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Maternal and Neonatal Factors Associated with Mortality of Preterm Babies Admitted in Newborn Unit of Kenyatta National Hospital, Kenya

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Abstract

Background: Preterm birth is a primary cause of neonatal morbidity and mortality especially in low-income countries. Although understanding the preventable factors of neonatal deaths in preterm infants is required for timely interventions, data on those factors is lacking in Kenya. We attempted to determine mortality and its associated factors in preterm babies in Kenya. **Methods and Materials:** A hospital-based, prospective study was implemented from July 2019 to October 2019 involving 163 preterm neonates and their mothers admitted at Kenyatta National Hospital. A systematic random sampling method was used to recruit the study participants. Data on mortality and the associated factors in preterm neonates were collected using a pretested questionnaire for mothers and neonatal medical records. Data was analyzed using descriptive and inferential statistics. **Results:** The mortality rate was 18.4%. Of the neonates who died, respiratory distress syndrome (63.3%) and neonatal sepsis (20.0%) were documented as the primary causes. Neonates born of single mother (AOR = 8.006, 95% CI 2.267 to 28.272, p = 0.001), unemployed (6.960, 1.059 - 45.757, p = 0.043), self-employed (4.040, 1.067 - 15.302, p = 0.040), anemic (7.465, 2.530 - 22.023, p < 0.001) and with history of bleeding during pregnancy were more likely to have died. The neonates born before 28 weeks of gestation (126.188, 14.554 - 1094.060, p < 0.001), those who did not cry immediately at birth (54.271, 5.970 - 493.395, p < 0.001) and the resuscitated at birth (54.406, 6.807 - 434.851, p < 0.001) were likely to die. **Conclusion:** High mortality rates of preterm neonates are attributed to both maternal and neonatal factors. Focused antenatal care should aim at early identification of high-risk mothers for early management of bleeding during pregnancy, close monitoring of nutritional status for mothers

and health education.

Keywords

Preterm Babies, Mortality Rate, Factors Associated with Preterm Babies' Mortality

1. Introduction

Worldwide, preterm births (born before 37 weeks gestation) are associated with significant neonatal and under-five deaths [1]. Globally each year, 11% of all deliveries are premature and one out of six million children's deaths are due to complications linked to prematurity [2] [3]. Additionally, neonatal mortality is a critical marker of maternal health and overall development in a country. The neonatal mortality rates in low- and middle-income countries (LMICs) is substantially higher at 20 per 1000 live birth compared to 3 per 1000 in the high-income countries, an indication of economic disparities between the developed and less developed countries [4]. In low-income countries, half of preterm babies die due to a lack of basic care for infections and breathing difficulties. Whereas, in high-income countries, almost all these babies survive [5]. In Kenya, despite interventions, the neonatal mortality rate is 21 deaths per 1000 live births higher than that of middle-income countries (17 deaths per 1000 live births) [6]. In Kenya, the main causes of neonatal death in 2015 were birth trauma and asphyxia (31.6%), prematurity (24.6%), and sepsis (15.8%) [6].

The complications associated with prematurity are common as more babies spend a long time in neonatal intensive care unit under physiological support, predisposing them to severe infections. These complications include neurodevelopment abnormalities, learning difficulties, visual disorders, and secondary effects on long-term health [7] [8] [9]. Several factors have been linked with the increase in premature births namely maternal malnutrition during pregnancy [10], infections, and pre-eclampsia/eclampsia [11]. A study carried out by Okube and Sambu [12] at Kenyatta National Hospital (KNH), Kenya, found that history of urinary tract infection during pregnancy, previous preterm birth, abortion, hypertension during pregnancy, advanced maternal age (≥31 years), and alcohol consumption during pregnancy were significant risk factors for preterm birth. Identification of risk factors and timely establishment of treatments can significantly reduce prematurity-related mortality and morbidity [13].

Despite the high prevalence and adverse outcomes associated with preterm births, very few studies have assessed the impact of prematurity on infants' mortality and morbidity in sub-Saharan Africa [14]. Collecting comprehensive, high-quality data on mortality and morbidity in infants born prematurely is crucial to understanding trends, opportunities for quality improvement, and ultimately interventions for better infant outcomes [11]. Importantly, regions with high

rates of preterm births, mainly sub-Saharan Africa, experiences fragile and underfinanced health programs hence increasing difficulties in tackling this health problem [15]. To achieve sustainable development goal (SDG 3), reducing newborn and under-five mortality as low as 12/1000 and 25/1000, respectively, is one of the Global strategies of WHO in African countries by 2030. This could be achieved through better prevention and management of preterm neonates as a key strategy [16]. The main objective of this study was to evaluate the mortality rate associated with preterm births in the newborn unit at Kenyatta National Hospital, Kenya.

2. Methods

2.1. Study Setting

This study was conducted at the newborn unit in KNH, a referral and teaching public health facility in Nairobi. It is the largest public hospital in Kenya and offers a wide range of outpatient and inpatient comprehensive services. Being a teaching and referral hospital, it receives many high-risk pregnancies and their outcomes. The newborn unit is one of the busiest wards in the hospital, rendering service under critical newborn care unit and kangaroo mother care. It is staffed with trained nurses, general practitioners, pediatricians, and neonatologists.

2.2. Study Design, Sampling Method, and Respondents

A prospective cross-sectional study was conducted among preterm neonates admitted to the newborn unit at KNH in Nairobi, Kenya. To determine the outcome (survival vs death), we followed each of 163 preterm neonates for a maximum of two months (July-October 2019). All infants born < 37 weeks' gestation and admitted to the newborn unit were eligible for this study. The sample size was determined using Fisher's formula (Fisher *et al.*, 1998; $n = Z^2pq/d^2$) by considering 95% CI and 5% margin of error (d). The proportion of preterm birth (20.2%) was taken from the study carried out by Okube and Sambu [12] (2017) at KHN. Hence, $n = Z^2p\ (1 - p)/d^2 = (1.96)^2\ 0.202\ (0.798)/(0.05)^2 = 248$. Since the target population during the study period was <10,000, sample size adjustment was done using the formula $nf = n/1 + n/N$, $nf = 248/1 + 248/480 = 163$. Where "n" is the initially calculated sample size (248), N = total population in two months period (480). Thus, after adjusting, the final sample size was calculated at 163 subjects.

A systematic random sampling method was used to select the study participants. During the study period, neonatal admissions at the newborn unit were at an average of 240 preterm neonates per month; this translated to 480 preterm neonates for the two months. This number (480) was divided by the minimum adjusted sample size (163) to get a sampling interval of 3. The first preterm neonate to be included in the study was chosen randomly by blindly picking one of three pieces of paper named for the first three preterm neonates on that day. Af-

ter that, every third neonate who was admitted to the newborn unit was included in the study until the desired sample size was attained.

2.3. Data Instruments, Collection Method, and Procedure

A pretested, structured questionnaire was used to collect the data. Data were collected through interviewing mothers and by reviewing neonates' medical records using pretested data extraction checklist. The maternal assessment comprised of socio-demographic, Antenatal Care attendance, Iron and Folic Acid Supplementation (IFAS) intake, anemic status, presence of any acute/chronic diseases during pregnancy, history of bleeding during pregnancy, dietary patterns, and cultural beliefs during pregnancy, other obstetric and gynecological complications, and place of delivery. Neonatal variables including gestational age at birth, sex of the neonate, birth weight, presence of birth asphyxia, Apgar score in 5 minutes, whether the baby immediately cried, history of resuscitation, suctioning, and invasive procedures were extracted from medical records. Birth weight was categorized as Normal ≥ 2.5 kgs, low 1.5 - 2.4 kgs, and very low birth weight < 1.5 kgs.

2.4. Validity and Reliability of the Study Tools

Assessment tools were reviewed for content validity by experts in the field of neonatology and obstetrics to ascertain relevance and completeness. To measure the reliability of the questionnaire, a test re-test method was employed whereby, a repeat pre-test was carried out after two weeks, and Cohen's kappa statistic was used to measure the level of agreement of the two results. The result of the repeated questions had a kappa value of 0.87 therefore, the questionnaire was considered reliable.

2.5. Ethical Consideration

Ethical approval to conduct the study was obtained from Kenyatta National Hospital-University of Nairobi Ethical Review Committee (KNH-UoN ERC) (Approval number (UP110/02/2019). Consent was obtained from the study participants before data collection after an explanation of the study objectives.

2.6. Data Analyses

Statistical analyses were performed using the statistical package for the Social Sciences (SPSS: version 22). The chi-square test of independence and binary logistic regression was employed to determine associations between the dependent and independents variables. Maternal and neonatal continuous variables were compared using Student's t-tests. Two binary logistic regression models (infant and maternal variables) with *backward conditional* were used to determine the variables independently contributed to the preterm neonatal mortality. A p-value of less than 0.05 was considered to be significant. The model fitness was determined using Hosmer and Lemeshow test ($p = 0.106$), which implies that the model is fit.

3. Results

3.1. Relationship between Maternal Related Factors and Neonatal Outcome

The majority of the mothers were aged 20 - 35 years (79.1%), married (86.5%), Protestants (53.3%), had a secondary level of education (59.5%) and self-employed were (54%). The mortality rate among preterm neonates was 18.4%. Further analysis revealed that maternal age, marital status, employment status, anemia, and bleeding during pregnancy as well BMI were significantly associated with the neonates' outcome. Preterm neonates born of younger mothers (below 20 years) were 5.6 times (COR = 5.667, 95% CI = 1.129 - 28.454; p = 0.035) more likely to die compared to those born of older mothers. Neonates born of single mothers were 5 times (COR = 5.042, 95% CI = 1.924 - 13.212; p = 0.001) more likely to die as compared to neonates born of married mothers. The risk of dying was 4 times (COR = 4.250, 95% CI = 1.378 - 13.108; p = 0.012) higher among neonates born of self-employed mothers compared to neonates born of employed mothers. The mortality rate of the preterm neonates was 5-fold (COR = 5.190, 95% CI = 2.235 - 12.053; p < 0.001) higher among preterm neonates born of anemic mothers compared to preterm neonates born of non-anemic mothers. Neonates born of mothers with a history of bleeding during pregnancy were about 4 times (COR = 3.926, 95% CI = 1.710 - 9.013; p = 0.001) likely to die compared to neonates born of mothers with no history of bleeding during pregnancy (Table 1).

3.2. Relationship between the Neonates' Related Factors and Outcome

A total of 163 neonates with a gestational age < 37 weeks were included in the study. The majority of the preterm neonates were male (55.8%), had low birth weight (64.4%), born between 28 and 33 weeks of gestation (50.3%), scored low Apgar score at 5th minutes (55.2%), and immediately cried at birth (56.4%). Of the preterm neonates included in the study, most (81.6%, n = 133) survived to be discharged home, while, 18.4% (n = 30) died. Further analysis revealed that neonates with very low birth weight were 9 times (COR = 9.154, 95% CI = 1.100 - 76.175; p = 0.041) more likely to die compared to neonates with normal weight. Neonates born before 28 weeks of gestation were 53 times (COR = 53.333, 95% CI = 10.360 - 274.558; p < 0.001) more likely to die compared to neonates born at ≥34 weeks of gestation. Neonates with low Apgar score (<7) at 5th minutes were 4 times (COR = 4.016, 95% CI = 1.559 - 10.573; p = 0.004) at higher risk of death compared to neonates with higher Apgar score (≥7). The mortality rate was significantly (COR = 2.812, 95% CI = 1.118 - 7.074; p = 0.028) higher among neonates who did not immediately cry at birth than those who cried. The mortality rate of neonates was about 6 and 7 times higher among neonates with history of resuscitation (COR = 5.673.153, 95% CI = 2.175 - 14.798; p < 0.001) and invasive procedure (COR = 7.402, 95% CI = 1.688 - 32.465; p = 0.008) compared

to neonates who did not have history of resuscitation and invasive procedure, respectively (Table 2).

Table 1. Relationship between maternal related factors and neonatal outcome.

Characteristics	Outcome of the preterm babies			COR (95% CI)	p-value
	Survived (n, %)	Died (n, %)	Total		
Maternal age (years)					
Below 20	7 (50.0)	7 (50.0)	14 (100)	5.667 (1.129 - 28.454)	0.035
20 - 35	109 (84.5)	20 (15.5)	129 (100)	1.040 (0.279 - 3.880)	0.954
Above 35	17 (85.0)	3 (15.0)	20 (100)	Reference	
Total	133 (81.6)	30 (18.4)	163 (100)		
Marital status					
Single	12 (54.5.3)	10 (45.5)	22 (100)	5.042 (1.924 - 13.212)	0.001
Married/cohabiting	121 (85.8)	20 (14.2)	141 (100)	Reference	
Total	133 (81.6)	30 (18.4)	163 (100)		
Religion					
Protestant	74 (85.1)	13 (14.9)	87 (100)	0.878 (0.095 - 8.140)	0.909
Catholic	54 (77.1)	16 (22.9)	70 (100)	1.481 (0.161 - 13.618)	0.728
Muslim	5 (83.3)	1 (16.7)	6 (100)	Reference	
Total	133 (81.6)	30 (18.4)	163 (100)		
Education level					
Non-primary	28 (82.4)	6 (17.6)	34 (100)	5.345 (0.589 - 48.524)	0.136
Secondary	77 (79.4)	20 (20.6)	97 (100)	6.587 (0.840 - 51.632)	0.073
Tertiary	28 (87.5)	4 (12.5)	32 (100)	Reference	
Total	133 (81.6)	30 (18.4)	163 (100)		
Employment					
Unemployed	16 (80.0)	4 (20.0)	20 (100)	3.187 (0.715 - 14.219)	0.129
Self-employed	66 (75.0)	22 (25.0)	88 (100)	4.250 (1.378 - 13.108	0.012
Employed	51 (92.7)	4 (7.3)	55 (100)	Reference	
Total	133 (81.6)	30 (18.4)	163 (100)		
Anemic status					
Anemic	24 (60.0)	16 (40.0)	40 (100)	5.190 (2.235 - 12.053)	<0.001
Not-anemic	109 (88.6)	14 (11.4)	123 (100)	Reference	
Total	133 (81.6)	30 (18.4)	163 (100)		
History of UTI					
Yes	82 (78.1)	23 (21.9)	105 (100)	2.044 (0.818 - 5.104)	0.126
No	51 (87.9)	7 (12.1)	58 (100)	Reference	
Total	133 (81.6)	30 (18.4)	163 (100)		
History of APH					
Yes	27 (64.3)	15 (35.7)	42 (100)	3.926 (1.710 - 9.013)	0.001
No	106 (87.6)	15 (12.4)	121 (100)	Reference	
Total	133 (81.6)	30 (18.4)	163 (100)		

Table 2. Relationship between the neonatal related factors and outcome.

Baby's characteristics	Outcome of the preterm baby		Total	COR (95% CI)	p-value
	Survived (n, %)	Died (n, %)			
Gender					
Male	73 (80.2)	18 (19.8)	91 (100)	1.579 (0.629 - 3.963)	0.331
Female	60 (83.3)	12 (16.7)	72 (1000	Reference	
Total	133 (81.6)	30 (18.4)	163 (100)		
Birth weight					
Very low birth weight	26 (60.5)	17 (39.5)	43 (100)	9.154 (1.100 - 76.175)	0.041
Low birth weight	93 (88.6)	12 (11.4)	105 (100)	1.806 (0.218 - 14.989)	0.584
Normal birth weight	14 (93.3)	1 (6.7)	15 (100)	Reference	
Total	133 (81.6)	30 (18.4)	163 (100)		
Gestational age at birth					
Less than 28 weeks	3 (23.1)	10 (76.9)	13 (100)	53.333 (10.360 - 274.558)	<0.001
28 - 33 weeks	66 (80.5)	16 (19.5)	82 (100)	3.879 (1.230 - 12.230)	0.021
34 weeks and above	64 (94.1)	4 (5.9)	68 (100)	Reference	
Total	133 (81.6)	30 (18.4)	163 (100)		
Apgar score in the 5th minutes					
Less than 7	66 (73.3)	24 (26.7)	90 (100)	4.016 (1.559 - 10.573)	0.004
7 and above	67 (91.8)	6 (8.2)	73 (100)	Reference	
Total	133 (81.6)	30 (18.4)	163 (100)		
Immediately cried at birth					
No	51 (71.8)	20 (28.2)	71 (100)	2.812 (1.118 - 7.074)	0.028
Yes	82 (89.1)	10 (10.9)	92 (100)	Reference	
Total	133 (81.6)	30 (18.4)	163 (100)		
History of resuscitation					
Yes	55 (69.6)	24 (30.4)	79 (100)	5.673.153 (2.175 - 14.798)	<0.001
No	78 (92.9)	6 (7.1)	84 (100)	Reference	
Total	133 (81.6)	30 (18.4)	163 (100)		
History of invasive procedure					
Yes	87 (75.7)	28 (24.3)	115 (100)	7.402 (1.688 - 32.465)	0.008
No	46 (95.8)	2 (4.2)	48 (100)	Reference	
Total	133 (81.6)	30 (18.4)	163 (100)		

COR = crude odds ratio.

3.3. Relationship between Neonatal Survival Markers and Maternal Anthropometrics and Clinical Outcome

Analysis with an independent t-test revealed a significant association between some neonatal **survival markers** and maternal variables **on clinical** outcome.

The deceased neonates were significantly (t = 3.999, df = 161, p < 0.001) had lower birth weight relative to the survived ones (1.47 vs 1.91). Similarly, the mean Apgar score at the 5th minute was significantly (t = 5.357, df = 161, p < 0.001) lower among the deceased neonates as compared to surviving ones (6.57 vs 7.73). The mean gestational age at birth was also significantly (t = 4.823, df = 161, p < 0.001) lower among the deceased neonates as compared to survived ones (30.03 vs 32.79 weeks). Additionally, the mean hemoglobin level for mothers of deceased neonates was significantly (t = 2.743, df = 161, p = 0.007) lower (10.08 vs 11.73) compared to mothers of surviving neonates (Table 3).

3.4. Disease Profile of the Preterm Neonates

Of the preterm neonates, only 11.7% did not have any complications. The most common morbidity associated with prematurity included respiratory distress syndrome (RDS) (27%), neonatal sepsis (NNS) (23.9%), and neonatal jaundice (NNJ) (22.1%). Additionally, some (15.3%) of the neonates had both NNS and NNJ (Figure 1).

Table 3. Relationship between the neonates/maternal related factors and outcome (mean ± SD).

Outcome	Birth weight	Total	t-test	df	p-value
Survived	1.91 (0.543)	133 (100)	3.999	161	0.000
Died	1.47 (0.571)	30 (100)			
Apgar score in the 5th minutes					
Survived	7.73 (1.081)	133 (100)	5.357	161	0.000
Died	6.57 (1.040)	30 (100)			
Gestational age at birth					
Survived	32.79 (2.708)	133 (100)	4.823	161	0.000
Died	30.03 (3.316)	30 (100)			
Maternal Hemoglobin					
Survived	11.73 (1.702)	133 (100)	2.743	161	0.007
Died	10.80 (1.592)	30 (100)			

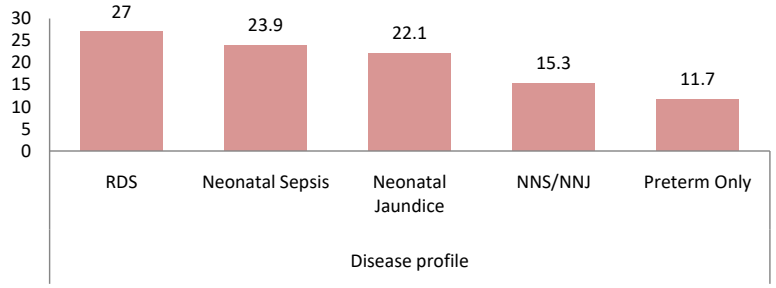

Figure 1. Disease profile of the preterm neonates (%).

3.5. Causes of Death of the Preterm Neonates

Figure 2 shows the causes of death in preterm neonates. The main cause of death among the preterm neonates was respiratory distress syndrome (RDS) (63.3%), while neonatal sepsis accounted for 20.0% of deaths among the preterms.

3.6. Predictors of the Neonatal Outcome as Established through Multivariate Binary Regression Output for Maternal Variables

Maternal factors significantly ($p < 0.05$) associated with neonatal outcome during a bivariate analysis were age, marital status, employment status, anemia, and history of bleeding during pregnancy. After subjecting these factors using the "*backward conditional*" method, five (5) variables remain independently predictors of neonatal outcome. Neonates born of a single mother were 8 times (AOR = 8.006, 95% CI 2.267 to 28.272, $p = 0.001$) more likely to die compared to neonates born of married mothers. Neonates born of unemployed and self-employed mothers were about 7 (AOR = 6.960, 95% CI 1.059 to 45.757, $p = 0.043$) and 4 times (AOR = 4. 040, 95% CI 1.067 to 15.302, $p = 0.040$), respectively, more likely to die compared to neonates born of employed mothers. Neonates born of anemic mothers were 7 times (AOR = 7.465, 95% CI 2.530 to 22.023, $p < 0.001$) at increased risk of death compared to neonates born of non-anemic mothers. Neonates born of mothers with a history of bleeding during pregnancy were 4 times (AOR = 4.252, 95% CI 1.470 to 12.297, $p = 0.008$) more likely to die compared to neonates born of mothers who reported did not have bleeding during pregnancy (Table 4).

3.7. Predictors of Neonatal Outcome as Established through Multivariate Binary Regression Output for Neonatal Variables

Binary logistic regression analysis was performed to model neonatal outcome as a dependent variable and the independent variables that revealed significant association at $p < 0.05$ during the bivariate analysis. Accordingly, the logistic model included the following factors: Birth weight, gestational age at birth, Apgar

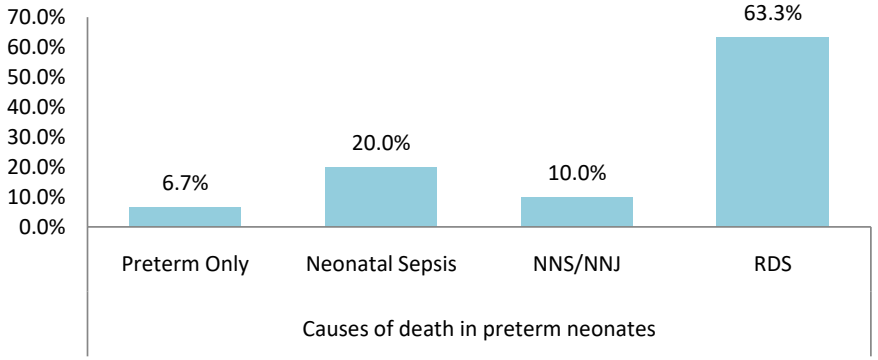

Figure 2. Causes of death of the preterm neonates.

Table 4. Multivariate Binary Regression output for maternal variables.

Variable	AOR	95% CI		p-value
		Lower	Upper	
Full/first model				
Age (years)				
Below 20	2.064	0.242	17.624	0.508
20 - 35	0.463	0.075	2.844	0.406
Above 35	Reference			
Marital status				
Single	8.006	2.267	28.272	0.001
Married/cohabiting	Reference			
Employment status				
Unemployed	5.622	0.776	40.702	0.087
Self-employed	3.910	0.998	15.323	0.050
Employed	Reference			
Anemic status				
Anemic	8.567	2.698	27.195	0.000
Not-anemic	Ref			
History of bleeding during pregnancy				
Yes	5.215	1.713	15.876	0.004
No	Ref			
Reduced/last model				
Marital status				
Single	8.006	2.267	28.272	0.001
Married/cohabiting	Reference			
Employment status				
Unemployed	6.960	1.059	45.757	0.043
Self-employed	4.040	1.067	15.302	0.040
Employed	Reference			
Anemic status				
Anemic	7.465	2.530	22.023	<0.001
Not-anemic	Reference			
History of bleeding during pregnancy				
Yes	4.252	1.470	12.297	0.008
No	Reference			

AOR = adjusted odds ratio.

score at 5th minutes, immediately cried at birth, history of resuscitation, and invasive procedure as neonatal factors. The *Backward conditional* method was

specified with removal at $p < 0.05$ to determine the independent predictors of the neonatal outcome as it removes the confounding variables until no further variables can be removed without a statistically insignificant loss of fit (last or reduced model). After considering all; gestational age at birth, immediately cried at birth, and history of resuscitation were independently associated with neonatal outcome. Neonates born before 28 weeks of gestation were 126 times (AOR = 126.188, 95% CI 14.554 to 1094.060, $p < 0.001$) more likely to die compared to neonates born at ≥34 weeks of gestation. The mortality rate was 54 times (AOR = 54.271, 95% CI 5.970 to 493.395, $p < 0.001$) higher among neonates who did not immediately cry at birth compared to those who cried. Neonates with a history of resuscitation were 54 times (AOR = 54.406, 95% CI 6.807 to 434.851, $p < 0.001$) more likely to die compared to neonates with no history of resuscitation (**Table 5**).

4. Discussion

The main objective of this study was to determine the mortality and its associated factors in preterm babies admitted in the newborn unit at KNH, Kenya. The mortality rate in our study was higher (18.4%) than a finding from Pumwani Maternity Hospital, Nairobi, Kenya at 12.8% [17] (Tele *et al.*, 2017). This might be due to the difference in the study setting and the study population which might have an impact on the outcome of these preterm neonates. The newborn unit at KNH receives highly complicated cases that might have been attributed to the higher death rate in our study compared to Pumwani Maternity Hospital. However, our finding was similar to studies conducted in Ethiopia 18.2% [18] and Cameroon 15.7% [19]. In line with our findings, reports from Kenya [20], Ethiopia [21] [22], Eritrea [23], and China [24] showed that neonatal RDS and sepsis as the main causes of death in premature infants. This highlights the importance of targeted interventions on infection control and respiratory support to preterm babies. It is, therefore, highly recommended for the newborn unit to be equipped with specialized manpower and advanced equipment.

In the current study, the mortality rate was higher among preterm babies born of single mothers as compared to those born of married mothers. In line with this finding, several studies in the Western countries reported that the mortality rate was higher among babies born of single mothers relative to those born in two-parent households [25] [26] [27]. This relationship can be explained by the fact that single mothers might not have adequate capacity to provide an ideal environment both during pregnancy and after delivery due to a lack of psycho-social support systems and pregnancy-related stress [28]. Pregnancy without a psycho-social support system is stressful and can lead to ill-health for both the mother and the newborn. Moreover, single motherhood comes with its share of financial burden. With additional nutritional requirements during pregnancy, single mothers may find it difficult to meet the extra demand and end up consuming less than required and hence poor pregnancy outcome [29] [30].

Table 5. Multivariate Binary Regression output for neonatal variables.

Variables	AOR	95% CI		p-value
		Lower	Upper	
Full/first model				
Birth weight				
Very low birth weight	1.917	0.098	37.487	0.668
Low birth weight	0.830	0.065	10.646	0.886
Normal weight	Reference			
Gestational age at birth				
Less than 28 weeks	46.539	4.297	503.998	0.002
28 - 33 weeks	3.975	0.638	24.757	0.139
34 weeks and above	Reference			
Apgar score in the 5th minutes				
Less than 7	2.681	0.406	17.706	0.306
7 and above	Reference			
Immediately cried at birth				
No	122.444	9.530	1573.228	<0.001
Yes	Reference			
History of resuscitation				
Yes	40.433	4.747	344.388	0.001
No	Reference			
History of invasive procedure				
Yes	3.086	0.526	18.093	0.212
No	Reference			
Reduced/last model				
Gestational age at birth				
less than 28 weeks	126.188	14.554	1094.060	<0.001
28 - 33 weeks	7.132	1.421	35.806	0.017
34 weeks and above	Reference			
Immediately cried at birth				
No	54.271	5.970	493.395	<0.001
Yes	Reference			
History of resuscitation				
Yes	54.406	6.807	434.851	<0.001
No	Reference			

AOR = adjusted odds ratio.

The mortality rate was higher among neonates born of self-employed and unemployed mothers as compared to neonates born of employed mothers. This

can be explained by the fact that particularly self-employed mothers may not have enough time and capacity to adequately care for themselves during pregnancy. Self-employed people, especially in developing countries, depend on their daily activity and must work for long hours with minimum rest. Pregnancy without enough rest can lead to ill-health for both the mother and the newborn. Further, self-employed mothers are less likely to attend antenatal care as they are busy with their daily activities and might miss regular check-ups and monitoring of pregnancy status.

Our study found that preterm neonates born of mothers with a history of bleeding and anemia during pregnancy were more likely to die compared to those born of mothers who did not have bleeding and anemia during pregnancy, respectively. Moreover, the mean hemoglobin level for mothers of deceased neonates was significantly lower as compared to mothers of survived neonates, which is consistent with previous reports [31] [32]. Poor maternal health and inadequate nutritional status are well-recognized risks for neonatal death [33] [34] [35]. The possible explanation for this association is that bleeding and being anemic during pregnancy reduces oxygen and micronutrient supply to the growing fetus making the intrauterine environment unfavorable. This can lead to premature delivery and many complications during or after delivery and subsequent death.

Neonates born before 28 weeks of gestation were at increased risks of death compared to neonates born at ≥34 weeks of gestation. The mortality rate among the infants was as high as 76.9% for infants born before 28 weeks gestation. Relevant to this finding, a prospective study conducted in Ethiopia reported a mortality rate as high as 86% in infants born before 28 weeks of gestation [22]. Similarly, several studies have reported that the rate of survival was directly proportional to gestational age [23] [36] [37] [38] [39]. Infants born before 30 weeks gestation are at high risk of RDS due to pulmonary surfactant deficiency and are prone to hospital admission and respiratory-related death. Moreover, preterm neonates are prone to infectious diseases, hypothermia, and subsequently death [40] [41] [42].

In the current study, the mortality rate was higher among neonates who did not immediately cry at birth and those with a history of resuscitation, which are in line with findings from Ethiopia [43]. Neonates who require resuscitation at birth are usually in critical situations mostly due to the absence of breathing that might lead to death. Moreover, resuscitation might serve as an entry point for microbial and causes infection as preterm neonates tend to have poor host defense. Several studies have reported a significant association between resuscitation at birth and neonatal sepsis [43] [44] [45], one of the major causes of neonatal death [21].

The results from this study highlight the need for early identification and appropriate management of risks to reducing neonatal mortality and make sustainable development goals achievable. These data are useful for exploring ways of improving the quality of care and health care delivery.

5. Limitations of the Study

Since the study was done on admitted neonates and in the biggest referral hospital in Kenya, the results might have limitations in generalizability to the entire population. Using a cross-sectional study cause-effect relationship cannot be verified.

6. Conclusion

The mortality rate among preterm neonates is high with the most common cause of death being respiratory distress syndrome (RDS) and neonatal sepsis. Both maternal and neonatal factors proved to be risk factors for preterm neonatal mortality. Most of those risk factors could be prevented by improving antenatal and neonatal care. Efforts to prevent preterm delivery and its complications should be aimed at identifying maternal factors including self-employed and single mothers for targeted antenatal care and prevention of bleeding and anemia during pregnancy. Priority of care should be given to infection control and respiratory support of preterm neonates. Hence, healthcare providers should exercise high standards of care when handling premature babies to avoid an infection.

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Authors' Contribution

Tekeste and Angela conceptualized the research problem and were involved in proposal writing and data collection. Tekeste carried out data analysis. Tekeste and Jane interpreted the results and prepared the paper. Dr. Kimani critically reviewed the manuscript.

Availability of Data and Materials

Pertinent data are presented in this manuscript. Additional data can be requested from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

Ethical approval was obtained from Kenyatta National Hospital-University of Nairobi Ethical Review Committee (KNH-UoN ERC) (Approval number (UP110/02/2019). We also sought study approval from the National Commission for Science, Technology, and Innovation (NACOSTI) (Approval number NACOSTI/P/20/3820). The institutional permission was granted by the administration of the Kenyatta national hospital. Consent was obtained from the study participants before data collection after an explanation of the study's aim and

objectives.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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