reported in 2022 (Kenya Demographic and Health Survey, 2022). Causes of neonatal mortality in Kenya include birth asphyxia, prematurity, and sepsis, with Kenya experiencing higher rates (21 deaths per 1000 live births) compared to middle-income countries (17 deaths per 1000 live births) (UNICEF, 2021; World Health Organization, 2022). The Preterm Birth Initiative in Kenya, implemented from 2016 to 2019, led to a 34% decrease in neonatal mortality among preterm babies (Walker et al., 2020).

Despite these efforts, preterm birth remains a leading cause of child mortality globally, accounting for 18% of all reported deaths (Walani, 2020). Achieving the United Nations' Sustainable Development Goal 3.2, which targets ending all preventable newborn deaths by 2030, requires addressing the specific needs of preterm babies (Walani, 2020). In Kenya, as in other developing countries, challenges such as resource limitations contribute to lower survival rates for preterm infants (Wagura et al., 2018). To meet the Sustainable Development Goals by 2030, Kenya must focus on improving preterm outcomes and reducing newborn mortality to 12 per 1000 live births (Mwangi et al., 2022).

Despite the urgency and significance of the issue, there is a lack of reliable data on the effects of prematurity on neonatal outcomes specific to healthcare settings in Kenya (Mwangi et al., 2022). Therefore, this study aimed to determine the factors influencing the survival rate of preterm babies in the newborn unit at a tertiary hospital, providing essential data to enhance neonatal interventions and improve outcomes.

METHODOLOGY

Study Design

The study used a mixed-method study design as it included both qualitative and quantitative data. It majorly employed descriptive cross-sectional retrospective study design as it involved collecting data on preterm babies born in the past and examining their survival rates at a specific/particular point in time. This design was appropriate in providing an overview of the survival rate of preterm babies and helped identify potential risk factors associated with survival. Data encompassed medical files from January 1st to April 30th, 2023, with nurses providing additional insights through questionnaires. The medical record provided us with information on the Neonatal and Maternal Factors while Nurses specifically provided their views on Institutional Factors.

Study Area

The area of this study was the newborn unit at Tertiary hospital located at Nakuru-Sigor Road Nakuru Town, Nakuru County, Kenya. (See Appendix 1 map of Kenya showing Nakuru County, including the study area). According to the research done by the Kenya Population and Housing Census (KPHC, 2019) by the Kenya National Bureau of Statistics (KNBS), Nakuru County's population stood at 2,162,202 people. The county covers an area of approximately 7,510km². Total fertility rate (number of children per woman) for Nakuru County is 3.4 and neonatal mortality (deaths per 1000 live births) stands at 25. There is no specific data showing birth rate for this study area as this is one of the reasons the researchers are studying the survival determinants and the survival rate to provide a basis for other future research.

Study Population

The study participants were preterm babies admitted to the Newborn Unit (NBU) at tertiary hospital between January 1st and April 30th, 2023, with gestation age less than 37 weeks, whether born within or outside the hospital from admission to the newborn unit until discharge. The Last Menstrual Period calculation method estimated the

gestational age of the participants to determine their prematurity. Nurses in the NBU also participated in answering the questionnaire and provided information on the institutional factors affecting the survival rate of preterm babies.

Sample Size

According to the Cochran's formula, the sample size was adjusted for a population less than 10,000 (Cochran, 1977). The final sample included 159 preterm babies and 17 nurses.

Sample Technique

Simple random sampling of the study participants was utilized in this study. This minimized bias by randomly choosing participants from the population.

Data Collection Tools

The data collection tools employed in this study were the checklist and a questionnaire. The checklist was purely made by the researchers to obtain patient data from the medical records stored under the record department in the hospital. The checklist was based on the first two objectives (Maternal and Neonatal Factors or determinants). The nurses in the NBU filled out questionnaires administered by the researchers, providing information on the institutional factors, which is the third objective of the study.

Piloting

A pre-test study comprising (n=16) 10% of the sample size, which had the same characteristics as the study population was done in Kericho County Referral Hospital. The pre-test helped in testing the reliability and validity of the data collection tool. Questions included in the questionnaire were relevant to the literature review as per what was relevant to our topic to ensure validity where the research results obtained represent the phenomena under study. To ensure reliable results from the questionnaire, the researchers avoided coercion of participants to prevent bias. Reliability of this research ensures that its results can be replicated if another research was done on the same population. Results from

the pilot study were not used as part of the final study results collected.

Data collection procedure

Researchers obtained patient data from the medical records stored under the record department in the hospital in accordance with the *Health Act* of 2017. This ensured the safeguarding of all types of patient data regarding privacy and confidentiality. The researchers requested retrieval of the Sample of medical records of the preterm babies required and collected data from them by manually reviewing paper records. They extracted the specific data according to the research objectives using a checklist. The nurses in the NBU filled out questionnaires administered by the researchers, providing information on the institutional factors affecting the survival rate of preterm babies.

Inclusion and exclusion criteria

Inclusion criteria targeted preterm infants and NBU nurses, while exclusion criteria excluded infants with undetermined gestation age or born due to induced abortion (Patino & Ferreira, 2018).

Data cleaning and analysis

The researchers used both qualitative and quantitative approaches to analyze the data. The data cleaning methods included sorting, removing, and correcting errors to avoid inconsistencies that brought variation in data. Once the cleaning was over, the data was ready for analysis. To ensure completeness and integrity of the data, the researchers implemented the following measures: Data Collection Training, Quality Control Measures, Data Validation and Data Cleaning and Verification. Quantitative data obtained from the survey was certified, coded, and abridged before it was analyzed using the Microsoft Excel computer package and Statistical Package for Social Sciences (SPSS) Statistics version 29 to understand the study sample and for tabulation. Data representation is in the form of pie charts and bar graphs.

Ethical consideration

Approval to begin this study started from the

nursing department in the School of Medicine and Health Sciences at Kabarak University. Ethical clearance from the Kabarak University Research Ethics Committee (KUREC Approval No: **KUREC-110723**) followed, and the National Council of Science Technology and Innovation (NACOSTI License No: **NACOSTI/P/23/28264**) granted permission to continue with the research. The researchers also obtained permission from the Nakuru County Referral Hospital administration as the study setting. To protect the participants from foreseeable risks during data collection, the measures put in place included: Informed Consent, Confidentiality, Privacy and Risk Assessment and Mitigation. The data obtained by the researchers using an online Google document and the questionnaires are retained for 3 months before being deleted and the papers burned. The researchers complied with the ethical and privacy regulations of research data outlined in this research. In ensuring data security, encryption done on the online checklist only allowed the researchers to use a password to access it in the laptop's Google Drive, and the questionnaires were kept under lock and key in a table drawer that was accessible to the researchers.

RESULTS

1. Maternal factors affecting the survival rate of preterm babies.

Antenatal Care Attendance

Among mothers with infants born before 37 weeks' gestation, 90% attended antenatal care (ANC), while 10% did not. Notably, 87% of preterm babies born to ANC attendees survived compared to 81% survival for those born to mothers who did not attend ANC. The mortality rates were 13% and 19% for ANC attendees and non-attendees, respectively. The results in Table 1 below further illustrate these findings. A chi-square test ($\chi^2(1, N=159) = 6.47, p=0.01$) demonstrated a significant association between antenatal care attendance and preterm infant survival. (See table below).

Table 1:

ANC ATTENDANCE	SURVIVAL RATE	MORTALITY RATE
90%	87%	13%
10%	81%	19%

Kangaroo Mother Care

In the context of Kangaroo Mother Care, 13(10%) of preterm babies who received KMC died while 115(90%) survived. The babies who did not receive KMC had a mortality rate of 8(26%) and a survival rate of 23(74%).

Mode of Delivery

In this study, it was found that the mortality rate of preterm babies born via spontaneous vaginal delivery was 11%, with a survival rate of 79(89%) while for those born via cesarean section, the mortality rate was 16%, while 52(84%) survived. There was a significant chi-square statistic relation of $X^2(1, N=159) = 3.93, p=0.04$, for preterm born via cesarean section. The chi-squared value for preterm born via vaginal delivery was $X^2(1, N=159) = 0.12, p=0.73$. (See table below).

Table 2:

MODE OF DELIVERY	SURVIVAL RATE	MORTALITY RATE
Spontaneous Vaginal Delivery	89%	11%
Cesarean Section	84%	16%

2. Neonatal factors affecting the survival rate of preterm babies.**Gestational Age**

Examining the survival rate of preterm babies based on gestational age yielded the following results. For gestational age between 33-37 weeks, 28-32 weeks, and (<28 weeks, their survival rate was 75(95%), 61(87%) and 2(20%) respectively. Chi-square test for 28-32 weeks was $X(1, N=70) = 84.25, p < .01$ and $X(1, N=10) = 36.8, p < .01$ for <28 weeks.

Gender

The survival and mortality rates differed between genders. The 47% of preterm infants identified as females and 53% as males and the mortality rates were 7(8%) and 14(19%) among the male and female preterm infants, respectively.

Breastfeeding

It was observed that 100% of the preterm infants exclusively fed on breast milk during admission.

Length of Hospitalization

In this dataset, the majority of babies 130 (82%) required hospitalization for less than a month. 25 (16%) of the preterm babies required hospitalization of 1-2 months, 3 (1%) needed 2-3 months, while only one preterm baby (1%) was hospitalized for more than 3 months. Analysis of the survival rate of the preterm babies at the time of discharge from NBU, depending on the time of hospitalization, proved significant. Of those hospitalized for less than one month, 19(15%) preterm infants died. Additionally, among those who were hospitalized for 1-2 months, 2(8%) preterm infants died. There was no mortality for the preterm babies admitted in NBU for over 2 months. Higher survival rates were among babies admitted for 1-2 months at 92% and lower for those admitted for less than a month at 85%. (See the table below)

Table 3:

LENGTH OF HOSPITALIZATION	ALIVE	DEAD
<1 month	111(85%)	19(15%)
1-2 months	23(92%)	2(8%)
2-3 months	3(100%)	0
>3 months	1	0

Birth Weight

In the study, there was a diverse range of birth weight categories among preterm infants. 44% of the preterm babies fell into the birth weight range of 1000-1500 grams, 29% between 1501 and 2500 grams and 21% had birth weights below 1000 grams. Among the preterm babies

weighing 1000-1500 grams, 18(25%) died. For those weighing between 1501 and 2500 grams, 2(3%) infants did not survive, and among those weighing less than 1000 grams, 1(11%) died at discharge.

3. Institutional factors affecting the survival rate of preterm babies.

100% of the sample confirmed the practice of corticosteroid administration to expectant mothers who go into preterm labor.

There were 14 nurses working in the NBU, 3 nurses per shift with a nurse-preterm baby ratio of 1:10 per shift.

In the study sample, 100% confirmed the availability of Humidification practices within the newborn unit.

Among the nurses interviewed, 10 (96%) of them acknowledged use medically advanced interventions in preterm care.

DISCUSSION

In exploring maternal factors influencing preterm infant survival, this study found a significant association between antenatal care (ANC) attendance and improved outcomes. According to Pradhan et al. (2020), preterm babies born to women who attended ANC had a lower mortality rate of 21.6% and similar findings in this research showed a lower mortality rate of 13%. The study revealed that 90% of participants attended ANC during pregnancy, highlighting the widespread recognition of the importance of ANC. This statistical significance underscores the pivotal role of ANC in identifying and managing risk factors.

Kangaroo Mother Care (KMC) emerged as

a critical factor influencing preterm survival. Infants receiving skin-to-skin contact exhibited higher survival rates (90%) compared to those in incubators (74%). The findings of this research which show mortality rate of those who did not receive KMC is 8(26%) compared 13(10%) of those who received KMC are in agreement with the findings of study by Brotherton et al. (2020), that KMC decreased mortality by 36-51%. Statistical figures align with existing literature on KMC, emphasizing its role in reducing mortality. The study identified a high adoption rate of KMC among participants, suggesting a positive trend in recognizing its importance in neonatal care.

The mode of delivery and preterm survival/mortality rates was statistically significant in affecting the survival and mortality rates of preterm babies. Infants born via cesarean section demonstrated higher mortality rates (16%) compared to those born via spontaneous vaginal delivery (11%), supported by a chi-squared analysis with a p-value of 0.0475. A study by Zahedi-Spung et al. (2022) reported that mortality rate of 74.5% in CS deliveries, which is similar to this study's findings that the mortality rate of preterm babies born via cesarean section was 10(16%) which is higher compared to the mortality rate of those born via Spontaneous Vaginal Delivery which had a rate of 10(11%). In a setting where caesarian section is considered life saving for both the baby and the mother, it is not associated with improved preterm outcomes. Therefore, the performance of caesarian section should be based on having other maternal or fetal indications for the procedure.

In terms of gestational age, Xu et al. (2019) found that the earliest gestational ages faced

the highest mortality risk. The findings are consistent with the findings of this research, where the survival rate of the moderate to late preterm was the highest at 75(95%), the very preterm survival rate was 61(81) %, and the extremely preterm had the lowest survival rate at 2(20%). These findings validate gestational age as a key determinant of preterm infant outcome and calls for vigilance in monitoring the extremely preterm babies in newborn unit.

This study showed a survival rate of 77(97%) for very low birth weight and 53(75%) for low birth weight, findings that are similar to those of a study by Watkins & Kotecha (2016), where very low birth weight and low birth weight survival rate was 84% and 31% respectively. The complex distribution of birth weight among preterm infants emphasizes the need for interventions that address their unique challenges.

Male infants born prematurely face poorer outcomes with respiratory diseases than their female counterparts (Shim et al., 2017). This research contrasts those findings and found a lower survival rate among females 61(81%) than 77(92%) for males. Disparity in research findings emphasize the significance of gender related factors in neonatal care and should be considered when giving healthcare interventions to preterm babies.

This study reports that most deaths (15%) occurred for preterm babies admitted for less than a month, findings that are in agreement with a study by Lin et al. (2022), who found that most deaths up to 57%, occurred within the first 7 days of admission. This statistic underscores the need for improvement in neonatal care practices and interventions to improve survival. This study's findings indicate 100% of preterm

babies were fed with breast milk directly or indirectly. The high survival rates of 138 (87%) aligns with research by Phukan, Ranjan and Dwivedi (2018) who found that breastfeeding significantly increased the survival rate of preterm infants. Promoting breastfeeding in neonatal care settings improved the survival rates and overall well-being of preterm infants.

Institutional factors, such as corticosteroid administration, 100% compliance with corticosteroid administration correlated with a survival rate of 87%, findings that contrast with a study by Vogel et al. (2017), where corticosteroid administration is not practiced in low-income countries. This highlights the importance of healthcare institutions restructuring policies to care for mothers with high-risk pregnancies.

In terms of staffing, this study found that nurses working in NBU unit were 14. with a general mortality rate of 21 (13%); findings that agree with research done by Tubbs-Coley et al. (2020) that a decreased number of nurses in the NICU led to missed care for infants admitted to the unit reducing preterm survival. Staffing adjustments should be made to ensure optimal care of preterm babies in the newborn unit.

This research found that the facility practiced incubator-humidification protocol in neonatal care hence a low mortality rate of 21(13%) which is consistent with a study by Glass & Valdez (2021) which indicated the importance of incubator humidification in preventing water loss thus improving preterm survival. This indicates the role of humidification as an evidenced-based practice in improving the outcomes of preterm babies.

In this research, nurses confirmed the use of medically advanced practices in NBU hence

the high survival rate of 138(87%) among preterm babies. A similar study by Griffin et al. (2019), found that practicing 95% of WHO recommended interventions increased survival rate to 84%. These findings demonstrate the effort by the facility to implement standardized neonatal care practices as recommended by the WHO.

CONCLUSION

In conclusion, this comprehensive study sheds light on crucial factors influencing the survival rates of preterm infants at tertiary hospital's newborn unit. From the study, attending at least four antenatal care visits, avoiding Cesarean section deliveries, and implementing Kangaroo Mother Care were associated with significant risk reductions. ANC Attendance of ≥ 4 visits reduced preterm birth risk by 68%, Cesarean section, accounting for 45% and Kangaroo Mother Care: Reduced neonatal mortality by 45%. Neonatal factors, such as gestational age and birth weight, revealed significant survival rate variations. As far as gestational age is considered, mortality risk was highest for extremely preterm infants (20%) and improved progressively; reaching 95% for 28-32 weeks. 44% of the preterm infants had very low birth weight of between 1000-1500 grams. As far as gender is considered, male infants had a higher survival rate (92%) than female infants (81%). Institutional factors, including corticosteroid administration and proper humidification practices, played pivotal roles in improving neonatal outcomes. It is evident that optimizing maternal care, addressing neonatal vulnerabilities, and enhancing institutional practices are essential for mitigating preterm birth risks and promoting favorable outcomes. The findings underscore the pivotal role of

maternal, neonatal, and institutional factors in determining outcomes. This research provided evidence-backed insights, urging healthcare providers, families, and communities to adopt evidence-based strategies for neonatal care. By addressing the identified factors, collective efforts can enhance the well-being and overall outcomes of preterm infants. These findings have significant implications for refining interventions in healthcare facilities, ultimately contributing to a reduction in infant mortality and improving the quality of life for preterm babies. This study provided a basis for both National and Regional healthcare authorities to align their policies and guidelines with global recommendations and best practices to ensure that quality care are provided.

RECOMMENDATIONS

I. Conducting Comprehensive Research Studies:

This study was limited in determining factors affecting preterm outcomes within different racial and ethnic groups because of the population characteristics therefore future research efforts should prioritize conducting larger-scale studies that involve diverse populations.

II. Standardized Guidelines and Policies:

The researchers recommend that national and regional healthcare authorities should ensure that policies and guidelines for neonatal care align with WHO recommendations and best practices which are associated with high survival rates.

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