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Factors Associated with Neonatal Sepsis: A Case Study at Chilenje General Hospital in the Neonatal Unit and Paediatric Wards

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Abstract

Background: Neonatal sepsis is known to result in 26% of mortalities in children below the age of five worldwide, countries in Sub-Saharan African recording the highest deaths. Although the deaths of neonates have reduced world over up to 3.6 million counts, Chilenje General Hospital continues to register significant numbers of neonatal sepsis. This study aimed at investigating the factors associated with neonatal sepsis at Chilenje General Hospital in Lusaka, Zambia. ***Methods***: An institution based cross-sectional study design was conducted at Chilenje General Hospital. Data were collected by the use of a researcher designed questionnaire and analysed using SPSS version 25. Frequencies were used for descriptive analysis while bivariate analysis was used to establish association among risk factors and outcome variables. Variables with significant association at 5% level were further subjected to multivariate analysis at $\alpha \leq 0.05$. ***Results***: The study showed that out of 156 neonates, 40.4% (63/156) developed neonatal sepsis. Maternal factors that projected the incidence of sepsis amongst neonates were distance to nearest health facility [AOR: 6.3 (95% CI: 1.8 - 21.3), p = 0.003], occupation [AOR: 5.8 (95% CI: 1.2 - 27.6), p = 0.026], number of antenatal visits [AOR: 6.3 (95% CI: 1.9 - 21.6), p = 0.003], number of vaginal examinations [AOR: 10.8 (95% CI: 2.8 - 42), p = 0.001], and pregnancy induced hypertension [AOR: 5.4 (95% CI: 1.4 - 20), p = 0.013]. Neonatal risk factor which projected the incidence of sepsis was Neonate's age [AOR: 18.8 (95% CI: 4.9 - 72.5), p = 0.000]. ***Conclusions***: The chance of developing neonatal sepsis was strongly correlated with both mother and child variables, according to the study. In order to lower the chance of the neonate acquiring sepsis, encouraging maternal antenatal care use would assist to detect risk factors during prenatal, perinatal

and postnatal care and apply the proper therapies.

Keywords

Neonatal, Sepsis, Factors, Maternal

1. Introduction

Neonatal sepsis is defined as an aggressive infection mostly caused by bacteria, present during the neonatal period [1]. It is a clinical syndrome whose sign is manifold, non-specific, and consists of reduced spontaneous activity, a reduced active breastfeeding or sucking, apnoea, reduced heart rate, unstable temperature, depressed respiration, vomiting, diarrhoea, stomach distention, restlessness, fits, and jaundice. [1] Neonatal sepsis is further classified into early onset neonatal sepsis (EONS) if clinical features of sepsis occur within the first week of life and late onset neonatal sepsis (LONS) if it occurs between 7 - 28 days of life [2]. These infections are the main causes of deaths and admissions among the neonates all over the world despite current improvements in the healthcare systems [3]. The occurrences of blood-stream infections in the neonates are 3 - 20 times more in developing countries and in certain nations, roughly 50% of the sick who are found in neonatal intensive care units (NICUs) get infected. The death rates from infections in neonates sometimes reach 52% adding to the near 1 million deaths and accounting for about 30% - 50% of the total deaths among neonates. This is despite sepsis related deaths largely being preventable through opportune recognition, lucid antimicrobial treatment and aggressive supportive care [4]. Even though the high burden of neonatal sepsis associated death and mortality are being reported from developing countries, most scientific evidences are derived from developed countries. Signs and symptoms clinically are not specific and are not adequate for recognizing neonates with early-onset sepsis (EOS). Infectious agents can be transmitted from the mother to the foetus or new-born by varied means [1].

According to the World Health Organization (WHO) [5], in 2017, nearly half (20 million) of all assessed sepsis cases globally happened in children under 5 years of age. In 2018, a projected 15% of all new-born deaths worldwide were attributed to sepsis. Studies have revealed that the uppermost frequency of neonatal sepsis happens in pre-term and low-birth-weight infants. Nevertheless, the general prevalence of neonatal sepsis is at peak in low-income nations. Whereas survival of pre-term infants is improving with time, neonates are predominantly susceptible to sepsis triggered by health care-associated infections, specifically in locations with low health care resources where the rates are highest [5] [6]. The initial 28 days of life (the neonatal period) are the utmost susceptible period for child survival. Each year, a projected 2.5 million neonates pass away in their first month of life, accounting for approximately one-half of deaths in children under 5 years of age as estimated by the United Nations Inter-Agency Group for Child

Mortality Estimation (UN IGME) [5] [6]. Severe neonatal infections (including sepsis, meningitis and pneumonia) signify a substantial cause of neonatal mortality (24%) and lead to short- and long-term complications, such as preterm birth and neonatal encephalopathy (33%) [1].

New-born infants are not as much capable of responding to infection for the reason of one or more immunologic deficiencies [7]. Concomitant situations regularly complicate the diagnosis and managing of neonatal infections. The clinical indicators of new-born infections differ and consist of sub-clinical infection, minor to severe manifestations of central or systemic infection, and, hardly, hereditary disorders ensuing from in utero infection, the timing of exposure, inoculums size, immune status, and virulence of the etiologic agent and influence the expression of disease [8].

Parental infection which is the origin of trans-placental foetal infection regularly remain undiagnosed throughout pregnancy for the reason that the mother was either without symptoms or had unspecified signs and symptoms during the time of acute infection [9]. A varied assortment of etiologic agents infects the new-born, including bacteria, viruses, fungi, protozoa, and mycoplasmas. Immature, very low birthweight (VLBW) new-borns have improved survival but continue in the hospital for a long time in an environment that puts them at constant risk for acquired infections [10]. As emphasized above, causative organisms of neonatal infections are varied in their epidemiology, clinical presentation, diagnosis and management.

A study done in Ethiopia [11] discovered a high incidence of neonatal sepsis (33.8%). The study documented that maternal age, several per digital vaginal examination, exclusive and instant breastfeeding within an hour of delivery and age of the neonate were factors affecting or predispose to neonatal sepsis. Another study conducted in Nigeria [12] revealed a 37.6% prevalence of neonatal sepsis and Escherichia coli was the most frequently isolated organism. The study discovered that neonates 0 - 7 days of age were 2.8 times less plausible to develop neonatal sepsis than older neonates and babies born with an Apgar score of <6 within the 1st min were 2.4 times more likely to develop neonatal sepsis than those whose Apgar score was higher. Neonates of mothers who had urinary tract infection during pregnancy were 2.3 times more likely to have sepsis and those whose mothers had premature rupture of membranes were 4.6 times more likely. Furthermore, Studies conducted in different countries speculated that neonates who were diagnosed with suspected sepsis ranged from 4.3% to 75.1% among the neonates admitted to the neonatal intensive care units (NICUs) [13] [14] [15].

In Zambia, neonatal sepsis remains one of the principal causes of sickness and death among neonates. Studies [16] [17] demonstrate that the incidence and mortality of neonatal sepsis in Zambia is quite high. Bloodstream infections are the most common hospital-acquired infections in neonatal populations and are associated with increased length of stay, healthcare-associated costs and mortality. The Sepsis Prevention in Neonates in Zambia study assessed the effects of a

bundle of infection prevention interventions on assumed sepsis, bloodstream infections and mortality in a tertiary neonatal intensive care unit in Lusaka [18]. Data collected from Chilenje General Hospital [19] show that 120 (2.7 percent) of all live births in 2018 developed neonatal sepsis and 145 (3.1 percent) in 2019, out of those 17 (0.3 percent) developed neonatal sepsis before discharge. Majority of the studies have focused on microbial causes and antibiotic sensitivity than the factors responsible for the infection. Undetected or poorly managed maternal infections can lead to sepsis, death or disability for the mother and increased likelihood of early neonatal infection and other adverse outcomes. This study was motivated by recognizing the need to foster new thinking and to catalyse greater action to address this important cause of new-born mortality and morbidity. Therefore, this study aimed at assessing factors that contribute to morbidity and mortality associated with neonatal sepsis infections a case study of Chilenje General Hospital.

2. Material and Methods

A descriptive cross-sectional design employing quantitative data collection methods was used in this study. The study was conducted at Chilenje General Hospital in Lusaka in the neonatal and newborn wards. The study population included all mothers whose neonates were admitted to the hospital. Simple random sampling using the lottery technique was used to select respondents to take part in this study from among the neonates diagnosed with neonatal sepsis. The eligibility criteria were having a neonate admitted to the hospital but not critically ill and only mothers who lived within Chilenje hospital catchment area and gave consent to participate in the study. Data were collected from 156 willing participants and were analyzed using SPSS version 25.

Study Design: cross sectional study.

Study Location: Chilenje General Hospital in Lusaka Province of Zambia.

Study Duration: May to September 2023.

Sample size: 156 parents of neonates diagnosed with neonatal sepsis.

Sample size calculation: Sample size of 156 was calculated using the Gosh formula (Gosh, 2013) from a population of patients diagnosed with neonatal sepsis in 2022 = 257 (Hospital 2020-2022 statistics).

Subjects & selection method: Simple random sampling using the lottery technique was used to select respondents to take part in this study from among the neonates diagnosed with neonatal sepsis. From the patient size of 257 and calculated sample size of 156.

Inclusion criteria:

For someone to be a suitable respondent to participate in this research, she must be a mother with a child diagnosed with neonatal sepsis, not critically ill and lived within Chilenje Hospital catchment area. The mothers who gave consent to participate in the study were further considered.

Exclusion criteria:

Mothers with critically ill neonates, mothers who lived outside the Chilenje

hospital catchment area and mothers who did not give consent to participate in the study.

Procedure methodology

Two trained Field Research Assistants were involved in reaching out to participants at the study site. Questionnaires were used collect data from individual participants using face to face approach.

Statistical analysis

Data were entered in Microsoft excel and exported to SPSS V.25 for analysis. After cleaning, descriptive statistics were calculated and presented as means with respective standard deviations, or medians as appropriate. Chi square statistical test was used to establish the association between dependent and independent variables at 95% confidence level and p-value of <0.05.

Ethical Consideration

The approval to conduct the study was obtained from University of Zambia Research Ethics Committee and National Health Research Authority (NHRA - NHRA.0002/11/05/2023). Informed consent was sought from each study participant prior to enrolment. In situations where the respondent desired to withdraw and it was outside the control of the interviewer, they were freely allowed to do so and all their information shredded immediately, however, no patient withdrew from the study. Information that was obtained during the study was treated with utmost confidentiality as it bordered on personal information. Written permission from study site was also obtained.

3. Result

After data collection, the questionnaires were sorted, responses verified, coded and entered on excel data master sheet to allow for easier analysis. Data was later exported to SPSS version 25 for analysis. The median with associated interquartile range were used to summarize continuous variables, whereas, frequencies and proportions were used to summarize categorical variables. Chi-square and Fisher's exact test were used test association between the dependent variable and categorical independent variables. For continuous variables, the Wilcoxon rank sum test was used to test for a difference in medians. Univariate and multivariable logistic regression analysis were used to identify factors and predictors of neonatal sepsis. Statistical significance was set at 5%, thus only p-value of or less than 0.05 indicated significance.

There were 156 respondents involved in the study, the mean age of mothers was 31.4 (SD ± 6.86) years ranging from 17 to 52 years with most 61.5% (96/156) of the respondents aged 21 to 34 years followed by 32.7% (51/156) respondents aged over 35 years while 5.8% (9/156) respondents were aged below 20 years. Majority, 76.9% (120/156) of the respondents were married, and 46.8% (73/156) of them were protestant Christians. Over half, 57.7% (90/156) of the respondents lived within 5km of the health facility. Most, 55.1% (86/156) of the respondents had secondary level education, and half 50% (78/156) of them were into business. Concerning the neonate, the means age of neonates was 9.6 (SD ± 4.32)

days ranging from 1 to 24 days with the majority 69.9% (109/156) of the neonates were aged 8 to 28 days, and 51.9% (81/156) of them were female (Table 1).

Most of the respondents were from Chilenje township (43.6%) followed by Libala (12.8%) and Chalala (10.3%) townships as shown in Figure 1.

Table 1. Distribution of maternal Socio demographic characteristics (n = 156).

Variables	Frequency	Percentage (%)
Age		
≤20 years	9	5.8
21 - 34 years	96	61.5
≥35 years	51	32.7
Marital status		
Single	27	17.3
Married	120	76.9
Widowed	2	1.3
Divorced/separated	4	2.6
Cohabiting	3	1.9
Religious affiliation		
Roman Catholic	67	42.9
Protestant Christian	73	46.8
Muslim	9	5.8
Non-religious	7	4.5
Distance to nearest health facility		
≤5 km	90	57.7
6 - 10 km	66	42.3
Educational level		
Never been to school	21	13.5
Primary	36	23.1
Secondary	86	55.1
Tertiary	13	8.3
Occupation		
Housewife	27	17.3
Civil servant	28	18
Business woman	78	50
Private organization	12	7.7
Daily laborer	6	3.8
Student	5	3.2
Neonate's age		
≤7 days	47	30.1
8 - 28 days	109	69.9
Neonate's sex		
Male	75	48.1
Female	81	51.9

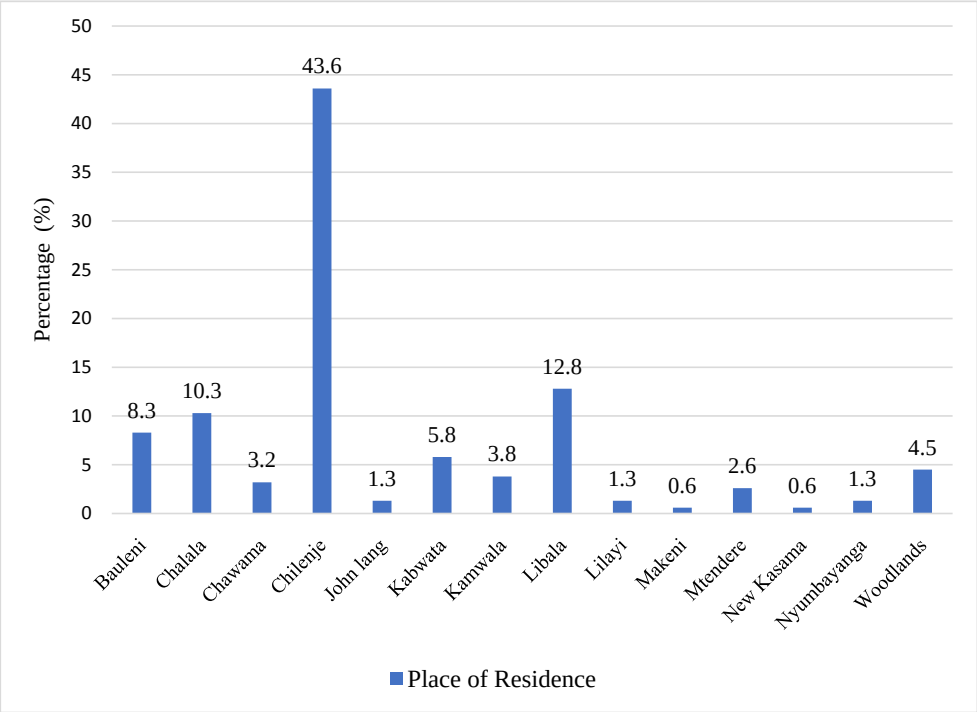

Figure 1. Bar Chart showing the distribution of residence among study participants (n = 156).

3.1. Maternal Obstetric Characteristics

This section presents responses on maternal obstetric factors, and is outlined in Table 2 below.

As shown in Table 2, most 48.7% (76/156) of the respondents were multipara with nearly all 94.9% (148/156) of them attended ANC. Over half, 54.5% (85/156) of the respondents had attended more than four ANC sessions during their last pregnancy. Majority, 68.6% (107/156) gave birth from the hospital and 23.7% (37/156) others from the health center, while 7.7% (12/156) respondents delivered from home.

Over three-quarters, 76.3% (119/156) of the respondents had spontaneous vaginal delivery, with a duration of labor of less than 6 hours in 64.1% (100/156) respondents. Most 66% (103/156) of the respondents had less than three vaginal examinations performed on them while 34% (53/156) others have more than three vaginal examinations. Concerning pregnancy complications, 7.7% (12/156) respondents had PROM with 58.3% (7/12) of them experienced PROM for 6 to 12 hours, 5.5% (9/156) respondents had fever during labor, while 30.8% (48/156) others had PIH, 9.6% (15/156) respondents had APH, and 21.2% (33/156) respondents had UTIs in pregnancy. None of the respondents had meconium-stained amniotic fluid (MSAF).

3.2. Neonatal Characteristics

This section presents responses on neonatal factors, and is outlined in Table 3 below.

Table 2. Distribution of maternal obstetric characteristics among study participants (n = 156).

Variables	Frequency	Percentage (%)
Parity		
Primipara	64	41
Multipara	76	48.7
Grand multipara	16	10.3
ANC attendance		
Yes	148	94.9
No	8	5.1
Number of ANC attendance		
≤3	71	45.5
≥4	85	54.5
Place of delivery		
Home	12	7.7
Hospital	107	68.6
Health center	37	23.7
Type of delivery		
Spontaneous vaginal delivery	119	76.3
Instrumental vaginal delivery	12	7.7
Caesarean section	25	16
labor personnel		
Health professional	144	92.3
Relatives	12	7.7
Duration of labor		
≤6 hours	100	64.1
7 - 12 hours	33	21.2
13 - 24 hours	23	14.7
Number of vaginal examinations		
<3	103	66
≥3	53	34
Experienced PROM		
Yes	12	7.7
No	144	92.3
Experienced fever during labor		
Yes	9	5.8
No	147	94.2
Experienced APH		
Yes	15	9.6
No	141	90.4
Experienced UTI in pregnancy		
Yes	33	21.2
No	123	78.8

Table 3. Distribution of neonatal characteristics among study participants (n = 156).

Variables	Frequency	Percentage (%)
Gestational age		
<32 weeks	11	7.1
32 - 36 weeks	27	17.3
37 - 41 weeks	115	73.7
≥42 weeks	3	1.9
APGAR score at 1 minute		
<7	21	13.5
≥7	135	86.5
APGAR score at 5 minutes		
<7	5	3.2
≥7	151	96.8
Birth weight		
<1500 g	7	4.5
1500 - 2499 g	37	23.7
2500 - 3999 g	108	69.2
≥4000 g	4	2.6
Resuscitated at birth		
Yes	17	10.9
No	139	89.1

As shown in Table 3, majority, 73.7% (115/156) of the neonates were delivered between the gestational age of 37 to 41 weeks. During delivery, majority 86.5% (135/156) of the neonates had an APGAR score of more than seven at one minute of birth, and at five minutes of birth, 96.8% (151/156) neonates had an APGAR score of more than seven. Majority, 69.2% (108/156) of the neonates had a birth weight of 2500 to 3999 grams. Majority, 125/156 (80.1%) of them had cried immediately at birth, with only 10.9% (17/156) neonates having been resuscitated at birth.

3.3. Maternal Cultural Practices

This section presents responses on common cultural practices, and is outlined in Table 4 below.

As shown in Table 4, about half (50.2%) of the respondents indicated that insertion of herbs or other applications in the birth canal helps to accelerate labor. Concerning the neonate, most of the respondents indicated that application of herbs (18.6%), chicken droppings (17.9%), baby powder (17.1%) and ashes (16.9%) on the umbilical cord helps to protect the baby. Also, most of the respondents indicated that applying herbs (38.2%), ashes (14.7%), anointed oil/water (12.1%), and baby powder (11.8%) on the baby's fontanelle was helpful.

Table 4. Distribution of cultural practices among study participants (n = 156).

Variables	Frequency	Percentage (%)
Cultural practices are performed on a woman to accelerate labor*		
Insertion of herbs or other applications in the birth canal	109	50.2
Introduction of fingers into birth canal to enlarge passage	42	19.4
Use of anointing oils	66	30.4
Practices believed to help and therefore applied on the umbilical cord of the neonate*		
Baby powder	68	17.1
Baby oil	50	12.6
Anointing oil/water	56	14.1
Herbal applications	74	18.6
Tattoos or others cuttings	11	2.8
Chicken droppings	71	17.9
Ashes	67	16.9
Practices believed to help and therefore applied on the fontanelle of the neonate*		
Baby powder	32	11.8
Baby oil	26	9.6
Anointing oil/water	33	12.1
Herbal applications	104	38.2
Tattoos or others cuttings	5	1.8
Chicken droppings	32	11.8
Ashes	40	14.7

*Multiple entries.

3.4. Magnitude of Neonatal Sepsis

This section presents the magnitude of neonatal sepsis based on the integrated management of childhood illnesses criteria for diagnosing neonatal sepsis. The results show that out of 156 neonates included in the study, 40.4% (63/156) of them had neonatal sepsis while the remaining 59.6% (93/156) neonates were admitted for other medical reasons than neonatal sepsis as shown in Figure 2 below.

This section presents results of bivariate and multivariate analysis of factors associated with neonatal sepsis among study respondents. The section first presents result from cross-tabulations between the examined independent variables and neonatal sepsis, with corresponding p-values from Chi-square and Fisher's exact tests. These are outlined in Tables 5-8. Thereafter, significant variables which were analyzed in multivariate regression analysis are presented in Table 9.

Table 5. Association between maternal demographics and neonatal sepsis (n = 156).

Variables	Neonatal Sepsis, n (%)		p-*value*
	Yes	No	
Age			**0.009**
≤20 years	8 (88.9)	1 (11.1)	
21 - 34 years	36 (37.5)	60 (62.5)	
≥35 years	19 (37.3)	32 (62.7)	
Religious affiliation			**0.009**
Roman Catholic	23 (34.3)	44 (65.7)	
Protestant Christian	38 (52.1)	35 (47.9)	
Muslim	0	9 (100)	
Non-religious	2 (28.6)	5 (71.4)	
Distance to nearest health facility			**0.000***
≤5 km	51 (56.7)	39 (43.3)	
6 - 10 km	12 (18.2)	54 (81.8)	
Educational level			**0.000**
Never been to school	6 (28.6)	15 (71.4)	
Primary	13 (36.1)	23 (63.9)	
Secondary	31 (36)	55 (64)	
Tertiary	13 (100)	0	
Occupation			**0.000**
Housewife	19 (70.4)	8 (29.6)	
Civil servant	8 (28.6)	20 (71.4)	
Business woman	18 (23.1)	60 (76.9)	
Private organization	7 (58.3)	5 (41.7)	
Daily laborer	6 (100)	0	
Student	5 (100)	0	
Neonate's age			**0.000***
≤7 days	37 (78.7)	10 (21.3)	
8 - 28 days	26 (23.9)	83 (76.1)	
Neonate's sex			0.515*
Male	28 (37.3)	47 (62.7)	
Female	35 (43.2)	46 (56.8)	

*Fisher's exact test.

Table 6. Association between maternal obstetric factors and neonatal sepsis.

Variables	Neonatal Sepsis, n (%)		p-*value*
	Yes	No	
Parity			0.175
Primipara	21 (32.8)	43 (67.2)	
Multipara	33 (43.4)	43 (56.6)	
Grand multipara	9 (56.3)	7 (43.8)	

Continued

ANC attendance			0.144*
Yes	62 (41.9)	86 (58.1)	
No	1 (12.5)	7 (87.5)	
Place of delivery			0.521
Home	3 (25)	9 (75)	
Hospital	45 (42.1)	62 (57.9)	
Health center	15 (40.5)	22 (59.5)	
Type of delivery			0.054
Spontaneous vaginal delivery	50 (42)	69 (58)	
Instrumental vaginal delivery	1 (8.3)	11 (91.7)	
Caesarean section	12 (48)	13 (52)	
labor personnel			0.363*
Health professional	60 (41.7)	84 (58.3)	
Relatives	3 (25)	9 (75)	
Duration of labor			**0.000**
≤6 hours	13 (13)	87 (87)	
7 - 12 hours	27 (81.8)	6 (18.2)	
13 - 24 hours	23 (100)	0	
Number of vaginal examinations			**0.000***
<3	27 (26.2)	76 (73.8)	
≥3	36 (67.9)	17 (32.1)	
Experienced PROM			**0.015***
Yes	9 (75)	3 (25)	
No	54 (37.5)	90 (62.5)	
Duration of PROM			0.240
6 - 12 hours	4 (57.1)	3 (42.9)	
13 - 18 hours	1 (100)	0	
>18 hours	4 (100)	0	
Experienced fever during labor			0.085*
Yes	1 (11.1)	8 (88.9)	
No	62 (42.2)	85 (57.8)	
Experienced PIH			**0.004***
Yes	11 (22.9)	37 (77.1)	
No	52 (48.1)	56 (51.9)	
Experienced antepartum hemorrhage (APH)			0.285*
Yes	4 (26.7)	11 (73.3)	
No	59 (41.8)	82 (58.2)	
Experienced UTI in pregnancy			0.596
Yes	12 (36.4)	21 (63.6)	
No	51 (41.5)	72 (58.5)	

*Fisher's exact test.

Table 7. Association between neonatal factors and neonatal sepsis.

Variables	Neonatal Sepsis, n (%)		p-*value*
	Yes	No	
Gestational age			**0.000**
<32 weeks	0	11 (100)	
32 - 36 weeks	4 (14.8)	23 (85.2)	
37 - 41 weeks	57 (49.6)	58 (50.4)	
≥42 weeks	2 (66.7)	1 (33.3)	
APGAR score at 1 minute			**0.000***
<7	0	21 (100)	
≥7	63 (46.7)	72 (53.3)	
APGAR score at 5 minutes			0.082*
<7	0	5 (100)	
≥7	63 (41.7)	88 (58.3)	
Birth weight			**0.000**
<1500 g	0	7 (100)	
1500 - 2499 g	5 (13.5)	32 (86.5)	
2500 - 3999 g	58 (53.7)	50 (46.3)	
≥4000g	0	4 (100)	
Resuscitated at birth			0.795*
Yes	6 (35.3)	11 (64.7)	
No	57 (41)	82 (59)	

*Fisher's exact test.

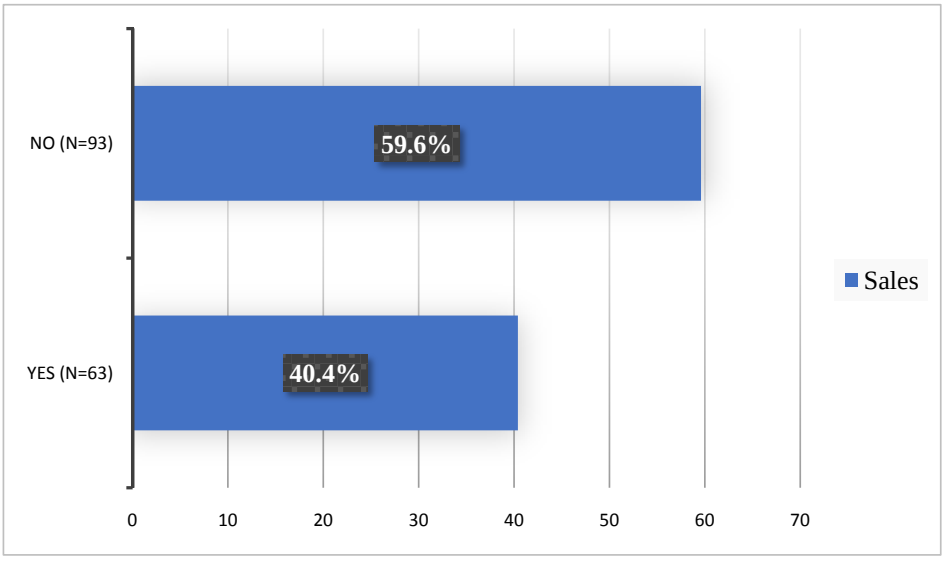

Figure 2. Bar chart showing the distribution of neonatal sepsis.

Table 8. Association between cultural practices and neonatal sepsis.

Variables	Neonatal Sepsis, n (%)		p-*value*
	Yes	No	
Cultural practices are performed on a woman to accelerate labor*			0.989
Insertion of herbs or other applications in the birth canal	42 (38.5)	67 (61.5)	
Introduction of fingers into birth canal to enlarge passage	16 (38.1)	26 (61.9)	
Use of anointing oils	27 (40.9)	39 (59.1)	
Practices believed to help and therefore applied on the umbilical cord of the neonate*			1.0
Baby powder	27 (39.7)	41 (60.3)	
Baby oil	19 (38)	31 (62)	
Anointing oil/water	22 (39.3)	34 (60.7)	
Herbal applications	29 (39.2)	45 (60.8)	
Tattoos or others cuttings	4 (36.4)	7 (63.6)	
Chicken droppings	28 (39.4)	43 (60.6)	
Ashes	25 (37.3)	42 (62.7)	
Practices believed to help and therefore applied on the fontanelle of the neonate*			1.0
Baby powder	12 (37.5)	20 (62.5)	
Baby oil	10 (38.5)	16 (61.5)	
Anointing oil/water	13 (39.4)	20 (60.6)	
Herbal applications	41 (39.4)	63 (60.6)	
Tattoos or others cuttings	2 (40)	3 (60)	
Chicken droppings	12 (37.5)	20 (62.5)	
Ashes	17 (42.5)	23 (57.5)	

Table 9. Logistic regression analysis for factors associated with neonatal sepsis.

Independent Variables	Univariate Logistic Regression			Multivariate Logistic Regression		
	p-*value*	COR	95% CI of COR	*p-value*	AOR	95% CI of AOR
Age						
≤20 years	Ref					
21 - 34 years	**0.017**	13.3	1.601 - 111.029	0.705	0.6	0.027 - 11.406
≥35 years	**0.018**	13.5	1.562 - 116.245	0.3	0.2	0.008 - 4.443
Marital status						
Single	Ref					
Married	0.075	2.2	0.925 - 5.014			
Widowed	0.999	-	-			
Divorced/separated	0.999	-	-			
Cohabiting	0.999	-	-			

Continued

Religious affiliation						
Roman Catholic	Ref					
Protestant Christian	0.056	0.5	0.243 - 0.952			
Muslim	0.999	-	-			
Non-religious	0.760	1.3	0.235 - 7.266			
Distance to nearest health facility						
≤5 km	Ref					
6 - 10 km	**0.000**	5.9	2.775 - 12.479	**0.003**	6.3	1.834 - 21.318
Educational level						
Never been to school	Ref					
Primary	0.561	0.7	0.221 - 2.27			
Secondary	0.520	0.7	0.25 - 2.016			
Tertiary	0.998	-	-			
Occupation						
Housewife	Ref					
Civil servant	**0.003**	5.9	1.854 - 19.014	0.192	3.3	0.549 - 19.829
Business woman	**0.000**	7.9	2.972 - 21.087	**0.026**	5.8	1.237 - 27.58
Private organization	0.464	1.7	0.413 - 6.976	0.922	1.1	0.101 - 12.641
Daily laborer	0.999	-	-	0.999	-	-
Student	0.999	-	-	0.999	-	-
Neonate's age						
≤7 days	Ref					
8 - 28 days	**0.000**	11.8	5.172 - 26.975	**0.000**	18.8	4.868 - 72.451
Number of ANC visits						
≤3	**0.000**	3.7	1.875 - 7.486	**0.003**	6.3	1.862 - 21.56
≥4	Ref					
Duration of labor						
≤6 hours	0.998	-	-			
7 - 12 hours	0.998	-	-			
13 - 24 hours	Ref					
Number of vaginal examinations						
<3	**0.000**	6.0	2.887 - 12.306	**0.001**	10.8	2.79 - 42.002
≥3	Ref					
Experienced PROM						
Yes	Ref					
No	**0.019**	5.0	1.297 - 19.277	0.165	5.0	0.517 - 47.755

Continued

Experienced PIH						
Yes	**0.004**	3.1	1.444 - 6.757	**0.013**	5.4	1.433 - 20.048
No	Ref					
Gestational age						
<32 weeks	0.999	-	-			
32 - 36 weeks	0.068	11.5	0.833 - 158.721			
37 - 41 weeks	0.566	2.0	0.179 - 23.073			
≥42 weeks	Ref					
APGAR score at 1 minute						
<7	0.998	-	-			
≥7	Ref					
Birth weight						
<1500 g	1	1	-			
1500 - 2499 g	0.999	-	-			
2500 - 3999 g	0.999	-	-			
≥4000g	Ref					

COR: Crude Odd Ratio; AOR: Adjusted Odd Ratio; CI: Confidence Interval.

Table 5 showed that there were statistically significant association between respondents' demographics and neonatal sepsis.

Interestingly, respondents aged younger than 20 years (88.9%) were more likely to have their babies develop neonatal sepsis compared to older respondents aged over 35 years (37.3%) (p = 0.009). Also, widowed-divorced/separated-cohabiting respondents (100%) were more likely to have their babies develop neonatal sepsis compared to their married counterparts (33.3%) (p = 0.002). Concerning religion, protestant Christians (52.1%) were more likely to have their babies develop neonatal sepsis compared to Muslims respondents (p = 0.009). Further, respondents who stayed within five kilometers of a health facility (56.7%) were more likely to have their babies develop neonatal sepsis compared to respondents who lived 6 to 10 kilometers from the health facility (18.2%) (p = 0.000). The results also showed that respondents with tertiary education (100%) were more likely to have their babies develop neonatal sepsis compared to respondents with no formal education (28.6%) (p = 0.000). The results further showed that respondents who were in school or daily laborers (100%) were more likely to have their babies develop neonatal sepsis compared to those in business (23.1%) (p = 0.000). Concerning the neonate, neonates aged less than seven days old (78.7%) were more likely to develop neonatal sepsis compared to older neonates aged 8 to 28 days (23.9%) (p = 0.000). However, respondents' residence (p = 0.972) and neonates' sex (p = 0.515) did not significantly associate with development of neonatal sepsis.

Table 6 showed that there were statistically significant association between some of respondents' obstetric characteristics and neonatal sepsis.

The results showed that respondents who attended ANC for more four times (54.1%) were more likely to have their babies develop neonatal sepsis compared to respondents had fewer ANC attendance (23.9%) ($p = 0.000$). Also, respondents with history of more 13 hours of labor (100%) were more likely to have their babies develop neonatal sepsis compared to respondents who had less than six hours of labor (13%) ($p = 0.000$). Further, respondents who had over three vaginal examinations performed (67.9%) were more likely to have their babies develop neonatal sepsis compared to respondents who had less than three vaginal examinations (26.2%) ($p = 0.000$).

The results also showed that respondents who had developed PROM (75%) were more likely to have their babies develop neonatal sepsis compared to respondents who had no PROM (37.5%) ($p = 0.015$). Also, respondents who did not have PIH (48.1%) were more likely to have their babies develop neonatal sepsis compared to respondents who had PIH (22.9%) ($p = 0.004$). However, parity ($p = 0.175$), ANC attendance ($p = 0.144$), place of delivery ($p = 0.521$), type of delivery ($p = 0.054$), labor personnel ($p = 0.363$), fever in pregnancy ($p = 0.085$), APH ($p = 0.285$), and UTI in pregnancy ($p = 0.596$) did not significantly associate with the development of neonatal sepsis.

Table 7 showed that there were statistically significant association between some of respondents' neonatal characteristics and neonatal sepsis.

The results showed that neonates born at over 42 weeks gestation (66.7%) were more likely to develop neonatal sepsis compared to those born at 36 weeks gestation (14.8%) or lower ($p = 0.000$). Also, neonates with an APGAR score of over seven at one minute of birth (46.7%) were more likely to develop neonatal sepsis compared to neonates with an APGAR score of less than seven ($p = 0.000$). Further, neonates born with a birth weight of 2500 to 3999 grams (53.7%) were more likely to develop neonatal sepsis compared to neonates born with birth weight of less than 1500 grams or over 4000 grams ($p = 0.000$).

However, APGAR score at five minutes ($p = 0.082$), crying immediately after birth ($p = 0.303$), and resuscitation at birth ($p = 0.795$) did not significantly associate with the development of neonatal sepsis.

Table 8 showed that there were no statistically significant association between respondents' cultural practices and neonatal sepsis.

The results showed that practices to accelerate labor ($p = 0.989$), and practices helpful to the neonate ($p = 1$) did not significantly associate with the development of neonatal sepsis (See Table 7).

After bivariate analysis significant variables were entered for further multivariate analysis while adjusting for maternal age. After adjusting for potential confounders; distance to nearest health facility ($p = 0.003$), occupation ($p = 0.026$), Neonate's age ($p = 0.000$), Number of ANC visits ($p = 0.003$), Number of vaginal examinations ($p = 0.001$), and PIH ($p = 0.013$) were significantly associated with neonatal sepsis.

The results showed that respondents who lived 6 to 10 km from the health facility were six times less likely to have their babies develop neonatal sepsis than those who lived within five kilometers [AOR: 6.3 (95% CI: 1.8 - 21.3)]. Also, respondents doing business were six times less likely to their babies develop neonatal sepsis than respondents who were housewives [AOR: 5.8 (95% CI: 1.2 - 27.6)]. Further, neonates older than eight days were 19 times less likely to develop neonatal sepsis than those younger than seven days old [AOR: 18.8 (95% CI: 4.9 - 72.5)].

The results also showed that respondents who had less than four ANC visits were six times less likely to their babies develop neonatal sepsis than those respondents who had more than four ANC visits [AOR: 6.3 (95% CI: 1.9 - 21.6)]. Further, respondents with less than three vaginal examinations were 11 times less likely to their babies develop neonatal sepsis than those with more than three examinations [AOR: 10.8 (95% CI: 2.8 - 42)]. Furthermore, respondents with PIH were five times less likely to their babies develop neonatal sepsis than respondents without PIH [AOR: 5.4 (95% CI: 1.4 - 20)].

4. Discussion of Findings

This study was intended to investigate the factors associated with neonatal sepsis at Chilenje General Hospital in Lusaka, Zambia. There were 156 neonates in all who had been brought into the neonatal unit by their mothers. According to the survey, respondents' ages ranged from 17 to 52 years old, with the majority (61.5%) falling between the ages of 21 and 34 (**Table 1**). Their mean age was determined to be 31.4 years (SD: 6.86). The majority of respondents (76.9%) were married, and 46.8% of them identified as protestant Christians. The average distance between respondents' homes and the hospital was 5 kilometers (57.7%). The majority of respondents (55.1%) had a secondary education, and 50% of them engaged in the business (**Table 1**). These results were comparable to those of an Ethiopian study [20], which found that mothers' ages ranged from 16 to 44 years, with a mean age of 28.21 (S.D. 6.35). The same study also stated that the majority of their study participants were Orthodox Christians, and that 85.7% of the cases and 86.47% of the controls were married. However, the study also discovered that, in contrast to this study's findings, 51.97% of the cases and 50.07% of the controls were housewives, while 19.5% of the cases and 18.27% of the controls were employed as civil servants [20]

Similar findings were made [21] where it was discovered that more than half of mothers among cases (63.6%) and more than two-thirds of controls (68.8%) were between the ages of 25 and 34. Mothers in cases made up 86.4 percent of the population, while controls made up 87.8 percent. However, the same study discovered that 51.8% of cases and 48.9% of controls were housewives, 30% of cases and 28.5% of controls had completed college or higher [21]. In addition, a 2018 Ghanian study found that the majority of women, who made up 60.2% of cases and 57.7% of controls, were between the ages of 20 and 29. Married people

made up 88.3% of cases and 81.9% of controls. About 85.4 percent of the mothers of cases and 85.6 percent of the mothers of controls, respectively, identified as Christians. However, the study discovered that 14.6% of cases and 11% of controls lacked a high school diploma, while 23.3% of cases and 13% of controls worked as housewives [22].

Concerning the neonate, the study found that the means age of neonates was 9.6 (SD ± 4.32) days with the majority (69.9%) of the neonates aged 8 to 28 days, and 51.9% of them were female. This conclusion was similar to one by Akalu *et al.* [20] who also noted that the mean age of neonates was 8.04 (S.D. 6.12) days and that more than half (58.4%) of cases and 51.9 percent of controls were females. In contrast to these findings the other study [21], discovered that 60.2 percent of controls and 55.5 percent of cases had neonates under the age of seven days, and that controls had a larger percentage of male neonates (55.7 percent) than cases (51.8%). Similar findings [22] were made where it was discovered that 56.3 percent of cases and 50.4 percent of controls were male and 24.3 percent of cases and controls were between 4 and 7 days old. Additionally, it was discovered that of the 380 neonates that took part in the study, 96.1 percent of them were between the ages of 0 and 7 days, and 50.8% of them were male [23].

The current study found that out of 156 neonates included in the study, 40.4% had neonatal sepsis (**Figure 2**). This result was greater than that of Akalu [20] who stated that out of 231 neonates examined in their study on the predictors of neonatal sepsis in East and West Ethiopia, 33.3% of their sample had neonatal sepsis [20]. Similar to this, Bejitual *et al.* noted that 33.2% of the 331 neonates included in the study had neonatal sepsis [21]. This finding differs from that of other studies [24] [25] [26] found that rates of neonatal sepsis, or EONS, to range from 59.3 percent to 81.4 percent. This discrepancy may be the consequence of different study designs. The finding is also less favorable than studies done in Ghana and Egypt (78.7% vs. 44.2 percent, respectively) [22] [27]. Variations in sample size, study duration, and sociodemographic may all be contributing factors. Further studies [23] revealed overall prevalence of neonatal sepsis as at 42.9 percent, with a confidence interval (CI) of (38.4 - 47.8). However, a significant disparity in study findings was seen in Mexico in 2012, when neonatal sepsis frequency was only 4.3%, a very low rate compared to other studies [28]. This discrepancy could have been caused by the presence of more highly trained workers and more modernized or advanced equipment in Mexico compared to the tests conducted in Africa.

The current study discovered that the respondents' occupation and distance to the health facility were significant socio demographic predictors of neonatal sepsis ($p = 0.026$ and $p = 0.003$, respectively). According to the study, respondents who lived 6 to 10 km away from the medical institution had a six-fold lower risk of their children developing neonatal sepsis than those who resided within five miles (**Table 1**). Additionally, respondents who worked outside the home had a six-fold lower risk of their children developing neonatal sepsis than respondents

who were housewives (Table 9). These results differed from those published by Akalu *et al.* [20], in their study, which found no correlation between maternal occupation and neonatal sepsis despite the fact that 40 (51.9%) of cases and 77 (50.0%) controls were housewives and 15 (19.5%) of cases and 28 (18.2%) controls were civil servants.

The study also discovered that a significant predictor of neonatal sepsis was the age of the neonates. Neonatal sepsis was 19 times less likely to occur in babies older than eight days than in those under seven days of age (**Table 9**). This result is analogous to one from a study [21] where it was discovered that neonates aged 8 to 28 days were 91 percent more protected from neonatal sepsis than those aged 0 to 7 days [AOR: 0.085, (CI = 0.01 to 0.73)]. Contradictory results were published in Nigeria, where it was demonstrated that lower neonatal age of less than 3 days was protective of sepsis compared to neonates over the age of 3 days, despite practically equal significance to the current study [29]. The sample's inclusion of individuals younger than three days of age may be one explanation for the discrepancy. Despite this other studies still revealed the opposite result, finding no connection between the age of the newborn and sepsis [20]. This might be because neonates who were younger had lower immune systems than those who were older than the first week of life. This discrepancy may result from the physiological events and changes that accompany age transfer as well as its nature.

The current study found that maternal education was not a major risk factor for neonatal sepsis (**Table 1**). This finding is in line with studies in Ghana [23] [30], but it is at odds with earlier findings in Nepal [31] which found that the risk of neonatal sepsis was statistically associated to maternal education in a case-control study in Nepal. Compared to mothers who were not educated, it is anticipated that women who are educated will have more understanding of how to care for the infant and practice better hygiene habits to avoid sepsis [32].

According to this study, 48.7% of the respondents were multipara. Parity, however, was not substantially linked to neonatal sepsis (**Table 2**). This result was at odds with earlier research. For instance, maternal parity was found to be strongly linked with the likelihood of the index neonate acquiring sepsis ($p = 0.027$) [22]. Additionally, the findings of the present study are at odds with those of Siakwa [30] who discovered that parity was statistically related with the likelihood of having neonatal sepsis ($p = 0.001$). According to the bivariate logistic regression used in these investigations, their index neonates are less likely to acquire sepsis as parity increases.

This current survey discovered that almost all the respondents (94.9%) participated in ANC. Nevertheless, there was no correlation between ANC attendance and neonatal sepsis (**Table 2**). Similar studies in Ghana and Ethiopia [23] [30] [33] and other researchers did not find evidence that using antenatal services increased the incidence of neonatal sepsis in their studies. The results of the current study are consistent with those of the studies done in Ethiopia and

Ghana earlier. According to the results of the current study, there were no significant differences in neonatal sepsis between moms who received antenatal care and those who did not. Although prenatal care use is important in reducing the risk factors of bad birth outcomes, including neonatal sepsis, that was not the case in the present study. Instead, the majority (41.9 percent) of neonates with sepsis were from mothers who used ANC services (**Table 2**). Further studies [23] found that neonates from mothers who had no history of ANC were 8.9 times more likely to suffer neonatal sepsis than neonates from mothers who had a history of ANC [AOR: 8.933 (CI = 4.9, 15.9)]. The results of the present investigation are in opposition to this finding. In light of this, literature on ANC may recommend raising awareness of and bolstering maternal reproductive health use, especially this crucial prenatal care [34].

Over half (54.5%) of the respondents in this study reported attending more than four ANC sessions during their most recent pregnancy (**Table 2**). The frequency of ANC visits and neonatal sepsis were shown to be significantly correlated in the study. Compared to respondents who attended ANC less frequently, neonates born to respondents who attended ANC more than four times were six times more likely to experience neonatal sepsis. The results were comparable to those established by Akalu [20], who also discovered a significant relationship between the quantity of maternal prenatal care services and neonatal sepsis. The study was different, though, in that Akalu's research revealed that neonates whose mothers received antenatal care services fewer than three times during their pregnancies were about four times more likely to develop sepsis than neonates whose mothers received such services more than three times during their pregnancies. This might be because the two research' sample distributions and conceptions of maternal and other risk variables differ. It is true that women with comprehensive ANC services may have better knowledge of risk factors and access to medical care than women with partial ANC services. Previous research from India and Uganda found that women who had ever received ANC care had a lower risk of having neonates who were sepsis-affected [35] [36]. However, these studies did not record the precise number of ANC visits those women received during their pregnancies; rather, they observed the presence or absence of ANC care regardless of the number.

The current study also showed that more than 76.3 percent of the respondents gave birth spontaneously by vaginal delivery (**Table 2**). Neonatal sepsis and this finding did not significantly correlate. In contrast to this finding, a previous study discovered that cesarean section delivery was a factor that was statistically associated with the probability of developing neonatal sepsis, which is consistent with the findings of the current study [37]. However, they frequently had lengthy hospital stays and delayed start to breastfeeding despite the fact that neonates delivered via CS are not exposed to vaginal and fecal germs [38]. After CS, breastfeeding should be started as soon as possible. Delayed breastfeeding could prevent the neonate from benefiting from colostrum's immunity-building and

pathogen-protective properties and contribute to sepsis [39]. The findings of the current study are consistent with more studies which showed that the technique of delivery was not statistically associated with neonatal sepsis (p = 0.535) and conducted their research in Ghana (30).

In the present study, it was discovered that 64.1 percent of respondents had labor that lasted less than 6 hours (**Table 6**). Neonatal sepsis and labor duration did not, however, appear to be significantly correlated in the study. This is however contrary to what was discovered in Ethiopia where it was found that there was a substantial correlation between the risk of neonatal sepsis and the length of labor following membrane rupture (>18 hours) [20]. Compared to neonates born from mothers whose labor took less than 12 hours to complete after the membranes ruptured, those whose labor took longer than 18 hours were around 10 times more likely to develop sepsis [20]. There is a connection between the length of labor and neonatal sepsis, according to additional research from Mexico, Pakistan, Ethiopia, .and the United States of America [24] [33] [40] [41]. These findings could be the result of aerobic and anaerobic pathogens colonizing the birth canal, which could lead to an infection of the ascending amniotic fluid and colonization of the neonate during birth. During labor and delivery, bacterial organisms that infect the amniotic fluid and birth canal may be transmitted from mother to fetus more frequently, which leads to EONS [42].

In this study, the majority (66 percent) of the respondents had undergone three vaginal examinations (**Table 2**). According to the study, there is a strong correlation between neonatal sepsis and the number of vaginal examinations that were conducted on the respondents. Neonatal sepsis was eleven times more likely to occur in babies born to respondents who had more than three vaginal examinations than in babies born to respondents who had less than three. This finding however is unique to Chilenje General Hospital as results from similar studies did not discover a connection between the frequency of per-vaginal examinations and neonatal sepsis, did not support the findings of the present investigation. [20]

The findings revealed that more than half (58.3%) of the responders to the research who experienced PROM for 6 to 12 hours (7.7%) or less reported having I (**Table 6**). The study, however, was unable to identify any connection between PROM, its length, and neonatal sepsis. This also contrary to a Ghanian study and numerous more research results which supported the claim that there was substantial (p 0.001) association between PROM and the risk of neonatal sepsis. claim [20] [28] [32].

The current study further discovered that none of the respondents had Meconium-stained Amniotic Fluid (MSAF). However, it has been discovered from other studies that MSAF and neonatal sepsis were related. For instance, there is a substantial correlation between MSAF and the risk of neonatal sepsis. Neonates born to women with MSAF were almost four times more likely to experience sepsis than those delivered to women without MSAF. Similar results that dem-

onstrated MSAF was an independent predictor of neonatal sepsis were also published in Mexico, South Africa, and India [28] [43] [44]. This may be because neonates born to mothers with MSAF are more likely to aspirate it and fill the lung's tiny airways and alveoli. Additionally, it promotes the growth of bacteria that lead to sepsis and raise the risk of LONS [42].

Only 5.8% of the respondents in the current study experienced fever during labor, it was discovered (**Table 2**). Additionally, the study did not discover any link between neonatal sepsis and maternal temperature during childbirth. This result was in contrast to similar studies which found a strong correlation between neonatal sepsis and maternal temperature during childbirth [20]. The same study found that neonates born to women who had intrapartum fever were almost four times more likely than those who hadn't to develop neonatal sepsis. In a similar vein, researches from Pakistan, India, and Ethiopia [33] [40] [44]; as well as other data from these countries found that fever during delivery was an independent predictor of neonatal sepsis. This may be because female fever is a sign of urinary tract infection or chorioamnionitis, two illnesses that can be local or systemic. This causes hematogenous spread and vertical pathogen transfer to the neonatal before or during labor and delivery, which further causes neonatal sepsis.

On the other hand, approximately a third (30.8%) of the respondents had PIH (**Table 2**) According to the research, neonates delivered from responders without PIH were five times more likely than those with Pregnancy Induced Hypertension (PIH) to experience neonatal sepsis (**Table 2**). This observation has been independently linked to neonatal sepsis. In Ghana found the opposite, reporting no connection between hypertension and neonatal sepsis ($p = 0.875$) Variations in sociodemographic characteristics, sample size, and study time could all be contributing factors [22]. Additionally, the current study found no significant association between APH and neonatal sepsis. However, it was discovered in a study that neonates born to women who had a history of anemia during a recent pregnancy had 2.5 times the likelihood of developing neonatal sepsis as compared to their counterparts. Moreover, a prospective study carried out in India discovered that 9% of neonates born to anemic mothers got neonatal sepsis [31]. Studies have shown that there is a considerable fall in the micronutrient content of breast milk in anemic mothers, which may be the cause [45]. This may impair the newborn's immune system and make them more susceptible to sepsis. The present study failed to discover a link between a pregnant Urinary tract infection (UTI) and neonatal sepsis (**Table 6**). This is in contrast to a study in Ethiopia which revealed that maternal UTI was substantially related with neonatal sepsis [20]. They found that neonates born from pregnant women who had UTI had a roughly eleven-fold increased risk of developing sepsis compared to neonates born from pregnant women who had no UTI. Maternal UTI was found to be an independent risk factor for neonatal sepsis in several studies carried out in Ethiopia, Mexico, and India [28] [33] [44]. This may be because microorganisms get colonized on the birth canal wall in women with UTIs. The majority of bacteria

that cause neonatal sepsis are often located throughout the birth canal, where they may raise the risk while the baby is still being born and pass through the vaginal wall [46] [47].

The findings of the current have showed that the majority (73.7%) of the neonates were born between 37 and 41 weeks of gestation (**Table 7**). Most of the neonates had an APGAR score of at least seven at one minute and five minutes after birth (86.5 percent vs. 96.8 percent, respectively). The majority (69.2%) of the neonates were between the weight range of 2500 to 3999 grams at birth. The majority of them (80.1%) had cried right away after birth, with only 10.9% of neonates receiving rapid CPR. These results were similar to those conducted in Ethiopia [20] where more than half (54.5%) of cases and nearly three-quarters (71.4%) of controls were within the range of gestational ages of 37 - 42 completed weeks. The proportion of neonates with an APGAR score greater than 7 in the first and fifth minutes was also lower in cases (40 percent and 68 percent, respectively) than in controls (84.1 percent and 95.9 percent) in those same time periods. Similar to this, cases (39%) had fewer neonates with a gestational age of 2500 - 4000 grams than controls (45%). Less than one-fourth of controls (16.2%) and more than half of cases (59.7%) had their babies revived at birth. Furthermore, similar studies in Ethiopia discovered that newborns with gestational ages between 37 and 42 weeks were 1.8 times more likely to have neonatal sepsis than newborns with gestational ages between 37 and 42 weeks [AOR: 1.869 (CI = 1.05 - 3.31)]. This might be because there are medical services available or because the study's methodology was similar [23].

This current study could not find any significant associations in multivariate logistic regression analysis with these factors (**Table 9**), which is comparable to studies carried out in Ethiopia. Despite the fact that numerous studies have identified gestational age (GA), birth weight, and crying at birth as significant predictors of neonatal sepsis [20] [28] [33] [48] [49], this study could not find any significant associations in this analysis. Although utilizing a precise case definition may have lessened this prejudice, this discrepancy may be the result of methodological differences as well as selection bias in the recruitment of study participants.

The study also could not detect any correlation between the first minute APGAR score and neonatal sepsis in multivariate logistic regression (**Table 9**). This result was in contrast to a similar study which established a substantial association between neonatal sepsis and a first minute APGAR score of 7. Neonates with first minute APGAR scores under 7 were about three times more likely than those with first minute APGAR scores above 7 to develop neonatal sepsis [20]. Studies carried out in Ghana and Indonesia that revealed an independent risk factor for neonatal sepsis as an APGAR score of less than seven in the first minute validated this finding [20] [30]. It is true that the APGAR core score serves as an overall measure of the newborn's condition in the extra uterine environment. Neonates with low APGAR scores may be in danger of suffocation due to bradycardia and require immediate care. Through non-sterile

helping equipment, this could expose patients to harmful bacteria. In addition, sepsis could have developed in the baby if the pathogen was transferred vertically (from mother to fetus) in utero before birth.

In this study, resuscitation at birth was not a significant risk factor for neonatal sepsis (**Table 9**). In contrast to studies which concluded that neonates who were resuscitated at birth were roughly five times more likely to acquire sepsis than those who were not resuscitated. Resuscitation at birth was a substantial risk factor for neonatal sepsis. Resuscitation during birth was identified in several researches from Ghana, Mexico, and Tanzania as an independent predictor of neonatal sepsis [15] [28] [30]. These results may be explained by the possibility that a violent resuscitation operation could lacerate the newborn's delicate mucous membrane, making it an entrance point for germs via contaminated instruments [42]. Additionally, it might cause microorganisms to enter the newborn's lower airway, which has a developing immune system. This is because a newborn's airways are too narrow and produce more respiratory secretions than older kids, which puts them at risk for sepsis and the quick demise of smaller air sacs. However, to verify these claims, more local data is needed. Negligent procedures and disregard for recommendations by medical personnel during resuscitation may increase the risk of sepsis in the newborn [22].

Since all research participants came from the same institution, there may have been neonates with sepsis signs and symptoms who weren't treated in the hospital, which would have weakened the study's external validity. The identification of sepsis cases in this study was also not dependent on sepsis that was verified by culture. However, it was predicated on sepsis-indicating laboratory results and suggestive clinical manifestations. Due to the possibility that neonates with sepsis signs and symptoms could test negative for culture, the gold standard for the diagnosis of sepsis, our results may be biased due to selection bias.

5. Conclusion

The results of this study indicate that maternal and neonatal factors were substantially linked with neonatal sepsis among neonates aged 0 - 28 days who were hospitalized to the newborn unit at Chilenje General Hospital. The age of the neonates was the only neonatal predictor that substantially correlated with neonatal sepsis, while maternal variables included the distance from the health facility, occupation, number of antenatal visits, number of vaginal examinations, and history of PIH. In order to reduce the risk factors of bad delivery outcomes, including neonatal sepsis, encouraging moms to use antenatal services may help identify risk factors and suggest potential remedies. Additionally, increasing maternal and newborn care provided by medical staff may play a significant role in lowering the incidence of neonatal sepsis.

Declaration

I, Godfridah Liholosi Monde, do hereby declare to the Senate of University of

Zambia that this dissertation is my own original work and has neither been submitted nor been concurrently submitted for degree award in any other Institution.

Ethics Approval and Consent to Participate

Ethical clearance was obtained from the University of Zambia Biomedical Ethic Committee (REF No. 3645.23) and the National health research committee.

Availability of Data and Material

The datasets used and/or analyzed during the current study are available from the corresponding author and the University of Zambia on reasonable request.

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Authors' Contributions

CN, MZ, and MB contributed to the conception of the project, proposal writing, data collection and study supervision, data analysis and manuscript writing.

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Conflicts of Interest

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

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