Survival and Risk Factors for Late Preterm and Early Term Neonates Compared to Full-Term Infants at Garissa County Referral Hospital, Kenya

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ABSTRACT

Preterm birth constitutes a significant health burden in Kenya, yet there is hardly any targeted research looking at the survival and specific risk factors associated with birth of late preterm neonates (LPNs) and early term neonates (ETNs), particularly in Garissa County. While studies on preterm birth determinants have been done in Kenya, factors specifically influencing LPNs and ETNs births and their survival relative to their full-term counterparts remain understudied. Studies done on preterm in general have identified maternal age, history of preterm birth, pregnancy-induced hypertension, and prolonged premature rapture of the membrane among others as significant risk factors, but their relevance to LPNs and ETNs specifically has not been fully investigated. This study aimed to address these gaps by determining maternal as well as fetal risk factors associated with LPN and ETN births compared to full-term neonates (FTNs) born at Garissa County Referral Hospital. Further, it sought to identify predictors of survival across these neonatal groups. The study conducted at Garissa County Referral Hospital employed a prospective cohort design. Mother-neonate dyads were enrolled using convenience sampling method until the required sample was achieved. Data was collected using pretested and validated questionnaires. STATA version 17 was used for analysis. Multinomial logistic regression analysis was performed to determine Relative Risk Ratio. The P-value was set $\alpha=0.05$ and $P<0.05$ was considered statistically significant. Survival rates were estimated using Kaplan-Meier survival analysis. Bivariate Cox regression analysis was employed to identify independent predictors at $p<0.20$. However, since all variables had p-values >0.02, multivariate Cox regression was not conducted. The study revealed that maternal age (P=0.042), occupation (P=0.024), ethnicity (P=0.021), religion (P=0.016) and absence of previous abortion/still birth/premature deliveries (P=0.015) were maternal related factors associated with birth of LPN, ETN and FTN. Birth weight was associated with LPN ($P<0.001$), while FTN had higher likelihood of delayed initiation of breastfeeding (P=0.038) but were less likely to have feeding difficulties compared to LPN and ETN (P=0.012). A comparison of fit model with the complete set of predictors with an intercept-only, or null model revealed that P-values for maternal (P=0.0175) and fetal ($P<0.001$) related risk factors were less than Fisher's value of 0.05, hence the null hypothesis was rejected. The Kaplan-Meier survival analysis revealed high survival rates across all gestational age categories, with 100% survival among LPNs. In conclusion, the study showed that maternal- and fetal-related risk factors associated with LPNs and ETNs are distinct from those of FTNs.

Keywords: Late Preterm Neonate, Early Term Neonate, Maternal-Related, Fetal-Related, Risk Factor, Birth, Garissa

I. INTRODUCTION

Preterm birth, defined as delivery before 37 weeks of gestation is a major contributor to neonatal morbidity and death globally, with diverse medical, psychological, developmental, and financial implications for affected families (Bérard et al., 2012; Karnati et al., 2020). Notably, late preterm births (LPTBs), defined as births that occur between 34 and 36 weeks of gestation, constitute about 75% to 85% of preterm births worldwide (Chawanpaiboon et

al., 2019; Karnati et al., 2020). Despite being recognized as closer to term, neonates born within the late preterm period exhibit higher risks of adverse health outcomes, including perinatal asphyxia, jaundice, respiratory distress, feeding difficulties, and long-term developmental challenges (Karnati et al., 2020; Shapiro-Mendoza & Lackritz, 2012).

Studies done over the last 10 years have also drawn attention to early term neonates (ETNs), delivered between 37 and 38 weeks, who experience health outcomes like late preterm neonate (LPN) (Brown et al., 2015, 2016). Both LPNs and ETNs share myriad of maternal and fetal risk factors, including complications during pregnancy, maternal socio-demographic factors, medical conditions, and environmental influences (Brown et al., 2015, 2016; Shapiro-Mendoza & Lackritz, 2012). However, the etiological differences between LPNs and ETNs remain poorly understood, with existing research showing some risk factors are unique to each group. For instance, while infections and inflammation are more commonly linked to late preterm neonates, maternal chronic conditions and hormonal imbalances are more frequently associated with early term neonates (Brown et al., 2015, 2016).

The increasing number of preterm births worldwide has been attributed to the rising rates of LPNs (Chawanpaiboon et al., 2019). However, the reasons behind this surge are complex and multifactorial, including the wider adoption of reproductive health technologies, advances in obstetric care, and increased rates of medically indicated preterm deliveries (Davidoff et al., 2006; Hankins & Longo, 2006; Linhart et al., 2000; Tan et al., 2014). About half to three quarters of LPTBs result from spontaneous labor or premature rupture of membranes (PROM), while three-quarters of all singletons preterm births occur spontaneously, often without an identifiable cause (Ananth et al., 2006; Karnati et al., 2020).

In Kenya, premature deliveries constitute a significant health burden, yet there is hardly any targeted research that have investigated the survival and specific risk factors associated with LPNs and ETNs, particularly in regions such as Garissa County. While studies on preterm birth determinants have been conducted in Kenya, (Okube & Sambu, 2017; Wagura et al., 2018), factors specifically influencing LPNs and ETNs birth relative to FTN remain understudied. The two studies identified maternal age, history of preterm birth, pregnancy-induced hypertension, and prolonged PROM as significant risk factors for preterm birth, but their relevance to LPNs and ETNs specifically is not known. The present study aimed to address these gaps by determining maternal and fetal risk factors associated with LPN and ETN births compared to full-term neonates (FTNs) at Garissa County Referral Hospital. It further sought to identify predictors of survival across these neonatal groups to provide critical insights to inform interventions tailored to improve neonatal outcomes in Garissa County.

II. METHOGOLOGY

2.1 Study design and setting

This study was part of a prospective cohort conducted at Garissa County Referral Hospital (GCRH) in Garissa Town, located around 366 km from Nairobi, the capital of Kenya. GCRH is a Level 5 public facility and the largest healthcare center in Northeastern Kenya, serving as a critical referral site for complex cases from neighboring counties like Mandera, Wajir, and Tana River. The hospital offers both primary and specialized healthcare services, including comprehensive emergency obstetric and neonatal care. With a capacity of 224 beds and a 33-bed neonatal unit, GCRH handles approximately 30% of all births in Garissa County, serving a population with varied ethnic and socioeconomic backgrounds.

2.2 Study population

Comprised of all live born singleton late preterm (34-36 weeks), early term (37-38 weeks) and full-term (39-41 weeks) neonates delivered at the hospital during the study period.

2.3 Sample size

Sample size calculation was based on the objective of comparing risk factors, outcomes and survival of LPNs, ETNs vis a vis FTNs using G* Power®, F-test ANOVA: using prioiri analysis. Statistical power was set at 80%, while level to detect significance was set at $P< 0.05$. To cater for the potential attrition, the final sample size was adjusted by 20 percent, giving a total of 192. At the analysis, data from 5 mother-neonate dyad equivalent of 2.6% of the total sample was excluded due to incompleteness giving a final response rate of 97.4 percent.

2.4 Recruitment study participants

Research assistants explained to mothers/caregivers the objectives and risks of the study prior to their recruitment. Upon mothers granting informed consent, mother-neonate pairs were consecutively enrolled into the study using convenience sampling technique until the required sample size was obtained.

2.5 Inclusion and exclusion criteria

Live LPNs, ETNs, and FTNs from single pregnancies who were delivered at GCRH, their gestational age was assessed and whose mothers/caregivers gave written informed consent were included in the study. Those with congenital anomalies such as neural tube defect, those who died prior to performing gestational age (GA) assessment, were not born at the facility, or were part of twin or multiple pregnancies or their mother/caregiver did not give consent were excluded. Those with lethal congenital anomalies known to be incompatible with life and from twin or multiple pregnancies were excluded as they have been shown to have different mortality and morbidity risks.

2.6 Data Collection Procedure

Data was collected with support of two research assistants (RA) who were trained nurses namely M1 and N1 working at the hospital maternity and newborn unit, respectively. Prior to engaging the research assistants to collect data, they were trained on research ethics and data collection protocols. They then administered pretested and validated questionnaires to collect the data. Before recruiting the mother-neonate pair into the study, the RA explained the objectives, benefits, and risk of the study to the mothers/caregivers of the neonates and sought their informed consent. Data collection took place between November 2022 and March 2023.

2.7 Data Collected

Data was collected using pretested, validated questionnaires administered within 24 hours of delivery. Research assistants also reviewed medical records to document maternal and neonatal information. A range of maternal related data were collected. These included demographics (age, education, marital status, occupation, residence, ethnicity, religion), medical history (serological and tuberculosis status, parity, gravidity, prior history of abortion, stillbirths, preterm deliveries), and clinical factors during gestation (preeclampsia, diabetes, hypertension, placenta previa, anemia, etc.). Additionally, obstetric information such as attendance of antenatal care, onset and duration of labor, details of delivery (mode, assistance, complications), premature rapture of the membrane, and maternal behaviors (smoking, drug use, herbal ingestion) was documented. Neonatal data collected comprised of birth characteristics (sex, weight, length, head circumference, gestational age, Apgar scores), delivery room events (crying after birth, resuscitation), and newborn complications (perinatal asphyxia, respiratory distress, hypothermia, etc.). Other variables were also collected. These included breastfeeding initiation, Kangaroo Mother Care (KMC), and interventions like phototherapy or NBU/ICU admission. Survival and mortality outcomes were tracked through structured follow-up at days 1, 3, 7, 14, and 28 post-delivery, focusing on neonatal conditions.

2.8 Data Management and Analysis

Data entry, cleaning, and analysis were performed using Stata version 17. Multinomial logistic regression was conducted to calculate the Relative Risk Ratio (RRR), with statistical significance set at $p<0.05$. Survival rates were estimated using Kaplan-Meier survival analysis. Bivariate Cox regression analysis was employed to identify independent predictors at $p<0.20$. However, since all variables had p-values >0.02, multivariate Cox regression was not conducted.

2.9 Ethical considerations

Ethical approval was granted by Masinde Muliro University of Science and Technology Institutional Ethics and Research Committee Approval No. MMUST/IERC/069/2022. Research permit was granted by National Commission for Science, Technology, and Innovation license No. NACOSTI/P/22/18367.

III. RESULTS & DISCUSSION

3.0 Results

3.1 Maternal-related risks factors associated with LPN and ETN birth relative to their full-term counterparts.

Table 1 presents the results of maternal-related risk factors associated with late preterm and early term neonates birth compared to those born at full-term. The study revealed that maternal age (p=0.042), occupation (p=0.024), ethnicity (p=0.021), religion (p=0.016), and absence of previous adverse pregnancy outcomes (p=0.015) were significant maternal related risk factors associated with birth of LPN, ETN and FTN births in Garissa County. Specifically, mothers aged 20-29 years were more likely give birth to FTN than LPN or ETN (RRR=6.42, p=0.042). Surprisingly, self-employed women had a higher likelihood of giving birth to FTNs compared to LPNs and ETNs (RRR=30.69, p=0.024). Protestant mothers were more likely to deliver FTNs than ETNs (RRR=0.01, p=0.016). Additionally, mothers from the Luo ethnic group showed a greater likelihood of having FTNs than other ethnic groups (RRR=422.17, p=0.021), suggesting a possible role of genetic or sociocultural factors in occurrence of preterm births. Furthermore, the study found that mothers with no history of abortion, stillbirth, or premature delivery had

approximately 14-fold likelihood of delivering FTNs compared to LPNs and ETNs (RRR=13.57, p=0.015). Apart from the four variables, no other variables showed significant differences among the groups (p>0.05). The multinomial logistic regression analysis identified that maternal-related risk factors associated with LPN, ETN, and FTN births are significantly different. The likelihood ratio chi-square test indicated that the model, which included predictors, was statistically significant ($\chi^2 = 111.23$, df = 82, p = 0.0175), hence the null hypothesis was rejected and alternative hypothesis that maternal risk factors is different was accepted. The model explained about 31 percent of the variance in the outcomes (Pseudo $R^2 = 0.3054$), reflecting a good fit.

Table 1

Maternal risk factors associated with LPN, ETN and FTN birth

	RRR	Std. Err.	z	P value	[95% Conf. Interval]		RRR	Std. Err.	z	P Value	[95% Conf. Interval]	
Control variables	**LPN**						**FTN**					
Marriage Type Monogamous (Ref.)												
(Polygamous)	1.4784	1.3347	0.43	0.665	0.1808	9.1301	0.8944	0.8538	-0.12	0.907	0.087251	5.135423
Live with Spouse (No)	6.4E-07	3.1E-03	0	0.998			1.6178	3.1695	0.25	0.806	0.014885	89.31024
Maternal Religion 1=Muslim (Ref.)												
2=Catholic	4.15E+07	1.64E+11	0	0.996	0.0000	.	0.0000	0.0000	-0.01	0.995	.	.
3=Protestant	7049718	2.79E+10	0	0.997	0.0000	.	0.0111	0.0209	-2.4	**0.016**	0.000179	0.452567
Ethnicity												
Kamba	9.0E-08	3.6E-04	0	0.997	0.0000	.	26.2985	50.5969	1.7	0.089	0.476974	1213.593
Kikuyu	4.5E-08	1.8E-04	0	0.997	0.0000	.	0.0000	0.0042	0	0.997	.	.
Meru	3.5E-08	1.4E-04	0	0.997	0.0000	.	0.0000	0.0196	0	0.997	.	.
Luo	5.2E-08	2.1E-04	0	0.997	0.0000	.	422.1670	1105.2920	2.31	**0.021**	3.395364	2618183
Malakote/Munyoyaya	1.9E-01	3.4E-01	-0.93	0.354	0.0035	13.9296	1.1247	1.3553	0.1	0.922	0.153398	84.76591
Others (specify)	4.7E-08	1.8E-04	0	0.997	0.0000	.	12.6161	19.5969	1.63	0.103	0.523321	339.5939
County of residence (Others specify)	0.737498	0.6238871	-0.36	0.719	0.1031	4.4933	0.9925	0.7708	-0.01	0.992	0.055557	2.740033
Maternal Age												
20-29	2.044107	1.77068	0.83	0.409	0.3442	14.2347	6.4153	5.8557	2.04	**0.042**	0.866897	42.2619
30-39	2.141904	2.551127	0.64	0.522	0.1195	30.6248	1.8399	2.2877	0.49	0.624	0.065624	36.60824
40+	2.665429	5.576473	0.47	0.639	0.0026	57.2286	0.0000	0.0008	0	0.998	.	.
Number of ANC Visits												
Two visits	0.450213	0.604221	-0.59	0.552	0.0021	5.0406	0.4837	0.8192	-0.43	0.668	0.003865	22.11822
Three visits	0.454757	0.5275279	-0.68	0.497	0.0016	2.0009	0.8034	1.2622	-0.14	0.889	0.00559	16.86578
Four visits	0.174799	0.2110488	-1.44	0.149	0.0005	1.0190	0.5446	0.8537	-0.39	0.698	0.003077	11.06289
	RRR	**Std. Err.**	**z**	**P value**	**[95% Conf. Interval]**		**RRR**	**Std. Err.**	**z**	**P Value**	**[95% Conf. Interval]**	
Control variables	**LPN**						**FTN**					
Maternal Education level												
Lower Primary	2.089761	3.735052	0.41	0.68	0.2507	685.4181	1.2754	1.9499	0.16	0.874	0.281452	471.5777
Upper Primary	0.421878	0.3464735	-1.05	0.293	0.0891	3.7037	0.4206	0.2983	-1.22	0.222	0.132036	3.119342
Secondary	2.307031	2.150315	0.9	0.37	0.5678	34.1513	0.9757	0.8149	-0.03	0.977	0.15629	5.99708

Post-Secondary	4.11941	6.07506	0.96	0.337	0.1623	82.1960	3.4395	5.0918	0.83	0.404	0.10027	37.59015
Maternal Occupation												
Employed (permanent and salaried)	0.379306	0.7432419	-0.49	0.621	0.0149	311.3528	0.0000	0.0001	0	0.997	.	.
Employed (temporary and salaried)	4.983008	10.58463	0.76	0.45	0.0567	862.7838	1.9096	4.0641	0.3	0.761	0.018458	408.1883
Self-employed/business	0.903587	1.540235	-0.06	0.953	0.0296	47.4518	30.6934	46.6157	2.25	**0.024**	2.431821	1753.913
Serological Status												
Negative	7236332	2.78E+10	0	0.997	0.0000	.	0.7555	1.4538	-0.15	0.884	0.017974	157.7188
Unknown	1.75E+07	6.73E+10	0	0.997	0.0000	.	0.0724	0.1690	-1.12	0.261	0.000278	15.78127
Parity												
Para 1	0.197177	0.207536	-1.54	0.123	0.0172	1.8483	1.0935	1.3390	0.07	0.942	0.143736	26.21439
Para 2	0.119562	0.1366324	-1.86	0.063	0.0009	0.9077	0.5307	0.6910	-0.49	0.627	0.025318	36.81154
Para 3	0.369331	0.4644009	-0.79	0.428	0.0003	1.9547	0.4358	0.6266	-0.58	0.564	0.006216	27.61952
Para 4	0.129973	0.1716397	-1.55	0.122	0.0000	0.1615	0.3572	0.5331	-0.69	0.49	2.06E-05	3.757323
Para 5	0.092371	0.1167505	-1.88	0.059	0.0000	0.0506	0.3035	0.4274	-0.85	0.397	5.49E-06	8.340565
Tuberculosis Status (Unknown)	1.476716	0.9044197	0.64	0.524	0.4555	6.3134	1.0558	0.5998	0.1	0.924	0.33532	4.068798
Prior history of abortion/still births/premature deliveries (No)	1.285688	1.00582	0.32	0.748	0.1922	11.9959	13.5733	14.5891	2.43	**0.015**	1.230818	187.6892
Presence of any medical problems (No)	0.384236	0.2643631	-1.39	0.164	0.0563	1.3574	0.5685	0.4013	-0.8	0.424	0.104807	2.729174
History of Child death (No)	2.733733	3.714513	0.74	0.459	0.1061	1701.6350	0.4122	0.4527	-0.81	0.42	0.017043	7.572989
	RRR	**Std. Err.**	**z**	**P value**	**[95% Conf. Interval]**		**RRR**	**Std. Err.**	**z**	**P Value**	**[95% Conf. Interval]**	
Control variables	**LPN**						**FTN**					
Maternal nutrition Status (MUAC>210 mm)	0.341404	0.3091271	-1.19	0.235	0.0315	1.7446	3.5522	4.7278	0.95	0.341	0.269509	81.19033
Mode of delivery (Caesarean Section)	1.655532	1.026606	0.81	0.416	0.3950	5.7019	2.7601	1.7305	1.62	0.105	0.693447	10.58947
Assisted delivery (No)	6.71E-08	0.0002624	0	0.997	.	.	0.0000	0.0001	0	0.996	0	.
Premature Rapture of the membrane (No)	0.219321	0.2961762	-1.12	0.261	0.0525	26.8160	0.3917	0.6299	-0.58	0.56	0.030562	25.13712
Had complications during delivery (No)	0.329353	0.3537347	-1.03	0.301	0.0304	4.5430	0.4603	0.5649	-0.63	0.527	0.012272	3.458968
Given abdominal massage (No)	1.469612	2.750063	0.21	0.837	.	.	2.7932	4.0975	0.7	0.484	0.058716	45.03235
Reference Outcome = ETN												
Log likelihood = -126.51347 LR chi2(82)= 111.23 Prob > chi = 0.0175 Pseudo R2= 0.3054 Multinomial Logistic Regression between outcome variable (LPN, FTN and ETN) and control maternal risks variables LPN= Late Pretern Neonate, ETN= Early Term Neonate, FTN=Full Term Neonate												

3.2 Fetal-related risks factors associated with late preterm and early term birth relative to full term neonates.

Table 2 presents the fetal-related risk factors associated with LPN and ETN births compared to FTN. Significant associations were found only for birth weight, breastfeeding initiation time, and feeding difficulties. Specifically, birth weight was inversely related to LPN births (RRR = 0.9963, $p < 0.001$), indicating a slight decrease in LPN likelihood with increased birth weight. However, birth weight was not significantly related to FTN births (RRR = 1.0012, $p = 0.053$), suggesting that higher birth weights may help lower the risk of LPN but not affect FTN outcomes. FTNs had a higher likelihood of delayed breastfeeding initiation (RRR = 3.61, $p = 0.038$) but were less likely to experience feeding difficulties compared to LPNs and ETNs (RRR = 0.0146, $p = 0.012$). No other factors showed statistically significant differences ($p > 0.05$), indicating comparability among LPN, ETN, and FTN births. The logistic regression model was statistically significant ($\chi^2 = 165.91$, df = 34, $p < 0.0001$) with a Pseudo R^2 of 0.4089, accounting for about 41 percent of the variability in neonatal outcomes. Since the $p < 0.0001$ was less than the Fisher value of 0.05, the null hypothesis was rejected.

Table 2

Fetal-related risk factors associated with LPN, ETN and FTN birth

Control variables	**RRR**	**Std. Err.**	**Z**	**P Value**	**[95% Conf. Interval]**		**RRR**	**Std. Err.**	**Z**	**P value**	**[95% Conf. Interval]**	
	LPN						**FTN**					
Infant Sex Male (Ref.)												
Female	1.8309	1.0402	1.06	0.287	0.6012	5.5751	0.6418	0.2804	-1.02	0.31	0.2726	1.5109
Birth weight	0.9963	0.0009	-4.23	0	0.9947	0.9980	1.0012	0.0006	1.93	0.053	1.0000	1.0024
Birth Length	0.7991	0.0999	-1.79	0.073	0.6254	1.0209	1.1853	0.1709	1.18	0.238	0.8935	1.5724
Birth Temperature	1.6151	0.9412	0.82	0.411	0.5154	5.0611	2.0265	0.9423	1.52	0.129	0.8146	5.0413
Bag and mask resuscitation after birth (No)	0.7398	1.4121	-0.16	0.875	0.0176	31.1776	2.4668	4.2451	0.52	0.6	0.0846	71.9361
Cried immediately after birth (No)	1.9558	2.5554	0.51	0.608	0.1511	25.3201	1.4876	2.1562	0.27	0.784	0.0868	25.4858
Apgar Score 1st minute	0.6504	0.4183	-0.67	0.504	0.1844	2.2940	0.9606	0.5144	-0.07	0.94	0.3363	2.7441
Apgar Score 5th minute	1.8009	1.3083	0.81	0.418	0.4336	7.4792	0.6542	0.4654	-0.6	0.551	0.1622	2.6378
Apgar_Score_10th minute	1.8155	0.8377	1.29	0.196	0.7349	4.4848	1.9104	1.1074	1.12	0.264	0.6134	5.9504
Perinatal asphyxia after birth (No)	0.2056	0.3481	-0.93	0.35	0.0074	5.6785	1.5529	2.4364	0.28	0.779	0.0717	33.6260
Respiratory distress after birth (No)	0.1841	0.2646	-1.18	0.239	0.0110	3.0774	0.1810	0.2718	-1.14	0.255	0.0095	3.4353
Diagnosed with hypoglycaemia on admission	1.2833	169.2963	0	0.998	6.60E-113	2.50E+112	2.0214	170.2685	0.01	0.993	4.04E-72	1.01E+72
Control variables	**RRR**	**Std. Err.**	**Z**	**P Value**	**[95% Conf. Interval]**		**RRR**	**Std. Err.**	**Z**	**P value**	**[95% Conf. Interval]**	
	LPN						**FTN**					
Initiated Breast Feeding after birth (>1 hr)	0.9414	0.6907	-0.08	0.934	0.2235	3.9657	3.6145	2.2415	2.07	**0.038**	1.0719	12.1878
Infant has feeding difficulties (No)	0.0265	0.0510	-1.89	0.059	0.0006	1.1510	0.0146	0.0246	-2.51	**0.012**	0.0005	0.3978
Kangaroo Mother care done (No)	1.6448	1.1986	0.68	0.495	0.3943	6.8610	0.3089	0.1876	-1.93	0.053	0.0939	1.0160
Noenate admitted NBU /ICU (No)	0.5855	0.6840	-0.46	0.647	0.0593	5.7795	3.7729	3.6327	1.38	0.168	0.5716	24.9029
cons	3.0883	818.0195	0	0.997	1.10E-225	9.00E+225	7.87E-18	1.33E-15	-0.23	0.816	3.9E-162	1.6E+127
	Reference Outcome=ETN											

Log likelihood = -119.90999 LR chi2(34) = 165.91 Prob> chi2=0.0000 Pseudo R2 =0.4089

Multinomial Logistic Regression between outcome variable (LPN, FTN and ETN) and control fetal variables

LPN=Late Preterm Neonate, ETN= Early Term Neonate, FTN= Full Term Neonate

3.3 Survival and mortality rates

Table 3 shows that survival rates were high across all gestational groups, with 100% for LPNs, 98.7% for ETNs, and 98.2% for FTNs. Mortality rates were minimal and similar for ETNs and FTNs, each recording 1.5%. Neonatal death rates per 1,000 live births were 0 for LPNs, approximately 13.16 for ETNs, and approximately 17.86 for FTNs. The statistical comparison yielded a p-value of 0.649, indicating no significant differences in neonatal outcomes across gestational age categories. These findings suggest that gestational age does not significantly impact immediate neonatal outcomes or mortality rates.

Table 3

Comparison of neonatal outcomes among LPN, ETN and FTN

Neonatal Outcome	Gestational Age Categories			P-value
	LPN (n=53)	ETN (n=77)	FTN (n=57)	
Alive; n (%)	53 (28.3)	76 (40.6)	56 (29.9)	0.649
Died; n (%)	0 (0.0)	1 (1.5)	1 (1.5)	

Data presented as n (%). Statistical significance determined by Pearson Chi-Square tests
LPN=Late Preterm Neonate, ETN=Early Term Neonate, FTN= Full Term Neonate

3.4 Predictors of survival of LPNs, ETNs, and FTNs born at Garissa County Referral Hospital

The Kaplan-Meier survival analysis was applied to 187 neonates, divided into LPN, ETN, and FTN groups (Figure 1). No events were observed in the LPN group (n=53), resulting in 100% censoring. The ETN group (n=77) had one event on day 2, with a cumulative survival probability of 98.7%, while the FTN group (n=57) recorded one event on day 4, with a survival probability of 98.2%. The overall censoring rate was 98.9%. The Log Rank (Mantel-Cox) test ($\chi^2 = 0.855$, df = 2, p = 0.652) indicated no significant differences in survival across the three groups. These results suggest that gestational age may not significantly impact neonatal outcomes within the neonatal period, though high censoring—especially in the LPN group—warrants cautious interpretation.

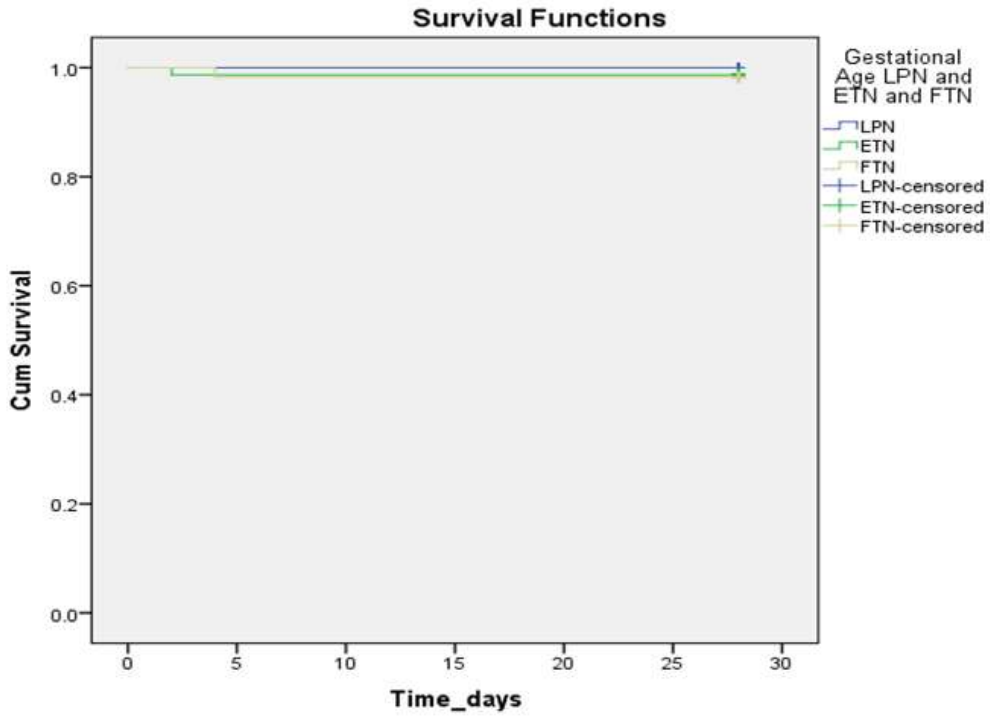

Figure 1

Kaplan Mayer Survival Analysis

To identify maternal related predictors of neonatal survival at GCRH, we conducted bivariate Cox regression analysis, results of which are shown in Table 4. Tuberculosis status, abortions, medical problems, past history of child dead and assisted delivery showed no significant association with neonatal survival (p > 0.05). However, maternal nutrition status (HR = 0.035, p = 0.025) and complications during delivery (HR = 5.10, p = 0.024) emerged as significant

predictors. These results suggest that maternal nutrition and delivery complications are key determinants of neonatal survival in in GCRH.

Table 4

Maternal Related Predictors of Survival

Predictor variable	HR	95% Confidence Interval		P-Value
County	.053	.000	134.846	.464
Tuberculosis Status	.147	.000	51.080	.520
Abortion	.198	.000	1756.263	.727
Medical Problems	.193	.000	596.920	.688
History of child dead	.204	.000	3850.460	.752
Maternal nutrition status	**.035**	.002	.662	**.025**
Assisted delivery	1.000	.012	80.535	1.000
Had complications during Delivery	**5.097**	1.245	20.863	**.024**

Hazard Ratio (HR), and 95% confidence intervals for HR

We did not perform multivariate Cox regression analysis as the two significant maternal predictors—maternal nutrition status and delivery complications—had p-values >0.02. Similarly, bivariate Cox regression for fetal-related predictors did not identify any statistically significant factors at the α=0.05 level (Table 5). However, some variables suggested potential influence on neonatal survival, such as bag and mask resuscitation (p=0.081), feeding difficulties (p=0.110), and perinatal asphyxia on Day 1 (p=0.152), which showed trends toward significance.

Table 5

Fetal-Related Predictors of Survival

Predictor variable	HR	95% Confidence Interval		P-Value
Bag and mask resuscitation after birth	3.643	.852	15.578	.081
Cried immediately after birth	.419	.102	1.728	.229
Perinatal asphyxia after birth	2.786	.652	11.907	.167
Respiratory distress after birth	2.399	.548	10.506	.245
Infant has feeding difficulties	4.222	.722	24.698	.110
Kangaroo mother care done	.153	.000	60.987	.539
Neonate admitted to ICU/NBU	1.889	.458	7.787	.379
Perinatal asphyxia Day 1	2.956	.672	12.997	.152
Respiratory distress on Day 1	.189	.000	762.903	.694

Hazard Ratio (HR), and 95% confidence intervals for HR

4.0 Discussion

This study investigated maternal as well as fetal risk factors associated with LPN, ETN and FTN births at Garissa County Referral Hospital. Maternal factors such as age, occupation, ethnicity, religion, and absence of prior adverse pregnancy outcomes were significantly associated with birth outcomes. Mothers aged 20-29 years had a higher likelihood of giving birth FTNs compared to ETNs and LPNs, supporting findings from previous research that identified increased preterm birth risks among mothers younger than 20 or older than 31 years of age (Delnord & Zeitlin, 2019; Okube & Sambu, 2017; Pusdekar et al., 2020; Torres-Muñoz et al., 2020). This suggests that the 20-29 age range is optimal for achieving full-term pregnancies.

In contrast to prior studies linking maternal occupation to preterm births (Etil et al., 2023; van den Broek et al., 2014), our findings revealed that women in self-employment or business had a higher likelihood of delivering FTNs compared to LPNs and ETNs. This positive association with self-employment has not been reported in existing literature, indicating a need for further research to uncover potential mechanisms. Additionally, Luo ethnicity was linked to increased FTN births, aligning with evidence suggesting that genetic, environmental, and socio-economic factors contribute to disparities in preterm birth rates among ethnic groups (Delnord & Zeitlin, 2019; Reddy et al., 2009). Similarly, the absence of prior adverse pregnancy outcomes was significantly associated with FTN births, consistent with previous findings that history of preterm birth is a strong predictor of subsequent preterm deliveries (Delnord & Zeitlin, 2019; van den Broek et al., 2014).

Interestingly, our study did not find significant associations with antenatal care visits, education level, serological status (e.g., HIV), parity, medical complications, maternal nutrition, or mode of delivery—factors commonly associated with preterm births in other studies (Delnord & Zeitlin, 2019; Eşki et al., 2023; Okube & Sambu, 2017; Vanin et al., 2020; Wagura et al., 2018). These discrepancies could be attributed to differences in study designs, demographic characteristics, sample sizes, or the healthcare context in Garissa County. The role of parity in neonatal outcomes remains complex, as some studies report it as a significant risk factor (Delnord & Zeitlin, 2019), while others do not (Algameel et al., 2020; Pusdekar et al., 2020). For instance, primiparity and grand multiparity have been associated with preterm births due to complications such as preeclampsia (Delnord & Zeitlin, 2019; Shapiro-Mendoza & Lackritz, 2012). In contrast, Reddy et al. (2020) found increased LPN births among multiparous women. Such inconsistencies underscore the complexity of parity as a risk factor, suggesting that its impact may vary across populations and settings.

From a fetal perspective, only birth weight, breastfeeding initiation time, and feeding difficulties were significant fetal related factors associated with birth of LPNs, ETNs and FTNs. Birth weight was inversely associated with LPN births, consistent with earlier research linking lower birth weights to higher risks of late preterm deliveries (Goldenberg et al., 2008; Karnati et al., 2020). FTNs were more likely to experience delayed breastfeeding initiation but had fewer feeding difficulties, aligning with studies emphasizing the feeding challenges faced by LPNs due to immature suck-swallow-breathe reflexes (Engle et al., 2007; Karnati et al., 2020). This highlights the need for targeted feeding support to prevent rehospitalization among LPNs. Additionally, the results from the present study diverge from previous studies that identified factors such as APGAR scores, birth length, perinatal asphyxia, and respiratory distress as significant predictors of preterm births (Algameel et al., 2020; Wang et al., 2004). Such differences may arise from variations in study design, demographics, and sample size. Notably, the lumping of ETN and FTN groups in previous studies may have contributed to attenuated results, given that LPNs and ETNs share several risk factors (Brown et al., 2015, 2016).

The Kaplan-Meier survival analysis revealed high survival rates across all gestational age categories, with 100% survival among LPNs. This contrasts with previous research indicating higher morbidity and deaths among LPNs compared to term neonates (Karnati et al., 2020; Shapiro-Mendoza & Lackritz, 2012). It also contrasts with results from several studies done in different parts of Ethiopia and Iran, where survival rates have been found to be significantly lower and heavily influenced by gestational age (Mengesha et al., 2016; Tamene et al., 2020). However, the high censoring rate in this study, especially among LPNs, suggests caution in interpreting these findings, as they may not accurately reflect the true population parameters.

Furthermore, our finding that maternal nutrition and delivery complications are significant predictors of survival among the three groups, align with findings a study that identified delivery complications as significant survival factors (Mengesha et al., 2016). It is worth noting that maternal nutrition as a survival predictor is less commonly reported, indicating a need for further investigation. No fetal-related factors were statistically significant, contrary to existing literature that identifies birth weight, respiratory distress, jaundice, and hypoglycemia as survival predictors(Tamene et al., 2020).

Overall, this study challenges some established views on the role of gestational age and maternal/fetal factors in predicting neonatal outcomes. The unique context of Garissa County and the specific healthcare environment may explain these discrepancies, underscoring the need for further, more powered studies in similar settings. The study had some limitations. These included the single-site design, observational nature, convenience sampling, and reliance on last menstrual period for gestational age estimation, which may limit the generalizability of findings. Despite these limitations, this study provides important insights into maternal and fetal risk factors and predictors of LPN, ETN and FTN Survival specific to Garissa County. While some findings align with global research, others offer new perspectives that warrant further exploration, particularly in other regions of Kenya as well as low- and middle-income countries.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study identified distinct maternal and fetal risk factors associated with LPN and ETN births compared to FTNs at Garissa County Referral Hospital. Key maternal factors included age, occupation, ethnicity, and absence of adverse pregnancy history, while significant fetal factors were birth weight, breastfeeding initiation, and feeding difficulties. While survival rates were high across all groups, particularly among LPNs, the high censoring rate calls for cautious interpretation.

5.2 Recommendation

Ministry of Health to consider incorporating the findings of this study when reviewing policies and guidelines on maternal and newborn care such as Newborn, Child and Adolescent Health Policy 2018; Comprehensive newborn care protocols 2022; National Guidelines on essential newborn Care 2015; National Guidelines for Quality obstetric and perinatal care 2011.

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Conflict of Interest

The authors declare no conflicts of interest, financial or otherwise.

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