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Research Article

Keywords: Anthropometry, Neonate, Neonatal anthropometry, Neonatal Weight, Neonatal Morbidity, Neonatal Mortality, Discharge Against Medical Advice

Posted Date: November 5th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11221099/v1

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Additional Declarations: No competing interests reported.

Neonatal Morbidity and Mortality in Relation to Perinatal Anthropometry in a Tertiary Hospital in Nigeria.

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Acknowledgements: specialists, doctors, nurses, other staff members of the neonatal intensive care unit of Bowen University Teaching Hospital, Ogbomoso.

The Physics Programme, Bowen University Iwo.

Dr Akinpelu Theophilus Onigbinde, Professor Abiodun Peter Aboyeji and Professor Olaleye Olabiyi

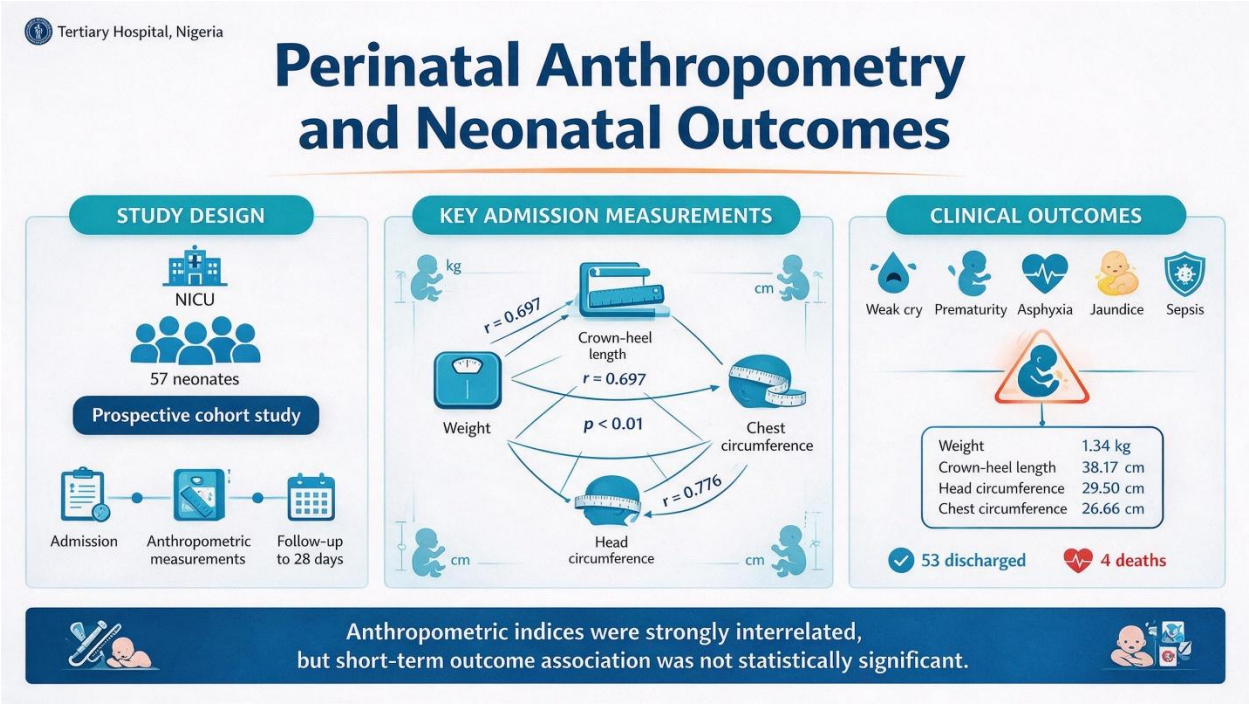
Abstract

Neonatal anthropometric parameters, routinely taken within the forty-eight hours of birth, are correlated with each other and neonatal outcomes. However, the relationship between neonatal anthropometry at admission (perinatal) and morbidity and mortality within twenty-eight days of life is understudied. The aim was to study neonatal morbidity and mortality in relation to perinatal anthropometry in a tertiary hospital in Nigeria.

A prospective cohort study with consecutive sampling was conducted at the neonatal intensive care unit (NICU) of Bowen University Teaching Hospital, Ogbomoso. A total of 57 subjects were recruited for the study. Socio-demographic data, anthropometric indices, and vital signs were taken at admission, and neonatal outcomes were assessed using a validated questionnaire. The data were analysed with SPSS version 25.

Socio-demographic results showed 68% were male and 49% were aged 1-7 days. Perinatal weight correlated with crown-heel length (r = 0.697), head circumference (r= 0.697), cand hest circumference (r=0.776), p-value < 0.01 for all. Neonates with weak cry had the lowest mean anthropometric indices among clinical presentation groups. Neonates diagnosed with prematurity had the lowest mean weight of all the anthropometric parameters [Weight(1.34kg), Crown heel length (38.17cm), Head circumference (29.50cm), and Chest circumference (26.66 cm)]. Perinatal asphyxia, jaundice, and Sepsis also showed different relationships with the anthropometric values observed. Fifty-three subjects were discharged, and four deaths were recorded.

This study demonstrated that neonatal anthropometric measurements were strongly interrelated; their direct association with short-term outcomes was not statistically significant. Neonatal weight was found to be a major indicator of prematurity, and reduced anthropometric indices had a strong correlation with neonatal outcomes.



Graphical Abstract

What is known

- Neonatal anthropometric measures (weight, length, head and chest circumferences) are routinely recorded within 48 hours, correlate with each other, and help identify prematurity and growth restriction.

- Most research uses measurements taken within 48 hours; evidence is limited on admission (perinatal) anthropometry's link with 28-day morbidity/mortality, especially from LMIC (low- and middle-income country) tertiary centres.

What is new

- In this Nigerian NICU cohort, admission weight strongly correlated with length and head circumference ($r \approx 0.70$) and chest circumference ($r = 0.776$).
- Lower perinatal anthropometric indices marked prematurity and adverse presentations, but direct associations with 28-day morbidity/mortality were not statistically significant in this small sample.

Running Title: Neonatal Anthropometry and Morbidity–Mortality in Nigeria

Keywords: *Anthropometry, Neonate, Neonatal anthropometry, Neonatal Weight, Neonatal Morbidity, Neonatal Mortality, Discharge Against Medical Advice*

Introduction/Background

Neonatal mortality remains a critical public health challenge in Nigeria, which records the highest burden of neonatal deaths in sub-Saharan Africa. Despite global reductions in neonatal mortality from 4.7 million in 1990 to 2.4 million in 2020, Nigeria continues to account for a

disproportionate share of these deaths, with significant geographical and socio-demographic variations in neonatal survival outcomes.

Anthropometric measurements, including birth weight and crown–heel length (CHL), are fundamental clinical tools for assessing newborn health, nutritional status, and growth trajectory. The gestational age of neonates has been related to neonatal morbidity and mortality (1). Neonatal anthropometry taken at birth have been found to be related to intra-uterine life, reliable to assess intra-uterine life and status of the new born in the first few hours after birth. Birth weight, in particular, is a widely recognized indicator of newborn maturity. Similarly, crown heel length provides essential information about fetal growth patterns and helps identify neonates who are small or large for gestational age, both of which are associated with increased risk of NICU admission and adverse outcomes. Likewise, the varying neonatal anthropometric parameters have correlations with each other and a corresponding risk of mortality. (2) described that birth weight has corresponding risk of mortality: 2.5 kg to 3.9kg as normal, 1.5kg to 2.49kg, and less than 1.5kg, has a risk of mortality in multiples of four and ten, respectively.

Extensive work has been established to relate anthropometric parameters taken within these first few hours after delivery to neonatal mortality risk

The Neonatal Intensive Care Unit (NICU) serves as a crucial interface for managing critically

ill newborns, particularly those born preterm, with low birthweight or experiencing perinatal complications. (3)

The socio-demographic characteristics of neonates and their mothers significantly influence NICU admission patterns and outcomes in low- and middle-income countries. Maternal factors such as age, educational status, socioeconomic position, parity, and antenatal care attendance have been shown to affect neonatal health and survival. Studies from Nigeria indicate that perinatal asphyxia, prematurity, neonatal sepsis, and congenital anomalies) are the leading causes of NICU admissions and mortality, with preventable conditions accounting for a substantial proportion of neonatal deaths. Furthermore, social determinants of health, including parental education, socioeconomic inequalities, and breastfeeding practices, increasingly influence both immediate and long-term outcomes among NICU graduates. (4)

In tertiary institutions across Nigeria, including Bowen University Teaching Hospital (BUTH) in Ogbomoso, understanding the socio-demographic profile and anthropometric parameters of neonates admitted to the NICU is essential for developing targeted interventions, optimizing resource allocation, and improving neonatal care quality. However, limited institutional data exist on the specific characteristics of neonates requiring intensive care in this setting. Establishing baseline information on perinatal weight, crown–heel length, and socio-demographic factors among NICU admissions at BUTH will contribute to the evidence base

for neonatal health in Southwest Nigeria and inform policy and practice improvements in regional neonatal care. (3)

This study therefore aimed to determine the socio-demographic characteristics of neonates admitted to the NICU of Bowen University Teaching Hospital and to assess their anthropometric parameters, specifically perinatal weight and crown–heel length. The findings will provide crucial institutional data to guide clinical decision-making, resource planning, and quality improvement initiatives in neonatal care services.

Despite the high burden of neonatal mortality in Nigeria and the critical role of NICUs in improving neonatal outcomes, several knowledge gaps persist:

1. Limited institutional baseline data: While studies from other Nigerian tertiary institutions have documented patterns of NICU admissions and neonatal outcomes, there is a paucity of published data specifically from Bowen University Teaching Hospital (BUTH) regarding the socio-demographic and anthropometric profile of neonates requiring intensive care. (5, 6)
2. Anthropometric measurement standardization: Although birth weight and crown–heel length are recognized as essential indicators of neonatal health and growth, there is limited documentation of these parameters among NICU admissions in Southwest Nigeria.

Aim of the Study

This study investigated the association between perinatal anthropometric measurements and neonatal morbidity and mortality.

Objectives

1. To determine the socio-demographic characteristics of the neonates admitted into the neonatal intensive care (NICU) of Bowen University Teaching Hospital (BUTH)
2. To assess anthropometric parameters; perinatal weight, crown heel length (CHL), of the neonates admitted into the neonatal intensive care (NICU) of Bowen University Teaching Hospital (BUTH)
3. To describe the pattern of admission, clinical conditions and outcomes of the neonates admitted into the neonatal intensive care (NICU) of Bowen University Teaching Hospital (BUTH), during the period of the study.
4. To evaluate the association between perinatal anthropometric parameters and neonatal morbidity and mortality.

Research Questions

1. What are the socio-demographic characteristics (including maternal age, educational status, mode of delivery, and gestational age) of neonates admitted to the NICU at BUTH?
2. What are the anthropometric parameters (perinatal weight and crown–heel length) of neonates admitted to the NICU at BUTH?
3. Is there an association between perinatal anthropometric parameters and outcome among neonates admitted to the NICU at BUTH?

Hypotheses

The null hypothesis (Ho): there is no significant association between neonatal socio-demographic characteristics, neonatal anthropometric parameters at varying age at presentation, and outcomes such as morbidity and mortality.

The alternative hypothesis (H_1): there is a significant association between neonatal socio-demographic characteristics, neonatal anthropometric parameters at varying age at presentation, and outcomes such as morbidity and mortality.

Justification of the Study

This study is justified on several grounds:

Clinical relevance: Understanding the socio-demographic profile and anthropometric parameters of NICU admissions provides essential baseline data for clinicians to identify high-risk neonates, anticipate complications, and tailor interventions accordingly. Birth weight and crown–heel length are strong predictors of neonatal survival and long-term health outcomes, making their assessment critical for optimal NICU care.

Institutional quality improvement: As a functional NICU, institutional data on admission patterns and neonatal characteristics are essential for resource planning, staff training, and quality improvement initiatives.

This study will provide the first comprehensive baseline data on NICU admissions at BUTH, enabling evidence-based decision-making for neonatal care services.

Public health significance: Nigeria continues to bear the highest burden of neonatal mortality

in sub-Saharan Africa, with preventable conditions accounting for a substantial proportion of deaths. Identifying socio-demographic risk factors associated with NICU admission can inform targeted interventions, such as improved antenatal care, maternal education, and early neonatal screening, to reduce preventable admissions and mortality. (7, 8)

Materials and Methods

Study Design and Setting

Study Design

The study design was a prospective cohort study among the neonatal age group to assess anthropometric parameters and morbidity and mortality patterns of admitted babies into the neonatal intensive care unit (NICU) of the Department of Paediatrics, Bowen University Teaching Hospital (BUTH), Ogbomoso, Oyo State, Nigeria. The study included newborns born within (inborn) and outside the hospital (out-born), the respective anthropometric parameters obtained at presentation, and information obtained, including APGAR score, age at admission, diagnosis at admission, duration of hospital stay, and outcomes.

Study setting

The neonatal intensive care unit (NICU) of the Department of Paediatrics, Bowen University Teaching Hospital (BUTH), Ogbomoso, 4 Osupa, Ogbomoso, Ogbomoso North, Oyo State, Nigeria, on Longitude 4.2327 °E, Latitude 8.1358 ° N. This is a world-class facility known for qualitative research, training of health professionals, and community service to the host community and environs. It provides optimal neonatal secondary care, serving surrounding health facilities as a referral center. Formerly a missionary health facility upgraded about two decades before its tertiary health facility status. It is a unit of the hospital BUTH. It provides optimal neonatal secondary care and serves as a referral center for other secondary health facilities in Oyo

State, Nigeria. The NICU has a fifteen-bed capacity for both inborn and outborn babies, a resuscitating machine, incubator, four phototherapy machines, a humidifying machine, oxygen delivery canisters, and admits babies from delivery to 28 days.

The unit runs a 24-hour emergency service throughout the week with cases referred from maternity homes, general practitioners, and general hospitals with expert and highly trained health personnel.

Sampling Technique

The study sampling technique was a consecutive sampling technique to recruit study participants by defining a random (probability) starting point and affixed sampling interval. Every eligible admission during the study period was enrolled. Based on the expected admission rate at the facility and the period of data collection, the average number of respondents needed per day was estimated. Mothers with their babies within 28 days of life and who consented to be involved in the study were randomly selected.

During the unit working hours, participants were identified, mothers/Guardian interviewed as the point of call, followed by the next admission as the next respondent. In cases when babies do not meet the inclusion criteria, the next participant admitted was screened. This sequence was repeated till the required calculated sample size was attained.

Questionnaires/ Data forms were completed by trained research assistants

Sample Size

The sample size for the study was calculated using the formula: Cochran formula

$$\mathrm{n} = \frac{z^2 pq}{e^2}$$

Where: e is the desired level of precision (i.e. the margin of error),

p is the (estimated) proportion of the population which has the attribute in question,

q is 1 – p. The z-value is found in a Z table.

(9 , 10 & 11)

When z= 1.96, p= 0.037 (“based on a neonatal mortality rate of 37 per 1000 live births from (12)

q= 0.967

$$n = \frac{1.96^2 \times 0.037 \times 0.967}{0.05^2}$$

n= 57

Ethical Approval

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Approval was granted by the Bowen University Teaching Hospital Research and Ethical Committee with the approval no: BUTH/REC-227.

The questionnaire and methodology of this study was also approved by the above-named Ethical Committee.

Consent to Participate

Written informed consent for participation in the study was obtained from the parents/legal guardians of all neonates included in this study. The study was conducted in accordance with the Declaration of Helsinki and approved by the relevant Institutional Health Research Ethics Committee.

Eligibility Criteria

The recruiting criteria were NICU admissions, products of a spontaneous vertex delivery SVD at term, elective Caesarean Section (CS), and emergency CS admitted within 28 days of life.

Inclusion and Exclusion Criteria

Inclusion Criteria

This included all babies admitted within their first day of life to 28 days old, born within the facility or referred from outside the facility.

Exclusion Criteria

This excluded babies older than 28 days, babies with congenital anomalies, and babies of mothers with human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) on antiretroviral therapy, to avoid confounding the antiretroviral use factor that directly affects anthropometry and outcomes.

Data Collection Tool

Data collection was carried out by the use of structured questionnaire to capture neonatal anthropometric values, maternal biodata, obstetric details, early neonatal and perinatal vitals. All these were obtained at admission, with provisional diagnosis noted.

A face-to-face interview using an open- and closed-ended questionnaire was adapted in the form of a validated questionnaire.

A field assistant was recruited and trained in the data collection technique and skills. Participants were recruited daily and the questionnaire administered. All respondents were made to answer the same question which were constructed in English. However, for respondents who could not read and write, the questions were asked in dialect, and their respective responses were written. Difficult

technical terms were avoided in the preparation of the questionnaire. The field assistant was trained to ensure standardization of the questionnaire.

The study instrument (questionnaire) was pre-tested at Ladoke Akintola University Teaching Hospital (LAUTECH), which has similar characteristics to the study site. The pre-test was undertaken to check the clarity, consistency, and acceptability of the questionnaire among people other than those interviewed for the study. This was adapted to further train the field assistant and also to ensure that the questionnaire met the stated objective. After the pre-testing, problems such as ambiguity associated with the questionnaire were rectified.

Assessment of neonatal mortality: defined as death of a newborn within 28 days of life.

A checklist was developed for all neonates admitted during the period of study and all neonates among the group who died before they were discharged. The checklist assessed the mode of delivery, diagnosis (provisional and final), duration of stay, and outcomes.

Materials used

Materials used in the study included a measuring tape and a weighing scale (Medata model)

Method

Anthropometric Parameters Measurement Landmarks

The anthropometric parameters that were measured included weight, crown-heel length, head circumference, and chest circumference, all obtained adopting the guidelines of the Institute of Medicine for direct anthropometric measurements.

All anthropometric measurements were taken by an investigator, recruited, trained field assistants designated with the neonate placed supine in anatomical position.

Weight (W) was taken after a proper exposure with the neonate seen nude, without clothing, using a portable electronic weighing scale (Medata Model) and calibrated using its tare function and to the nearest 5g.

Crown heel length (CHL) was taken from the head to the heel with the legs fully extended and toes pointing upwards.

Duration of the Study

The study lasted for over twelve weeks

Data Analysis

Regular verification and validation of the data collected was done, with all inconsistencies checked by the researcher and research assistant.

All data collected were imputed and analysed with Statistical Package for Social Sciences (SPSS) version 25.

Results of the analysed data were generated using descriptive and some analytical statistical variables. Associations between variables were tested using Pearson correlation test Chi-square test as appropriate. Variables analysed within the scope of this study include neonatal factors, anthropometry (BW & HC), neonatal clinical features (APGAR Score, jaundice, temperature, respiratory rate, heart rate, blood glucose, immaturity, crying after birth, poor suckling), gender/sex (male or female).

Results

Socio Demographics of Study Participants

Table 1: Socio-demographics of neonatal and maternal parameters

Unbooked: babies not registered for antenatal care.

Variable	Frequency	Percentage
State of origin		
Kogi	**2**	**3.5**
Kwara	**2**	**3.5**
Ogun	**1**	**1.8**
Osun	**5**	**8.8**
Oyo	**47**	**82.4**
Mother's religion		
Christianity	**42**	**73.6**
Islam	**15**	**26.4**
Antenatal status		
Booked	**46**	**80.7**
Unbooked	**11**	**19.3**
Maternal disease		
None	**52**	**91.2**
Systemic hypertension	**2**	**5.3**
Others	**3**	**3.5**
Gestational age		
<37 weeks	**15**	**26.3**
≥37 weeks	**42**	**73.7**
Facility of birth		

Inborn	**23**	**40.4**
Outborn	**34**	**59.6**
Mode of delivery		
Elective c/s	**5**	**8.8**
Emergency c/s	**6**	**10.5**
Spontaneous delivery	**46**	**80.7**

Table 1 shows that 47 (82.4%) of the neonates were from Oyo State and 42 (73.6%) of them delivered by Christian mothers. Forty-six (80.7%) were products of booked pregnancies, 15 (26.3%) were delivered before 37 weeks of gestation and 46 (80.7%) delivered spontaneously.

Insert Figure 1 near here

Insert Figure 2 near here

Anthropometric Measurements of Neonates

Table 2: Descriptive statistics of anthropometric measurements of neonates at presentation

	N	Minimum	Maximum	Mean	Std. Deviation
Weight(kg)	57	1.11	3.89	2.53	.76
Crown heel length(cm)	57	33.00	58.00	44.98	6.01

Table 2 shows that neonates' weight ranged between 1.11kg and 3.887kg (with a mean of 2.53 ± 0.76). The crown-heel length ranged between 33cm and 58cm, head circumference ranged between 26cm and 38cm while the chest circumference ranged between 24cm and 38cm.

Table 3 Distribution of Anthropometry of Neonates at Presentation

Anthropometry	**Normal**	**Low**	**References**
		[#]Count (%) Ref	
Weight	31 (54.4)	26 (45.6) <2.5kg	UNICEF. (2020)
Crown heel length	19 (33.3)	38 (66.7) <48cm	

The count refers to the number of neonates with values below the reference value observed in this study. The number in parenthesis is the percentage of neonates in this study below the reference value. The ***Ref*** is the reference value as obtained from previous studies.

Table 3 shows that neonates aged 15-21days were more likely to have normal weight than those within other age categories, but this was not significant (p=0.457). Neonates of mothers aged 35 years and above and mothers who did not book for antenatal care were likely to have low weight, but these associations were not significant (p=0.341 and 0.508 respectively). However, neonates

with gestational age less than 37 weeks were more likely to have low weight, and this association was significant ($p<0.001$). Low weight defined as < 2.5 kg

Insert Figure 3 near here

Insert Figure 4 near here

Insert Figure 5 near here

Insert Figure 6 near here

Relationship Between Anthropometric, Morbidity and Mortality Outcomes in Neonates

Table 4: Association between neonatal factors and weight at presentation

Variable	Weight of neonate		Statistics
	Low(n=26)	**Normal (n=31)**	
Age of neonate			
< 24 hours	10 (47.6)	11 (52.4)	$\chi^2 = 3.637$
1-7 days	14 (50.0)	14 (50.0)	df = 4
8-14	1 (50.0)	1 (50.0)	p = 0.457
15-21	0 (0.0)	4 (100.0)	
22-28	1 (50.0)	1 (50.0)	
Sex			$\chi^2 = 0.204$
Female	9 (50.0)	9 (50.0)	df = 1
Male	17 (43.6)	22 (56.4)	p = 0.652
State of origin			
Kogi	1 (50.0)	1 (50.0)	LR = 1.340
Kwara	1 (50.0)	1 (50.0)	df = 4
Ogun	0 (0.0)	1 (100.0)	p = 0.855
Osun	2 (40.0)	3 (60.0)	
	22 (46.8)	25 (53.2)	
Oyo			$\chi^2 = 1.698$
Mother's religion	17 (40.5)	25 (59.5)	df = 1
Christianity	9 (60.0)	6 (40.0)	p = 0.193
Islam			$\chi^2 = 2.151$
Mother's age	7 (41.2)	10 (58.8)	df = 2
18-24	14 (42.4)	19 (57.6)	p = 0.341
25-34	5 (71.4)	2 (26.8)	
>35			$\chi^2 = 0.438$
Antenatal	20 (43.5)	26 (56.5)	df = 1
Booked	6 (54.5)	5 (45.5)	p = 0.508
Unbooked			$\chi^2 = 18.686$
Gestational Age	14 (93.3)	1(6.7)	df = 1
<37 weeks	12 (28.6)	30 (71.4)	**p < 0.001**
≥37 weeks			

Maternal disease	22 (42.3)	30 (57.7)	$\chi^2 = 3.150$
None	2 (100.0)	0 (0.0)	df = 2
Systemic hypertension	2 (66.7)	1 (33.3)	p = 0.207
Others			$\chi^2 = 0.071$
Facility of birth	10 (43.5)	13 (56.5)	df = 1
Inborn	16 (47.1)	18 (52.9)	p = 0.790
Outborn			
Mode of delivery	2 (40.0)	3 (60.0)	LR = 0.529
Elective c/s	2 (33.3)	4 (66.7)	df = 2
Emergency c/s	22 (47.8)	24(52.2)	p = 0.768
Spontaneous delivery			

LR means Likelihood Ratio

Table 4 shows that neonates aged 15-21days were more likely to have normal weight than those within other age categories but this was not significantly significant (p=0.457). Neonates of mothers aged 35 years and above and mothers who did not book for antenatal care were likely to have low weight but these associations were not significantly significant (p=0.341 and 0.508 respectively). However, neonates with gestational age less than 37 weeks were more likely to have low weight and this association was significantly significant (p<0.001).

Low weight defined as <2.5kg

Table 5: Association between presenting complaints and weight at presentation

Variable	Weight of neonate		Statistics
	Low(n=26)	Normal (n=31)	
Delayed meconium			$\chi^2 = 1.214$
no	25 (44.6)	31 (55.4)	df = 1
yes	1 (100.0)	0 (0.0)	p = 0.456
Regurgitation of saliva			$\chi^2 = 0.016$
no	25 (45.5)	30 (55.4)	df = 1
yes	1(50.0)	1 (50.0)	p = 1.000
Vomiting			$\chi^2 = 0.566$
no	24 (44.4)	30 (55.6)	df = 1
yes	2 (66.7)	1 (33.3)	p = 0.587
Abdominal distention			$\chi^2 = 1.214$
no	25 (44.6)	31 (55.4)	df = 1
yes	1 (100.0)	0 (0.0)	p = 0.456
Diarrhea			$\chi^2 = 0.854$
no	26 (46.4)	30 (53.6)	df = 1
yes	0 (0.0)	1 (100.0)	p = 1.000
Jaundice			$\chi^2 = 0.072$
no	22 (44.9)	27 (55.1)	df = 1
yes	4 (50.0)	4 (50.0)	p = 1.000
Reduced activity			$\chi^2 = 0.566$
no	24 (44.4)	30 (55.6)	df = 1
yes	2 (66.7)	1 (33.3)	p= 0.587
Poor sucking			$\chi^2 = 0.854$
no	26 (46.4)	30 (53.6)	df = 1
yes	0 (0.0)	1 (100.0)	p = 1.000
Weak cry			$\chi^2 = 0.144$
no	19 (44.2)	24 (55.8)	df = 1
yes	7 (50.0)	7 (50.0)	p = 0.704
Fever			$\chi^2 = 2.173$
No	22 (51.2)	21 (48.8)	df = 1
Yes	4 (28.6)	10 (71.4)	p = 0.140
Difficulty with breathing			$\chi^2 = 4.135$
No	24 (52.2)	22 (47.8)	df = 1
Yes	2 (18.2)	9 (81.8)	**p = 0.042**
Seizure			$\chi^2 = 0.408$
No	24 (47.1)	27 (52.9)	df = 1
Yes	2 (33.3)	4 (66.7)	p = 0.678
Skin change			$\chi^2 = 1.497$
no	23 (43.4)	30 (56.6)	df = 1
yes	3 (75.0)	1 (25.0)	p = 0.322
Outcome			$\chi^2 = 0.737$
Morbidity	25 (47.2)	28 (52.8)	df= 1
Mortality	1 (25.0)	3 (75.0)	p=0.391

Table 5 shows that 26 (45.6%) neonates had low weight and 31 (54.4%) had normal weight at presentation. Most complaints showed no significant association with weight (all $p > 0.05$).

However, breathing difficulty was significantly associated with weight, with 81.8% of affected neonates having normal weight (\chi^2 = 4.135, df = 1, $p = 0.042$)

Table 6 Association between presenting complaints and crown heel length at presentation

Variable	Crown heel length		Statistics
	Low(n=38)	Normal (n=19)	
Delayed meconium			$\chi^2 = 0.509$
no	37 (66.1)	19 (33.9)	df = 1
yes	1 (100.0)	0 (0.0)	p = 0.476
Regurgitation of saliva			$\chi^2 = 1.036$
no	36 (65.5)	19 (34.5)	df = 1
yes	2 (100.0)	0 (0.0)	p = 0.309
Vomiting			$\chi^2 = 1.583$
no	35 (64.8)	19 (35.2)	df = 1
yes	3 (100.0)	0 (0.0)	p = 0.208
Abdominal distention			$\chi^2 = 0.509$
no	37 (66.1)	19 (33.9)	df = 1
yes	1 (100.0)	0 (0.0)	p = 0.476
Diarrhea			$\chi^2 = 0.509$
no	37 (66.1)	19 (33.9)	df = 1
yes	1 (100.0)	0 (0.0)	p = 0.476
Jaundice			$\chi^2 = 0.291$
no	32 (65.3)	17 (34.7)	df = 1
yes	6 (75.0)	2 (25.0)	p = 0.590
Reduced activity			$\chi^2 = 0.000$
no	36 (66.7)	18 (33.3)	df = 1
yes	2 (66.7)	1 (33.3)	p= 1.000
Poor sucking			$\chi^2 = 2.036$
no	38 (67.9)	18 (32.1)	df = 1
yes	0 (0.0)	1 (100.0)	p = 0.154
Weak cry			$\chi^2 = 0.757$
no	30 (69.8)	13 (30.2)	df = 1
yes	8 (57.1)	6 (42.9)	p = 0.384
Fever			$\chi^2 = 0.047$
No	29 (67.4)	14 (32.6)	df = 1
Yes	9 (64.3)	5 (35.7)	p = 0.828
Difficulty with breathing			$\chi^2 = 2.760$
No	33 (71.7)	13 (28.3)	df = 1
Yes	5 (45.5)	6 (54.5)	p = 0.097
Seizure			$\chi^2 = 0.000$
No	34 (66.7)	17 (33.3)	df = 1
Yes	4 (66.7)	2 (33.3)	p = 1.000
Skin change			$\chi^2 = 0.134$
no	35 (66.0)	18 (34.0)	df = 1
yes	3 (75.0)	1 (25.0)	p = 0.714
Outcome			$\chi^2 = 0.538$

Morbidity	36 (67.9)	17 (32.1)	df = 1
Mortality	2 (50.0)	2 (50.0)	p = 0.463

Table 6 above shows that 38 (66.7%) neonates had low crown–heel length, while 19 (33.3%) had normal measurements. No presenting complaint or clinical outcome was significantly associated with crown–heel length (all $p > 0.05$). Fever and breathing difficulty showed no significant associations, and outcome was also unrelated to crown–heel length (\chi^2 = 0.538, df = 1, p = 0.463).

Table 7: **Association between Diagnosis and weight at presentation**

Variable	Weight of neonate		Statistics
	Low(n=26)	Normal (n=31)	
Diagnosis			
Congenital pnuemonia	3 (42.9)	4 (57.1)	LR = 10.391
Jaundice	3 (42.9)	4 (57.1)	df = 5
Perinatal asphyxia	5 (38.5)	8 (61.5)	p = 0.065
Prematurity	6 (100.0)	0 (0.0)	
Sepsis	5 (38.5)	8 (61.5)	
Others	4 (36.4)	7 (63.6)	

Table 7 shows that neonates with prematurity were likely to have low weight while those with perinatal asphyxia and sepsis were likely to have normal weight. However, the association between diagnosis and weight of neonates is not statistically significant (p=0.065).

Table 8 Association between Diagnosis and crown heel length at presentation

Variable	Crown heel length		Statistics
	Low(n=38)	Normal (n=19)	
Diagnosis			
Congenital pnuemonia	4 (57.1)	3 (42.9)	LR = 9.101
Jaundice	6 (85.7)	1 (14.3)	df = 5
Perinatal asphyxia	6 (46.2)	7 (53.8)	p = 0.105
Prematurity	6 (100.0)	0 (0.0)	
Sepsis	8 (61.5)	5 (38.5)	
Others	8 (72.7)	3 (27.3)	

Table 8 shows neonates who were diagnosed of prematurity and jaundice were likely to have low crown heel length compared to others. However, this difference was not statistically significant (p=0.105)

Discussion, Conclusion and Recommendations

Discussion

This study evaluated the socio-demographic characteristics, clinical presentation, anthropometric indices, perinatal weight and crown-heel-length and outcomes of neonates admitted to BUTH, a tertiary health facility, in the South West of Nigeria, with particular emphasis on correlation between routine selected neonatal anthropometric measurements; weight at presentation, crown heel length, relationship with presenting symptoms, Apgar scores, diagnoses and overall outcomes.

Socio-demographic and Maternal Characteristics

The majority of neonates in this study were from Oyo State, reflecting the hospital's catchment area and referral pattern, (14) reported similar geographic clustering as found in other Nigerian tertiary facilities and this is often influenced by proximity, cost of transportation, and referral practices. Most mothers were Christians and within the age group 25–34-years, which is considered the peak reproductive age, though associated with relatively better pregnancy outcomes when adequate antenatal care is accessed (13).

A high proportion (80.7%) of neonates were products of booked pregnancies, which contrasts with some Nigerian studies reporting lower booking rates among mothers of admitted neonates (15). This finding may suggest improved antenatal care utilization in the study environment. However, despite good booking status, a considerable proportion of neonates were delivered outside the study facility (outborn), highlighting persistent challenges in delivery planning, emergency referrals, and access to skilled birth attendance.

Gestational Age, Mode of Delivery, and Birth Characteristics

Most neonates were delivered at term (≥37 weeks), and spontaneous vaginal delivery was the predominant mode of delivery. This aligns with reports from similar settings where vaginal delivery remains the most common mode, even among neonates subsequently requiring admission (16). Nonetheless, over one-quarter of neonates were preterm, underscoring prematurity as a major contributor to neonatal morbidity (17 & 18).

Male neonates predominated, which is consistent with the well-documented male disadvantage in neonatal outcomes, possibly related to biological vulnerability and differences in lung and immune maturation (19).

Anthropometric Measurements of Neonates

The mean weight at presentation of 2.53 ± 0.76 kg observed in this study is comparable to findings from other Nigerian neonatal cohorts (20). However, a substantial proportion of neonates had low weight at presentation, reflecting the burden of prematurity and intrauterine growth restriction in the population. Strong positive correlations were demonstrated between weight and other anthropometric indices, crown heel length, head circumference, this finding is consistent with established neonatal growth patterns, where weight is closely related to linear growth and body proportionality (21). Crown-heel-length showed a strong correlation with weight, suggesting its potential usefulness as a surrogate marker for neonatal nutritional status, particularly in low-resource settings where weighing scales may be unavailable or unreliable.

Weight at Presentation and Associated Factors: GA was the only factor significantly associated with neonatal weight, with preterm neonates being more likely to have low weight. This is biologically plausible and consistent with extensive literature identifying prematurity as the

strongest determinant of low birth weight as well as intra uterine growth restrictions, multiple gestations (22). Other maternal and neonatal factors, including antenatal booking status and maternal age, were not significantly associated with weight, although trends suggested poorer outcomes among unbooked mothers and those aged ≥35 years. This reinforces the profound impact of prematurity on overall growth and development and highlights the need for targeted preventive strategies.

Implications of Findings

The strong correlations among anthropometric variables and their association with gestational age underscore the importance of routine anthropometric assessment in neonatal care

Contribution to Knowledge

This thesis makes several important contributions to the field of neonatal and clinical anthropometry:

First, it provides context-specific empirical data on neonatal anthropometry and outcomes from a Nigerian tertiary hospital, addressing the paucity of local data in this area.

Second, the study uniquely evaluates anthropometric measurements at admission rather than at birth, offering new insight into their relevance in ongoing neonatal assessment and clinical decision-making.

Third, the study affirms that anthropometrics can be used to predict prematurity in neonates as evidenced from this report where neonates presented with overall low weight, head circumference, crown heel length and chest circumference presents with prematurity. On the other way round neonates with normal weight were found to have difficulty with breathing, perinatal asphyxia and sepsis.

Limitations

Included sourcing for fund which was personal and within a limited budget, patients declining consent and DAMA cases.

Recommendations

Studies with a larger, multi-centre cohort study as well as a serial anthropometric measurement from birth are recommended to further explore the relationship.

Research contribution: This study will contribute to the limited literature on neonatal anthropometry and socio-demographic determinants of NICU admissions in Southwest Nigeria, filling a regional knowledge gap and providing comparative data for other institutions.

The findings may also inform national guidelines on neonatal care and anthropometric monitoring in resource-limited settings. (23)

Declarations

Ethics approval and consent to participate

Ethical approval for this study was obtained from the Bowen University Teaching Hospital Health Research Ethics Committee (BUTH/REC-2272). Written informed consent was obtained from the parents or legal guardians of all participating neonates. The study was conducted in accordance with the Declaration of Helsinki.

Consent for publication

Consent to Publish declaration: not applicable. No identifiable individual participant data or images are presented in this manuscript.

Clinical trial number

Not applicable.

Availability of data and materials

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Authors' contributions: All authors contributed substantially to the conception, design, data acquisition, analysis, interpretation, drafting, or critical revision of the manuscript. All authors approved the final version for publication.

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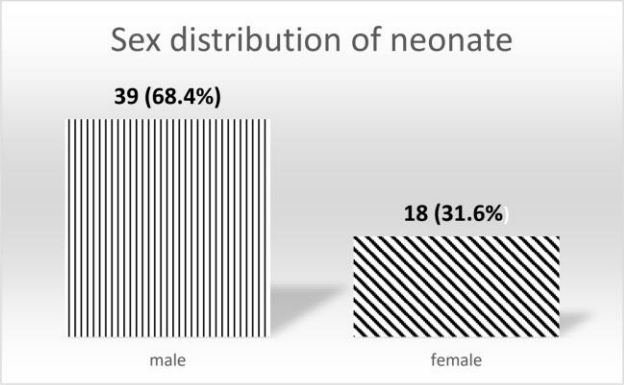
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Morbidity and Mortality in Neonates



Sex Distribution Figure 1: Bar chart of sex distribution of neonates.

Sex distribution of neonates showing that 39 (68.4%) of the neonates are males' neonate with the remaining 18(31.6%) being females

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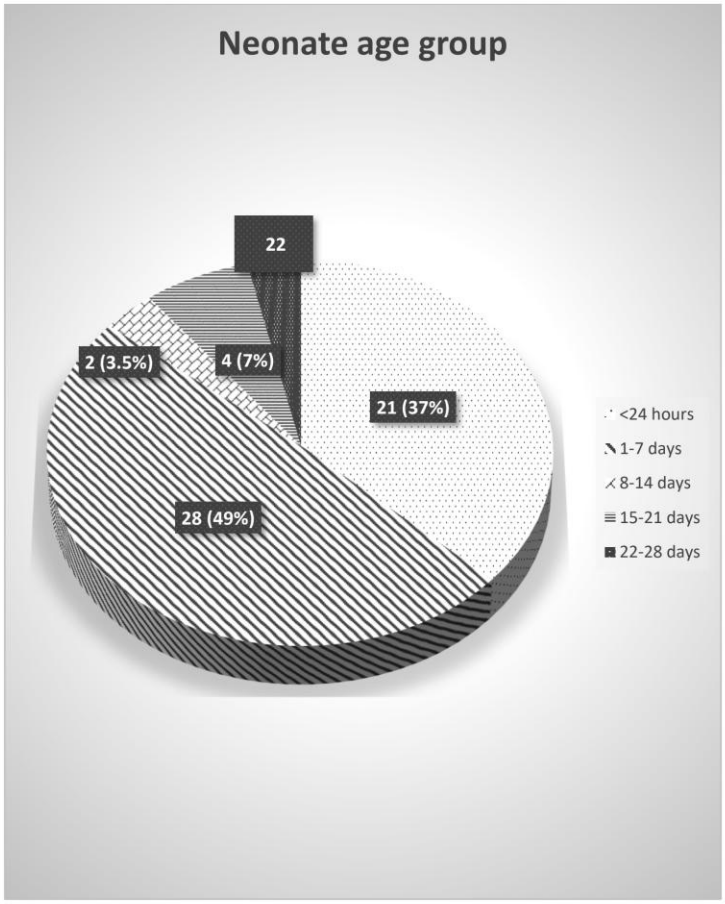


Figure 2: Pie chart of neonate age group.

The age group distribution shows that highest distribution; 28 (49%) of the neonates were between 1 to 7 days, followed by <24 hours, 15-21 days and 22-28/8-14 days respectively.

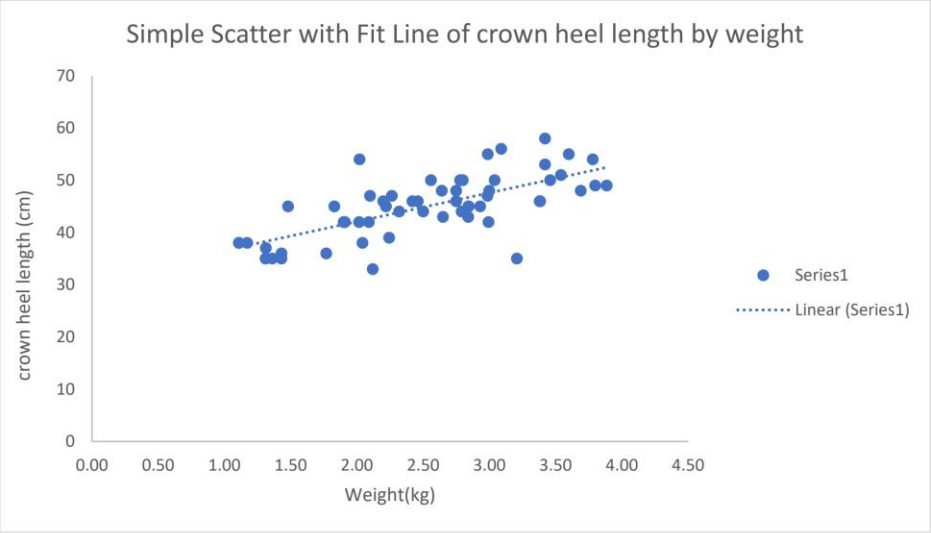


Figure 3: Simple Scatter with Fit Line of crown heel length by weight.

Figure 3 scatter diagram shows a strong positive correlation (r=0.697) between crown heel length and weight of neonates. LR means Likelihood Ratio

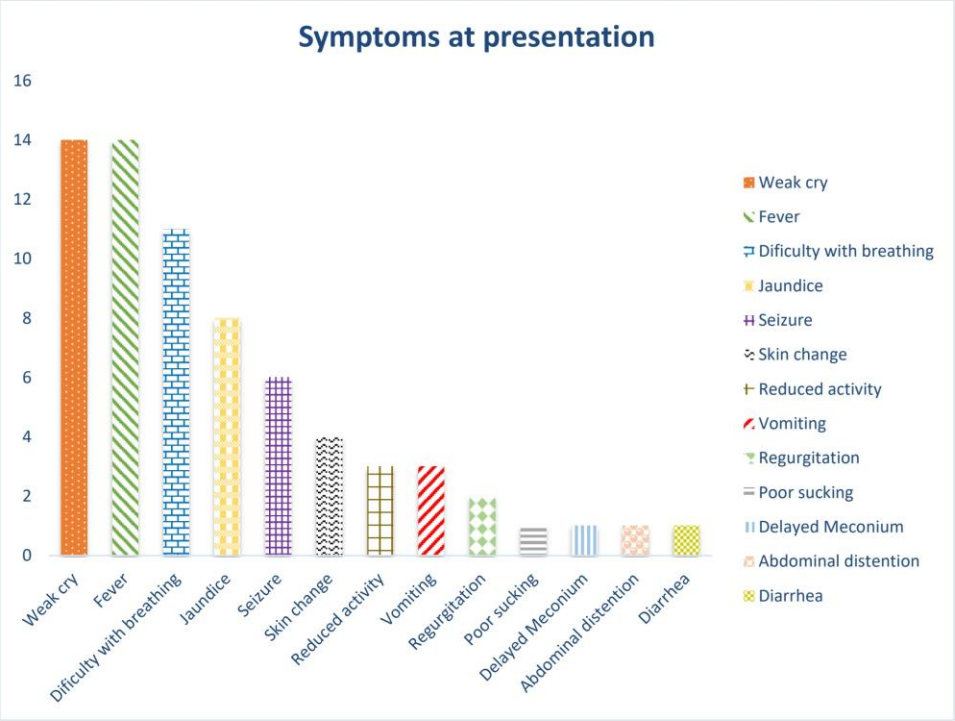
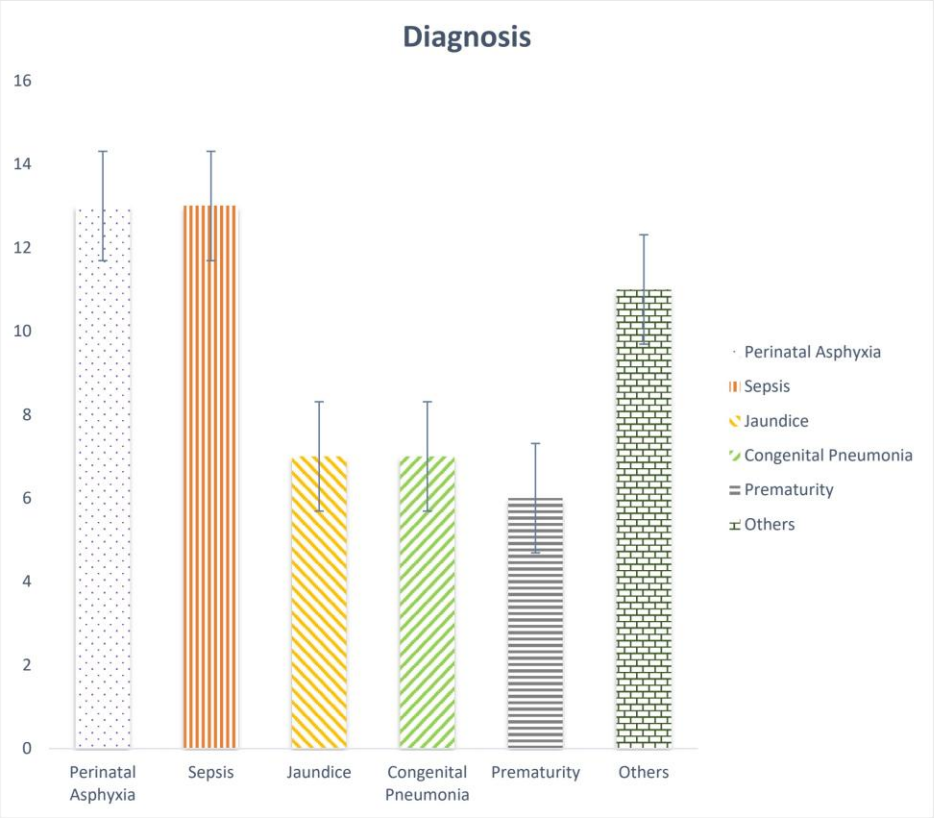


Figure 4: Bar chart showing the symptoms of neonates at presentation.

Figure 4 shows the symptoms of neonates at presentation. Weak cry and fever had the highest frequency while poor sucking, delayed meconium, abdominal distention and diarrhoea had the least frequency.

Morbidity and Mortality in Neonates

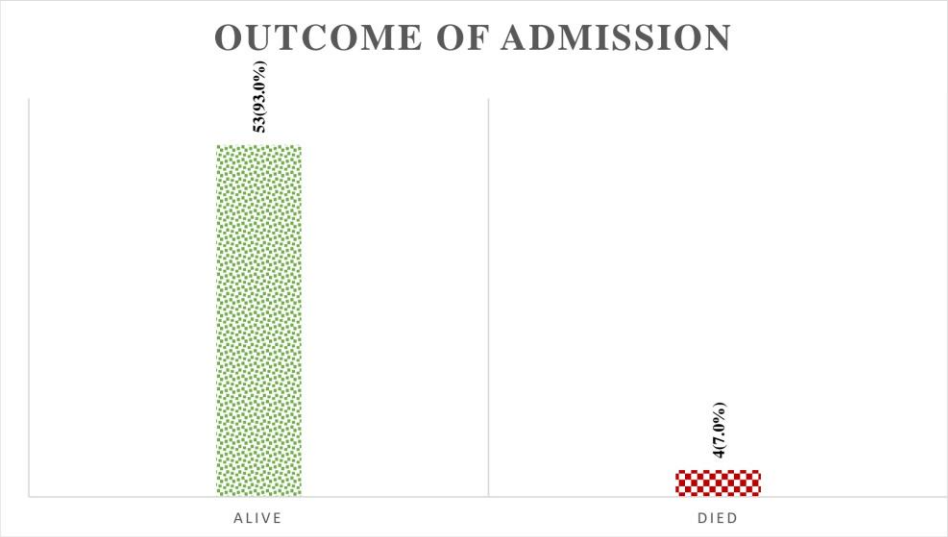


Diagnosis

Figure 5: A Bar Chart of Diagnosis.

Figure 5 above shows that perinatal asphyxia and sepsis were the leading diagnosis of neonates at presentation. Others include meningitis, imperforated anus, breast abscess, meconium aspiration syndrome and so on.

Morbidity and Mortality in Neonates



Outcomes

Figure 6: Bar chart showing the distribution of neonatal admission outcome

Figure 6 shows the distribution of neonatal admission outcome with 4(7.0%) mortalities.