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Research article

Determinants of neonatal seizure among neonates admitted to neonatal intensive care units in the Awi Zone hospitals, 2023: A multi-center unmatched case control study

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ABSTRACT

Background: Neonatal seizure is a common medical emergency that signals severe insult to the neonatal brain. It is a major risk factor for neonatal morbidity and mortality. It has a wide worldwide variation, ranging from 5 per 1000 live births in the United States of America to 39.5 per 1000 live births in Kenya. To decrease this significant figure, it is better to investigate its causes further. Therefore, this study aimed to assess its determinants since there was no prior evidence about it in the context of study area.

Objective: Aim to assess the determinants of neonatal seizures among neonates admitted to neonatal intensive care units in the Awi Zone Hospitals, 2023.

Methods: An institution based unmatched case-control study was conducted on 531 admitted eligible neonates from January 1, 2023, to May 30, 2023. A pretested tool was employed to collect data. The collected data were coded, edited, and entered into Epi-data version 3.1 and then exported to SPSS 26. Chi-square and odds ratios were used to assess the relationship between factors associated with the occurrence of neonatal seizure. Model goodness of fit was tested by Hosmer and Lemeshow. Bivariate and multivariate analysis was declared at $P < 0.25$ and $P < 0.05$ respectively to show a significant association with neonatal seizure at a 95 % level of significance.

Results: A total of 506 (130 cases and 376 controls) of admitted neonates were used in the final analysis model. Neonates admitted within 24 h of birth [AOR; 5.98 (95 %, CI: 2.18–16.43)], gestational age <32 weeks [AOR; 2.89 (95 %, CI: 1.29–6.53)], body temperature >37.5 °C [AOR;

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4.82 (95 %, CI: 1.82–12.76)], blood glucose level <40 g/dl [AOR; 4.95 (95 %, CI: 2.06,11.88)], neonatal sepsis [AOR; 2.79 (95 %, CI: 1.46–5.35)] and perinatal asphyxia [AOR; 8.25 (95 %, CI: 4.23, 16.12)] were found to be determinants of neonatal seizure.

Conclusion: and recommendations: In this study, neonatal seizure was determined by the factors of neonatal age, gestational age<32 weeks, body temperature >37.5 °C, blood glucose level <40 g/dl, neonatal sepsis, and perinatal asphyxia. Therefore, the presence of such factors requires prompt recognition and treatment.

1. Introduction

Neonatal seizure is clinically defined as a paroxysmal alteration in motor, behavioral, and/or autonomic function due to excess neuronal activity of the neonatal brain [1–3]. It is one of the most common overt emergency signs of potentially life-threatening neurological dysfunction in neonates [1–5]. Even if majority of neonatal seizures are electrographic, those neonates with clinical feature are also included in proposed classification. International League Against Epilepsy develops anew classification of seizure in neonates as motor (automatisms, clonic, epileptic spasms, myoclonic, tonic) and non-motor (autonomic, behavior arrest), or sequential presentation [6].

The incidence of seizures varies from nation to nation. It has been reported that 5 per 1000 live births occurred in the United States of America [7] and 39.5 per 1000 live births in Kenya [8]. The incidence is higher in premature and low birth weight neonates than in term and normal birth weight neonates [7].

Neonatal seizures can cause short-term and long-term effects in neonates. The short term includes higher mortality, prolonged hospitalization, and discharge with neurologic deficits [1,2]. For example, a study conducted in Italy revealed ~16 % of patients with neonatal seizures died early, whereas 33 % had neurological deficits [9].The long-term effects also includes increased risk of neuro disability among seizure survivors [10–12]. For instance, a study reported that ~17–56 % of neonatal patients with seizures developed post neonatal epilepsy [9].

Different studies explained that neonatal seizures are determined by different maternal and neonatal related covariates [1,2,8,13]. From this, the most frequent risk factor was hypoxic–ischemic encephalopathy [4], followed by Other factors like neonatal sepsis [8], neonatal age, gestational age, low birth weight and others [14].

Even though Ethiopia apply different strategies such as Millennium Development Goals, Health Sector Development Program, Health Development Army at different year and expanding NICU service to improve neonatal health, the mortality and morbidity didn't reduced as the government planned. The 2019 mini Ethiopian demographic health survey indicated that 33neonates died per 1000 live births in 2019 which showed an overall reduction of 15 % over the past 14 years [15].

In general, even if neonatal seizure is a public health concern, and a common problem among hospitalized neonates, there has been no prior evidence about its determinants among neonates admitted to NICU in the context of the Ethiopia as well as in the study area. Therefore, this unmatched case control study was done to assess the determinants of neonatal seizures among neonates admitted to neonatal intensive care units in the Awi Zone, public Hospitals.

2. Methods

2.1. Study area and period

Awi zone is located in the Amhara region, which is 426 km away from the capital city of Ethiopia, Addis Ababa. Based on 2021 census information the zone has a total population of 1,342,324 of whom 51 % are females. The zone has a total of 52 health institutions. Of which 47 are health centers, 4 are primary hospitals, and 1 general hospital. All of them (Injibara General Hospital, Agew Gimjabet Primary Hospital, Dangila Primary Hospital, Changi Primary Hospital & Jawi Primary Hospital.) provide neonatal admission services. The study was conducted from January 1/2023–May 30/2023.

2.2. Study design

A multicenter unmatched case control study design was conducted.

2.3. Population characteristics

2.3.1. Source population

All neonates admitted to Neonatal Intensive Care Units in Awi Zone public Hospitals.

2.3.2. Study population

All neonates admitted to the neonatal intensive care units and fulfilling inclusion criteria in Awi Zone Hospitals during data collection time from January 1, 2023, to May 30, 2023.

Cases: Neonates admitted with the first observation of neonatal repetitive involuntary muscle contractions, abnormal tonic

extensions, or jerky movements of any part of the limb, face, or mouth that are not stimulus sensitive and unresponsive to restraining maneuvers or repetitive abnormal chewing, ocular, or pedaling movements at the admission. These include subtle signs such as rolling of the eyes, oral ducal lingual activities, changes in behavior, twitching, and frank convulsion. Finally, it was diagnosed by the ward physician.

Control: Are those neonates who didn't fulfill the diagnostic criteria of neonatal seizures and decision was made after reviewing neonatal chart.

2.4. Eligibility criteria

2.4.1. Inclusion criteria

Neonates admitted to neonatal intensive care units from January 1, 2023, to May 30, 2023, in the Awi Zone Hospitals and who came with their mothers were included.

2.4.2. Exclusion criteria

Abandoned neonates and those whose mothers were not mentally competent to be interviewed were excluded.

2.5. Sample size determination and procedure

2.5.1. Sample size determination

The sample size for this study was determined by using a double population proportion formula in the Epi info version 7. By taking

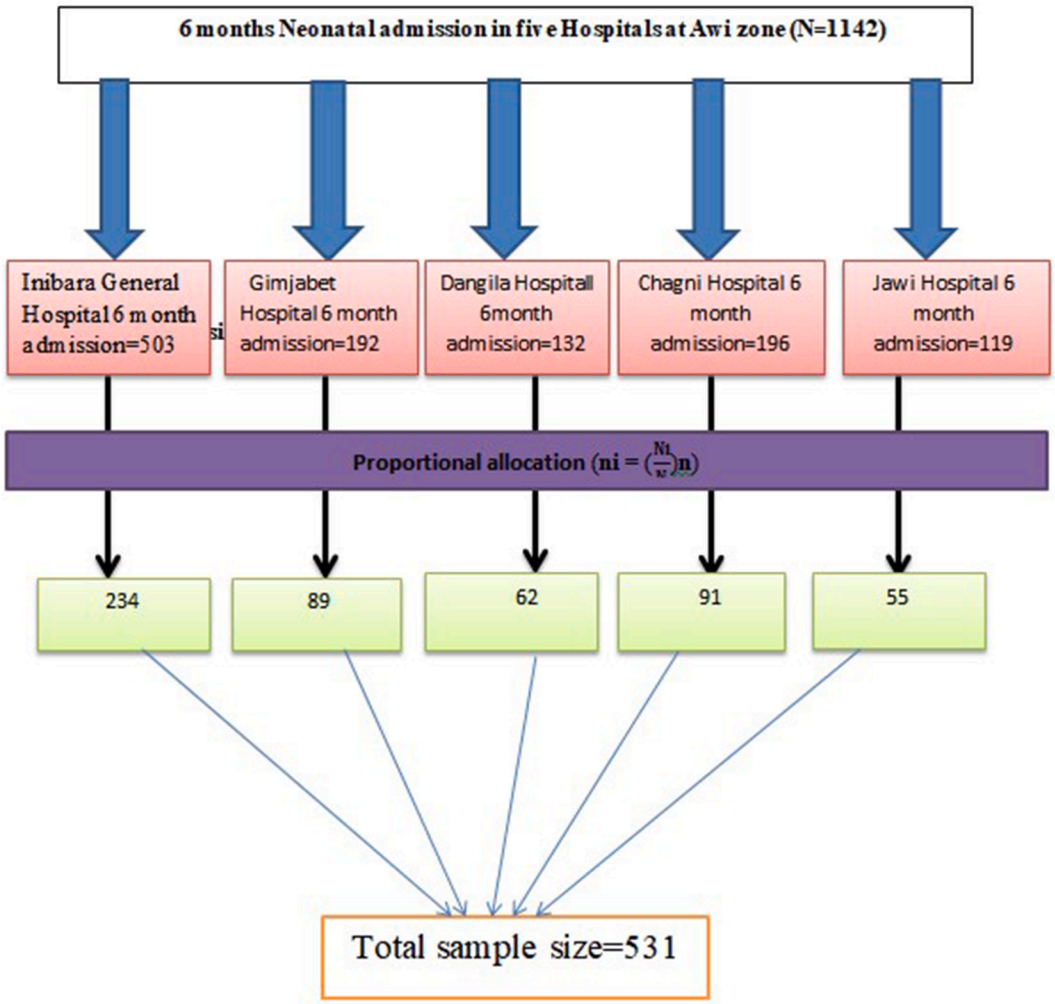

Fig. 1. Diagrammatic presentation of the sampling procedure for the assessment of neonatal seizure among neonates admitted to Neonatal Intensive Care Units in Awi Zone hospitals, Ethiopia, 2023(n = 531).

determinant variables from previous studies(Apgar score at 5 min, perinatal asphyxia, Preeclampsia, placental pathology, hypoglycemia, and intraventricular hemorrhage) [13]. By considering the following statistical assumption of a 95 % confidence interval, a four to one allocation ratio of control to case (4:1), and a power of 90 %, the maximum sample size was obtained from the variable intraventricular hemorrhage, which gave maximum sample size. The proportion of cases exposed to intraventricular hemorrhage was 30 %, and proportion of controls exposed to intraventricular hemorrhage was 15 % [13].The calculated sample size was 483. After adding a 10 % non-response rate the final sample became 531 with control 398 and 133 cases.

2.5.2. Sampling procedure

There are a total of 5 hospitals that provide neonatal intensive care service in Awi Zone. All hospitals were included in the study. The total average of six months neonatal admissions in the selected Hospitals as per the 2021 report was 1142, which was considered as the study population. Then, the sample size was allocated proportionally for each selected Hospitals based on its respective average six months neonatal admission as of 2021 report. For controls, systematic random sampling technique was used, and cases were subsequently included. K value was calculated as $N/n = 1142/531 = 2$. Finally, from eligible admitted study populations, controls were selected every 2 intervals by systematic random sampling method until we got a calculated sample size. See Fig. 1.

2.6. Method of data collection

Data were collected using a structured questionnaire for interviewing mothers in the NICU at admission. The questionnaires have been adapted and modified from different studies conducted in low income and high income countries [8,13,16,17]. Additionally, a structured checklist adapted from the aforementioned studies was also used to abstract data on some maternal and neonatal determinants of neonatal seizure. Using the checklist, data collectors made observations and measurements. To prevent duplication of neonates referred from the district hospital, a special participant code was written on the referral sheet.

Maternal socio-demographic characteristics, antenatal and intrapartum factors were obtained from direct maternal interviews in the NICU at admission. Moreover, these antenatal and intrapartum factors of neonatal seizure were examined and crosschecked with respective reports in the neonatal charts, as these factors were often recorded in the chart. Similarly, neonatal risk factors of seizure were obtained from direct maternal interviews and crosschecked with the report in the neonatal charts. The cases and controls group were taken by reviewing neonatal chart following ward physician diagnosis by detailed history and physical examination.

2.7. Operational definitions

Neonatal seizure: is defined as the first observation of neonatal repetitive involuntary muscle contractions, abnormal tonic extensions, or jerky movements of any part of the limb, face, or mouth that are not stimulus sensitive and unresponsive to restraining maneuvers or repetitive abnormal chewing, ocular, or pedaling movements during the follow-up period. These include subtle signs such as rolling of the eyes, oral buccal lingual activities, changes in behavior, twitching, and clear convulsion [18].

Cases: Neonate admitted with clinical signs and symptoms of seizure and confirmed by attending ward physician at the time of data collection.

Control: Neonates without signs and symptoms of neonatal seizure or not diagnosed as neonatal seizure by physician at the time of data collection.

2.8. Data processing and analysis

After checking the completeness of collected data, it was coded, cleaned, and edited at epidata version 3.1. Then, it was exported to SPSS version 26 for data transformation and further analysis. Frequencies, proportion, rates, summary statistics, and cross tabulation were used to describe the study population in relation to relevant variables. Then results were presented in text form, tables, and graphs. Chi-square and odds ratios (OR) were used to assess the association between factors associated with the occurrence of neonatal seizure. The goodness of fit of the final model was checked using the Hosmer and Lemeshow test. Bivariate analysis was first conducted to identify factors that have crude odd ratio of association with neonatal seizure ($P < 0.25$). Using these factors, multivariable analysis was also carried out to identify factors that have significantly adjusted odds of association with developing neonatal seizure ($P < 0.05$) at a 5 % level of significance.

3. Results

3.1. Socio demographic characteristics

A total of 506 (130 cases and 376 controls) neonates admitted to the NICU of hospitals found at Awi zone were included in the final analysis with a response rate of 95.29 %. In this current study, the mean age of mothers was 27.72 (SD $\pm$ 5.85), with an age group of 16–46. More than half of the study participants (71) cases and (198) controls were from rural areas. Male neonates accounted for 51.33 % of controls and 59.23 % of cases from all neonates admitted to the NICU respectively. The mean age of neonates at the time of admission was 3.86(SD $\pm$ 5.66) days. Most of the mothers (96.8 %) were married. Regarding maternal occupation, 35.37 % of controls and 40 % of cases were farmers, whereas 35.12 % controls and 31.54 % of cases, 13.03 % controls & 13.85 % cases and 15.69 % controls & 13.85 % of cases were housewives, government employed, private employed respectively, and 0.79 % was other

professions. See Table 1.

3.2. Maternal antepartum, intrapartum, and postpartum-related factors

Most (95.38 %) of the cases and (92.55 %) of the controls had antenatal care (ANC) follow-ups at nearby health institutions. From this, 58.06 % of cases and 57.47 % of controls had visited health institutions≥4 times. More than half of the cases 76(58.46 %) and 241 (64.1 %) of controls were multigravida mothers. Of all mothers, 88(17.39 %) had a history of bad obstetrics such as abortion, fetal death, and newborn death. Only 60(11.86 %) of mothers were diagnosed with preexisting medical conditions and obstetric complications. Most commonly 24(40 %) of them were diagnosed with preeclampsia. The duration of labor after the rapture of membrane in 41(31.54) cases and 102(27.13 %) controls was less than 18 h. In the category of mode of delivery, a greater number of cases, 55 (42.31) and 256 (68.1 %) controls gave birth through SVD. See Table 2.

3.3. Neonatal common medical diagnosis

The mean birth weight of the study participants was 2709.62g with SD ± 709.66g. More than half of cases (59.23 %) and controls (61.44 %) were within the gestational age range of 37–42 completed weeks. Almost more than 1/3 of cases were diagnosed with neonatal sepsis 97(28.69 %) and nearly 3/4 of controls 241(71.30 %) were also diagnosed with neonatal sepsis. Similarly, less than half 59(45.38 %) of cases and 71(54.62 %) controls were diagnosed with perinatal asphyxia. Nearly 2 % of cases and 7 % of controls had neonatal jaundice. Out of a total of 51 birth injuries of any type, 11 were cases and 40 were controls. Almost equal number of cases (23) and controls (21) had their random blood glucose level below 40 g/dl. Most of the controls 319(84.84 %) had their random blood glucose level between 40 and 125 g/dl. Similarly, 70 % of cases had also their random blood glucose level between 40 and 125 g/dl.See Fig. 2.

3.4. Patterns of neonatal seizure

Out of 130 total seizure cases, the subtle type of seizure accounted for 37.69 %(49) followed by tonic-clonic 31.54 %(41), multifocal 25.38 %(33), clonic 3.08 %(4), and less than 3 % were tonic cases. See Fig. 3.

3.5. Bivariate and multivariate binary logistic regression model for determinants of neonatal seizure

Within the bivariate logistic regression, the factors that showed significant association with the occurrence of neonatal seizure were sex of the neonate, age of neonate, maternal age, place of delivery, labor duration, pregnancy type, number of parity, history of antenatal care follow up, number of gravidities, pregnancy-related hypertension, neonatal blood glucose level, neonatal temperature, birth weight, gestational age, neonatal sepsis, neonatal jaundice, and perinatal asphyxia. In the adjusted binary logistic regression model, blood glucose level, neonatal temperature, gestational age, neonatal sepsis, perinatal asphyxia, and neonatal age were only

Table 1
Socio-demographic characteristics of neonates admitted to NICU of Awi Zone hospitals from Jannuary to May 2023 (N = 506).

Variables	Category	Cases	Control
		Frequency (%)	Frequency (%)
Maternal age	<25 years	64(49.23)	157(41.76)
	25–35 years	47(36.15)	156(41.49)
	>35 years	19(14.62)	63(16.76)
Sex of neonate	Male	77(59.23)	193(51.33)
	Female	53(40.77)	183(48.67)
Neonatal age	<24hrs	98(75.38)	162(43.09)
	24hrs-7days	26(20)	137(36.44)
	7–28days	6(0.62)	77(20.48)
Residency	Rural	71(54.62)+	198(52.66)
	Urban	59(45.38)	178(47.34)
Place of delivery	Home	3(2.31)	28(7.45)
	Health institution	127(97.69)	348(92.55)
Occupation	Farmer	52(40)	133(35.37)
	Housewife	41(31.54)	132(35.11)
	Gov,t employed	18(13.85)	49(13.03)
	Private employed	18(13.85)	59(15.69)
	Others	1(0.59)	3(0.8)
Marital status	Unmarried	4(3.08)	12(3.19)
	Married	126(96.92)	364(96.81)
Maternal educational status	Unable to read & write	27(20.77)	54(14.36)
	Primary school	47(36.15)	153(40.69)
	Secondary school	33(25.38)	112(29.79)
	Diploma and above	23(17.69)	57(15.16)

Table 2
Maternal antepartum, intrapartum, and postpartum characteristics of neonates admitted to NICU of Awi Zone hospitals from January to May 2023 (N = 506).

Variables	Category	Cases	Controls
		Frequency (%)	Frequency (%)
No of ANC	One time	1(0.81)	2(0.57)
	Two times	15(12.09)	52(14.94)
	Three times	36(29.03)	94(27.01)
	Four and above	72(58.06)	200(55.65)
Gravidity	Prmigravida	65(50)	140(37.23)
	Multigravida	65(50)	236(62.77)
Parity	Prmipara	53(40.77)	109(28.99)
	Multipara	77(59.23)	267(71.01)
Preeclampsia	Yes	12(9.23)	12(3.19)
	No	118(90.77)	364(96.81)
Anemia	Yes	7(5.38)	10(2.66)
	No	123(94.62)	366(97.34)
Preexisting hypertension	Yes	3(2.31)	6(1.6)
	No	127(97.69)	370(98.4
Duration membrane rapture	≥18hrs	41(31.54)	102(27.13)
	<18hrs	89(68.46)	274(72.87)
Labor duration	Precipitated	10(7.69)	81(21.54)
	Prolonged	12(9.23)	20(5.32)
	Normal	108(83.08)	275(73.14)
Mode of delivery	SVD	55(42.31)	256(68.1)
	Instrumental	53(40.77)	70(18.61)
	C/S	22(16.92)	50(13.29)

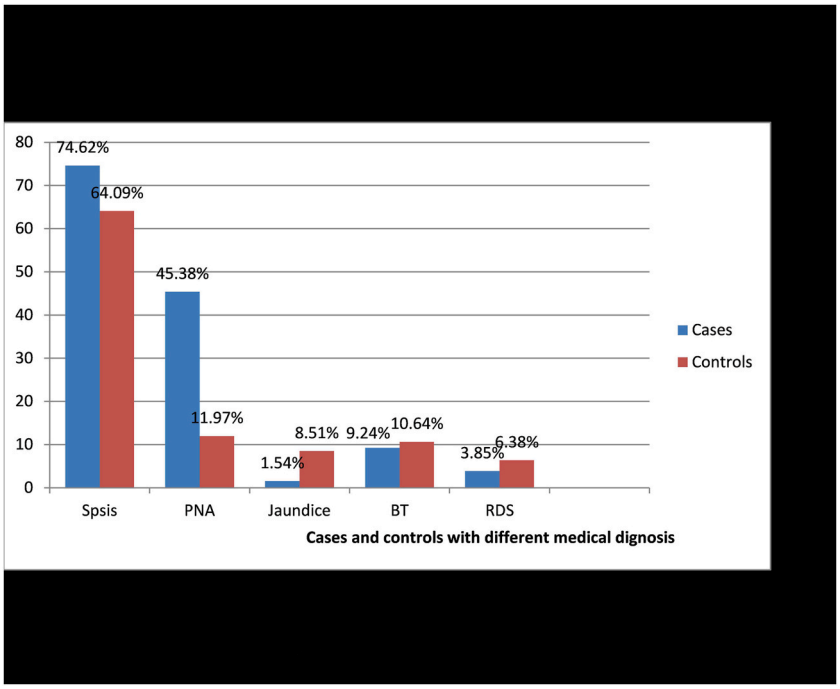

Fig. 2. Common medical illness of neonates among neonates admitted to NICU of Awi Zone hospitals from January to May 2023 (N = 506).

showed significant association.

The odds of developing neonatal a seizure were 5.98 times higher in those neonates admitted within 24 h of birth as compared to those neonates 7–28 days old [AOR; 5.98(95 %, CI: 2.18–16.43)]. Neonates delivered at gestational age <32 weeks had a 2.89 times higher risk of developing neonatal seizure as compared to neonates delivered at gestational age >37 weeks [AOR; 2.89 (95 %, CI: 1.29–6.53)]. The odds of having neonatal seizure were 4.82 times higher for those neonates whose body temperature was >37.5 °C as compared to neonates having a normal body temperature [AOR; 4.82 (95 %, CI: 1.82–12.76)]. Similarly, neonates with blood glucose level <40 gm/dl were 4.95 times more likely to develop a neonatal seizure than neonates whose blood glucose level was between 40

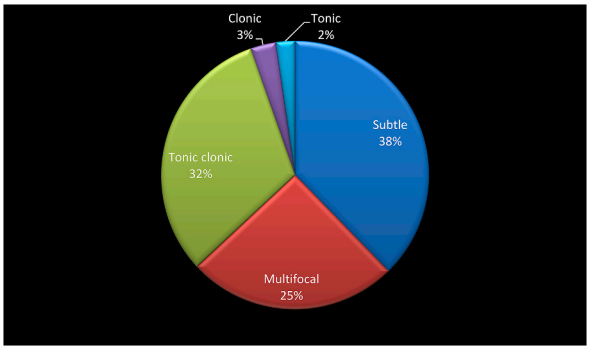

Fig. 3. Types of seizure among neonates admitted to NICU of Awi Zone hospitals from January to May 2023 (N = 506).

Table 3
Bivariate & multivariate logistic regression outputs of neonates admitted to NICU of Awi Zone hospitals from January to May 2023 (N = 506).

Covariates	Variable Category	Status		COR(95 % CI)	AOR(95 % CI)
		Case	Control		
Sex	Female	53(40.77)	183(48.67)	1	1
	Male	77(59.23)	193(51.33)	1.38(0.92,2.06)	1.59(0.95, 2.69)
Neonatal age	7–28 days	6(0.62)	77(20.48)	1	1
	1–7 days	26(20)	137(36.44)	2.44(0.96,6.18)[b]	2.00(0.70, 5.70)
	≤24hrs	98(75.38)	162(43.09)	7.76(3.26,18.49)[c]	**5.98(2.18, 16.43)**[c]
Maternal age	25–35 years	47(36.15)	156(41.49)	1	1
	≤25 years	64(49.23)	157(41.76)	1.35(0.87,2.09)[a]	0.88(0.45,1.74)
	≥35 years	19(14.62)	63(16.76)	1.00(0.55,1.84)	1.43(0.61,3.33)
Place of delivery	Health institution	127(97.69)	348(92.55)	1	1
	Out of health institution	3(2.31)	28(7.45	3.41(1.02,11.39)[b]	0.47(0.12, 1.89)
Gravidity	Multigravida	65(50)	236(62.77)	1	1
	Prmigravida	65(50)	140(37.23)	1.69(1.13,2.52)[a]	0.95(0.35, 2.57)
Parity	Multi para	77(59.23)	267(71.01)	1	1
	Prmipara	53(40.77)	109(28.99)	1.48(0.99,2.21)[a]	1.94(0.67, 5.62)
Pregnancy-related hypertension	No	118(90.77)	364(96.81)	1	1
	Yes	12(9.23)	12(3.19)	3.05(1.27,7.32)[b]	1.63(0.49, 5.43)
Labor duration	Normal	108(83.08)	275(73.14)	1	1
	Precipitated	10(7.69)	81(21.54)	0.31(0.16,0.63)[c]	0.88(0.41,1.87)
	Prolonged	12(9.23)	20(5.32)	1.53(0.72,3.23)	1.24(0.51,3.04)
Pregnancy type	Single	126(96.92)	340(90.43)	1	1
	Multiple	4(3.08)	36(9.57)	0.30(0.11, 0.86)[b]	0.22(0.06,0.89)
Birth weight	>2500g	97(74.62)	232(61.70)	1	1
	<1000g	2(1.54)	6(1.59)	0.79(0.19,4.02)	1.46 (0.35,6.07)
	1000–1500g	2(1.54)	29 (7.71)	0.17(0.04, 0.71)[b]	1.07(0.41,2.79)
	1500–2500g	29(22.31)	109(28.99)	0.67(0.39,1.02)[b]	0.89(0.46,1.73)
Gestational age	>37weeks	77(59.23)	230(61.17)	1	1
	<32 weeks	30 (23.08)	27(7.18)	3.32(1.86,5.93)[c]	**2.89(1.29,6.53)**[b]
	32–37weeks	23(17.69)	118(31.38)	0.58(0.35,0.98)[b]	0.79(0.40,1.55)
Temperature	36.5–37.5	11(8.46)	113(30.05)	1	1
	<36.5	96(73.85)	222(59.04)	3.69(1.98,6.88)[b]	2.19(09.03,4.67)
	>37.5	21(16.15)	43(11.44)	4.17(1.92,9.06)[c]	**4.82(1.82,12.76)**[c]
Blood glucose	40–125 g/dl	91(70)	319(84.84)	1	1
	<40 gm/dl	23(6.12)	21(5.59)	3.84(2.03,7.25)[c]	**4.95(2.06,11.88)**[c]
	>125 g/dl	16(12.31)	36(9.57)	1.56(0.83, 2.94)[a]	1.42(0.63,3.19)
Neonatal sepsis	No	33(25.38)	135(35.9)	1	1
	Yes	97(74.62	241(64.1)	1.65(1.05,2.58)[a]	**2.79(1.46,5.35)**[c]
PNA	No	71(54.62)	331(88.03)	1	1
	Yes	59(45.38)	45(11.97)	6.11(3.84,9.73)[c]	**8.25(4.23,16.12)**[c]
Jaundice	No	128(98.46)	344(91.49)	1	1
	Yes	2(1.54)	32(8.51)	0.17(0.04, 0.71)[a]	0.24(0.05,1.16)

Notice.
[a] p-value <0.25.
[b] p-value <0.01–0.05.
[c] p-value <0.01.

gm/dl and125 g/dl [AOR; 4.95 (95 %, CI: 2.06,11.88)]. The risk of having a neonatal seizure was 2.79 times higher in the neonates with sepsis as compared to neonates without sepsis [AOR; 2.79 (95 %, CI:1.46–5.35)]. Lastly, the odds of occurrence of neonatal seizure among neonates with perinatal asphyxia were 8.25 times higher than its counterpart [AOR; 8.25 (95 %, CI: 4.23, 16.12)]. See Table 3.

4. Discussion

This study mainly investigated the determinants of neonatal seizure at five public hospitals in the Awi zone. Using a binary logistic regression model, our investigation assessed socio-demographic, maternal antepartum, intrapartum, postpartum, and neonatal factors.

In this study tonic-clonic seizure accounted of 31.54 %(41) next to subtle seizure 37.69 %(49). Which is very higher than the study conducted in Switzerland 6.67 %(7) [3]. This might be study sitting difference. In Switzerland it was performed at territory hospital with available EEG where as in this study without EEG available facility. Secondly, study design difference. Small number of cases was used in this study and all of them were included in the study without sampling. This increases the role of chance. Since seizure is rare case the study used one to four ratios (1 case: 4 control).More ever, based on International League Against Epilepsy classification of seizure in neonates tonic clonic seizure is not reported [6].

In the socio demographic variables maternal age, gender, residence, and maternal occupation didn't show the association to neonatal seizure. However, the other study conducted in Californian indicated that the risk of seizures in neonates born to mothers aged ≥40 years was increased compared with neonates aged 25–29 years [12]. The study conducted in the Iran indicated that being male gender is associated with increased rate of neonatal seizure [19].

The odds of developing neonatal seizure were nearly six times higher in neonates admitted within 24 h of birth as compared to neonates 7–28 days old. This aligns with a study conducted in Landon [20], Kathmandu University in Dhulikhel [21], the University of Gonder in Ethiopia [13], and Dhaka Medical College in India [17]. This is because immediately after birth, neonates are challenged with an extra uterine environment and their organs such as the brain are not completely grown. This makes neonatal brains easily to be provoked when it is exposed to different factors [22,23].

Neonates delivered at the gestational age <32 weeks had a 2.89 times higher risk of developing neonatal seizure as compared to neonates delivered at gestational age >37 weeks. This is consistent with studies conducted in Sweden [24], United States of America [25], and Italy [26]. This is because more preterm neonate didn't complete their brain development such as cerebral and cerebellar parts, diminished cortical gyrification, and finally delayed maturation of gray,and white matter structures, which leads the brain not to function normally [27]. Additionally, this might be passive systemic/cerebral pressure, immature vasculature in the ependymal and presence of additional risk factors such as chorioamnionitis or necrotizing enter colitis or bronco pulmonary dysplasia etc.

The risk of having neonatal seizure was nearly five folds higher among neonates whose axillary body temperature was greater than 37.5 °C as compared to those neonates whose body temperature is normal. This finding is similar to a study in Iran [28] and Kynea [8]. This is because of inflammatory responses outside the central nervous system increase cytokine concentrations in the CNS through neuro-immune network, and the released cytokines in turn trigger neuronal hyper excitability in the central nervous system to generate convulsions [29].

Similarly, neonates with blood glucose level <40 gm/dl were five times more likely to develop neonatal seizure than neonates whose blood glucose level was between 40 gm/dl and 125 gm/dl. This finding is also in line with studies conducted in Iran [19], India [30].In fact, babies need sugar or glucose for energy source and most of the glucose in their body is being used up by their brains. If so, severe or prolonged hypoglycemia in a newborn exists, it can cause serious brain injury and the body to convulse [31].

The risk of having a neonatal seizure was 2.79 times higher in the neonates with sepsis as compared to neonates without sepsis. It is consistent with studies in India [30], Kenya [8]. This is due to the fact that some infections have ability to damage and passé blood brain barrier that increases the translocation of cytokines, carrying the proinflammatory response from the serum into the brain and favoring seizure susceptibility [32,33].

Lastly, the odds of occurrence of neonatal seizure among neonates with perinatal asphyxia were 8.25 times higher than its counterpart. Which was consistent with studies in Italy [34], in Ethiopia at university of Gonder [34],India [30].This due to when hypoxia and ischemia occurs, there is a cascade of events that cause a decrease in energy production in the brain. In turn that leads to an increase in an excitatory neurotransmitter called glutamate, which causes excessive activity in the cortex [35].

5. Limitations

The study might have reduced external validity since controls were not likely to be representative of the source population that produced the cases. The other limitation was the ward physicians only used history and physical examination to diagnose seizure rather than sophisticated investigations like CT scan and EEG due to unavailability in the facilities which reduces certainty of findings.

6. Conclusion and recommendation

The findings of this study indicated that among sociodemographic, maternal and neonatal factors; neonatal age, gestational age<32 weeks, body temperature >37.5 °C, blood glucose level <40 g/dl, neonatal sepsis, and perinatal asphyxia were significantly associated with neonatal seizure among neonates admitted to NICU of public hospitals in Awi zone hospitals. Therefore, health professionals who works in the NICU should better to give priority for those neonates admitted to NICU within 24 h than others and give close follow up and initiate early care. Great attention would also be given for those neonates delivered at gestational age of

≤32weeks. Additionally, health professionals should apply aseptic technique during caring neonates. Moreover, it is better to prevent low blood glucose level, fever and perinatal asphyxia. For researchers, it is better to do further on this title to proof the occurrence of tonic clonic seizure in the neonatal period.

Ethical approval

This study was conducted after getting ethical clearance from the ethical review committee of Injibara University, College of Medicine and Health Science with protocol number 326/2023. Following the approval, official letters of cooperation was given to the Hospital managers to get permission. After getting permission from them, the mothers were told that the information they gave to be treated with complete confidentiality and didn't cause any harm.Then informed verbal voluntary assent was obtained from each mother. Moreover, data collectors applied infection prevention techniques such as proper hand washing, gloving, and alcohol rubbing of instruments before touching neonates for the non-maleficent sake of the study.

Consent for publication

Not applicable.

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Data availability statement

All the data supporting the results were indicated in the manuscript and available in the library of Injibara University." However, the university doesn't have available repository on online and accession number. Raw data is attached as supplementary file.

CRediT authorship contribution statement

Tamiru Alene: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Tilahun Degu Tsega:** Formal analysis, Data curation, Conceptualization. **Tamene Fetene Terefe:** Visualization, Supervision, Methodology, Funding acquisition. **Nigatu Dessalegn:** Writing – review & editing, Visualization, Supervision, Software. **Zemenu Addis Alem:** Methodology, Investigation, Formal analysis, Conceptualization. **Workineh Tamir:** Funding acquisition, Formal analysis, Data curation. **Abrham Amare Tesfa:** Validation, Software, Formal analysis, Data curation. **Yefiru Andualem Mitiku:** Software, Resources, Project administration, Methodology. **Zewdu Bishaw Aynalem:** Writing – review & editing, Writing – original draft, Validation, Investigation, Formal analysis. **Workineh Necho Melaku:** Validation, Resources, Methodology, Funding acquisition. **Getachew Amare:** Project administration, Methodology, Investigation, Funding acquisition, Data curation. **Biresaw Wassihun Alemu:** Writing – review & editing, Writing – original draft, Software, Methodology.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Abbreviations

ANC	Antenatal Care
AOR	Adjusted Odd Ratios
BT	Birth Trauma
COR	Crude Odd Ratios
NICU	Neonatal Intensive Care Unit
ANC	Antenatal Care
PNA	Perinatal Asphyxia

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e32537.

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