Magnitude of Jaundice and Associated Factors among Neonates Admitted to Neonatal Intensive Care Unit in Eastern Ethiopia

Mitike Yohannes[1], Habtamu Bekele[2*], Yunus Endris[3], Adera Debella[2], Sisay Habte[2], Bikila Balis[2], and Tesfaye Assebe Yadeta[2]

[1]Hiwot Fana Comprehensive Specialized University Hospital, College of Health and Medical Sciences, Harmaya University, Ethiopia.

[2]School of Nursing and Midwifery, College of Health and Medical Sciences, Haramaya University, Ethiopia.

[3]School of Medicine, College of Health and Medical Sciences, Haramaya University, Ethiopia.

Abstract

Background: Neonatal jaundice is the most dangerous sign of neonatal illness. It is the most common cause of neonatal re-admission and mortality in South Asia and sub-Saharan Africa. However, there is limited information regarding neonatal jaundice in Ethiopia. Therefore, this study aimed to assess the magnitude of Jaundice and associated factors among neonates admitted to neonatal intensive care units in Eastern Ethiopia.

Methods: A facility-based cross-sectional study was conducted among newborns admitted to selected public hospitals in eastern Ethiopia from January 1/2019 to December 31/2020. The neonates' medical records were selected by systematic random sampling for examination. Data were collected using a structured checklist and analyzed SPSS version 20. Both bivariate and multivariable logistic regression analyses were used to identify factors associated with neonatal jaundice. A p-value of < 0.05 was used to declare a level of statistical significance.

Results: The magnitude of neonatal jaundice was 32 % (95% CI: 28.8, 35.8). Being preterm (AOR = 2.21; 95% CI:1.45, 3.38), Instrumental delivery (AOR = 2.23; 95% CI:1.11, 4.48), neonatal hypoglycemia (AOR=2.27, 95% CI: 1.35, 3.82), neonatal sepsis (AOR =2.13, 95%CI: 1.83, 4.38), ABO blood group incompatibility (AOR= 5.16; 95% CI:4.5, 13.71), and birth trauma (AOR = 2.23; 95% CI: 1.14, 4.34) were factors significantly associated with neonatal jaundice.

Conclusion: The magnitude of neonatal jaundice was found to be relatively high. Preventing and treating conditions like neonatal infection, birth trauma, and neonatal hypoglycemia can reduce the likelihood of neonatal jaundice.

Keywords: Neonatal Jaundice, Hyperbilirubinemia, NICU, Ethiopia.

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Introduction

Neonatal jaundice is a clinical disorder characterized by yellowish discoloration of the skin, sclera, and mucus membranes secondary to bilirubin accumulation (Mitra and Rennie, 2017). This is caused by increased production of bilirubin or limited bilirubin elimination (Kleigman, 2008). This increased bilirubin level in the blood leads to an increased risk for bilirubin-induced neurological dysfunction with a significant risk of neonatal death and lasting neurodevelopmental problems (Hameed *et al*., 2011; Maisels, 2015). It occurs in 60% of term and 80% of preterm newborns in the first weeks of life (Ullah *et al*., 2016).

Infants who survived severe neonatal jaundice might be complicated with long-term neurodevelopmental problems such as cerebral palsy, sensorineural hearing loss, intellectual difficulties, upward gaze palsy, seizure, gross dental dysplasia, and developmental delays in the survivors and death (Mwaniki *et al*., 2012; Maulik and Darmstadt, 2007). Neonatal jaundice is the most common cause of neonatal re-admission. It is also caused around 75% of neonatal mortality in South Asia and sub-Saharan Africa (Bhutani *et al*., 2013). Ethiopia ranked among the top ten countries with jaundice-related neonatal mortality (Csa, 2016). A study finding from Ethiopia showed that neonatal jaundice was one of the substantial forecasters of death among neonates under 7 days of age (Yismaw and Tarekegn, 2018).

Several studies reported that risk factors for neonatal jaundice vary in developed and developing countries varies (Brits *et al*., 2018; Richard and Pamela, 2011). In developed countries, feto-maternal blood groups incompatibilities (Yu *et al*., 2022), however, in developing countries, factors like prematurity, low birth weight, birth trauma, sepsis, and herbal medications

Corresponding Author; Email: habti.bekele@gmail.com

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during pregnancy were reported associated with neonatal jaundice (Olusanya *et al*., 2015; Garosi *et al*., 2016). In addition, studies from some hospitals in Ethiopia evidenced that prolonged labor, hypothermia, and sepsis are the most contributing factors to neonatal jaundice (Lake *et al*., 2019; Kassa *et al*., 2018; Bizuneh et al., 2020).

To confront this neonatal complication, the Ethiopian government tried to make phototherapy treatment accessible in hospitals. Currently, the Ethiopian government planned to minimize the neonatal mortality rate from 28/1000 live births to 11/1000 live births by 2035 (FMOH, 2015). Consequently, data related to the occurrence of neonatal jaundice and its determinants are vital. However, epidemiologically reliable prevalence and factors associated with neonatal jaundice were not well studied with adequate sample size and study. Therefore, this was aimed to assess the magnitude of jaundice and associated factors among neonates admitted to the Neonatal Intensive Care Unit (NICU) in Eastern Ethiopia.

Materials and Methods

Study Setting

The study was conducted in Hiwot Fana Comprehensive Specialized University Hospital (HFCSUH) found in Harari regional state and Dil Chora referral (DCRH) hospital of Dire Dawa city administration, Eastern Ethiopia from January 1, 2019, to December 31, 2020. Both hospitals provide level III (subspecialty) NICU services which have professional and essential equipment needed to give life support. According to the health management information system's two-year report, the estimated number of neonatal admissions to NICU were 3560 and 1920 for HFCSUH, and Dilchora referral hospital, respectively.

Study Design and Population

A retrospective cross-sectional study design was conducted on the medical records of neonates admitted to HFCSUH and DCRH. All medical records of neonates admitted to NICU at (HFCSUH) and DilChora Referral Hospital were considered as a

Inclusion and Exclusion Criteria

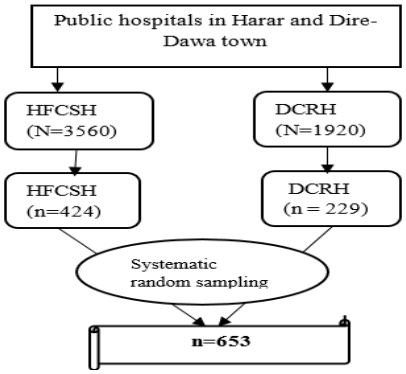
All medical records of neonates admitted to the NICU at HFCSUH and DCRH from 1st January 2019 to 31st December 2020 were included in the study. While, medical records with incomplete information, missing variables, and unknown diagnoses were excluded.

Sample Size Determination

The sample size was calculated using a single population using the proportion 44.9% neonatal jaundice report from a study conducted at Tikur Ambesa Specialized Hospital (Gudeta, 2017), 95% confidence interval, and 4% margin of error and 10% nonresponse rate. The final sample size was 653.

Sampling Technique

The sample size was proportionally allocated for both hospitals. The unique medical record number (MRN) of the neonates was obtained from the registration book and used to create the sampling frame. The total number of neonates during the study period in each hospital was divided by the total sample size assigned to each hospital to obtain the fixed periodic interval value which was eight (8th) for both hospitals. Then, a medical record was selected by systematic random sampling technique. The first medical record number (MRN) was selected by the lottery method. Then the rest MRN were selected using every interval value (Figure 1).



N; Total neonates admitted to NICU form1st January 2019 to 31st December 2020, n; sample size.

Figure 1: Schematic presentation of the sampling procedure for the study conducted on the magnitude and associated factors of jaundice among neonates admitted to NICU in Eastern Ethiopia, 2021.

Data Collection Techniques

Data were extracted from medical records by 12 BSc nurses using a structured and pretested checklist, which was developed by a review of different literature (Bogale *et al*., 2019; Gudeta, 2017; Bizuneh *et al*.,

2020a; Bizuneh *et al*., 2020). The data collection tool contains variables like socio-demographic (occupation, residency, age of mother), maternal\Obstetrics (parity, mode of delivery, gestational age, duration of labor, maternal chronic illness, time of delivery, place of delivery), hematological (rhesus factor incompatibility, ABO incompatibility, polycythemia), neonatal (sex of neonate, age of neonate, breastfeeding, birth weight, neonatal sepsis, birth trauma, birth asphyxia, hypoglycemia, and hypothermia).

Operational Definition

Neonatal jaundice: diagnosed through laboratory investigations (Total Serum Bilirubin= >12gm/dl for the term and >15gm/dl for a preterm infant) by physicians (General practitioners, pediatricians, and neonatologists) (Kleigman, 2008). Data on neonatal jaundice were labeled as "yes" and "no" later for analysis with codes 1 and 0, respectively.

Birth Trauma: is defined as an injury of neonates during labor and delivery which includes neonates admitted with Intra and extracranial hemorrhage, trauma of the scalp, musculoskeletal injury, and nerve injury which are diagnosed by a physician (Collins and Popek, 2018).

Neonatal sepsis: defined as the presence of one or more of the established Integrated Management of Newborn and Child Illness clinical features [either of fever (≥37.5 0C) or hypothermia (≤ 35.5 0C), fast breathing (≥60 breath per minute), severe chest in drawing, not feeding well, movement only when stimulated, convulsion, and lethargic or unconscious along with ≥ 2 of the hematological criteria, (total leukocyte count (12000 cells/m3, absolute neutrophil count (7500cells/mm3), Erythrocyte Sedimentation Rate (ESR) (>15/1 h), and platelet count (440 cells/m3) (Vergnano *et al*., 2005).

Data Quality Control

The data collection tool was pretested on 5% of the sample size. Then adequacy of the checklist was evaluated, and ambiguous questions were modified before the actual data collection period. In addition, training was given to data collectors and supervisors on the objective of the study, confidentiality of information, and data extraction before actual data collection. The completeness, accuracy, and consistency of the collected data were checked daily by supervisors and principal investigators. Furthermore, double data entry was done and a comparison was made to the original data.

Data Processing and Analysis

Data were entered into Epi-Data Version 3.1 computer software package and then exported to SPSS version 20 for analysis. Descriptive statistics like median, interquartile range, mean, standard deviation, and frequency were calculated. Then, the results were presented using frequency tables and figures. The magnitude of neonatal jaundice was determined as the proportion of those jaundiced among study participants. A multicollinearity test was checked using variance inflation factor. Bivariate and multivariable logistic regression was used to identify factors associated with neonatal jaundice. Variables with P ≤0.2 in the bivariate analysis were considered a candidate for multivariable logistic regression analysis. The final model was considered a good fit by the Hosmer-Lemeshow statistic (p=0.410). Variables with P-value <0.05 at a 95% confidence interval (CI) were declared statistical significance factors

Ethical Consideration

Ethical clearance was obtained from Haramaya University, College of health and medical Sciences Institutional Health Research Ethics Review Committee with the ethical number of HIRERC/093/2021.Letters of permission were written by the college to HFSCH and Dire-Dawa city administrative health bureau. The health bureau wrote an official letter of permission to Dilchora referral hospitals. An informed, voluntary, written and signed consent was obtained from the head of each hospital after clearly informing them about the purpose, risk, and benefit of the study. Confidentiality of information was maintained during data collection and data processing.

Results

Socio-demographic characteristics of mothers

In this study, a total of 640 selected neonates' medical records were included in the analysis making the response rate 98%. The median maternal age was 25 years with an interquartile range (IQR) of 9 years.

A total of 203 (33%), of the mothers, were between the ages of 20-24 years. The majority of mothers were from rural areas (65.9%), had ANC follow-up (73%), multi-parous (55.6%), singleton pregnancy (89.2%), and give birth through spontaneous vaginal delivery (71.2) (Table 1).

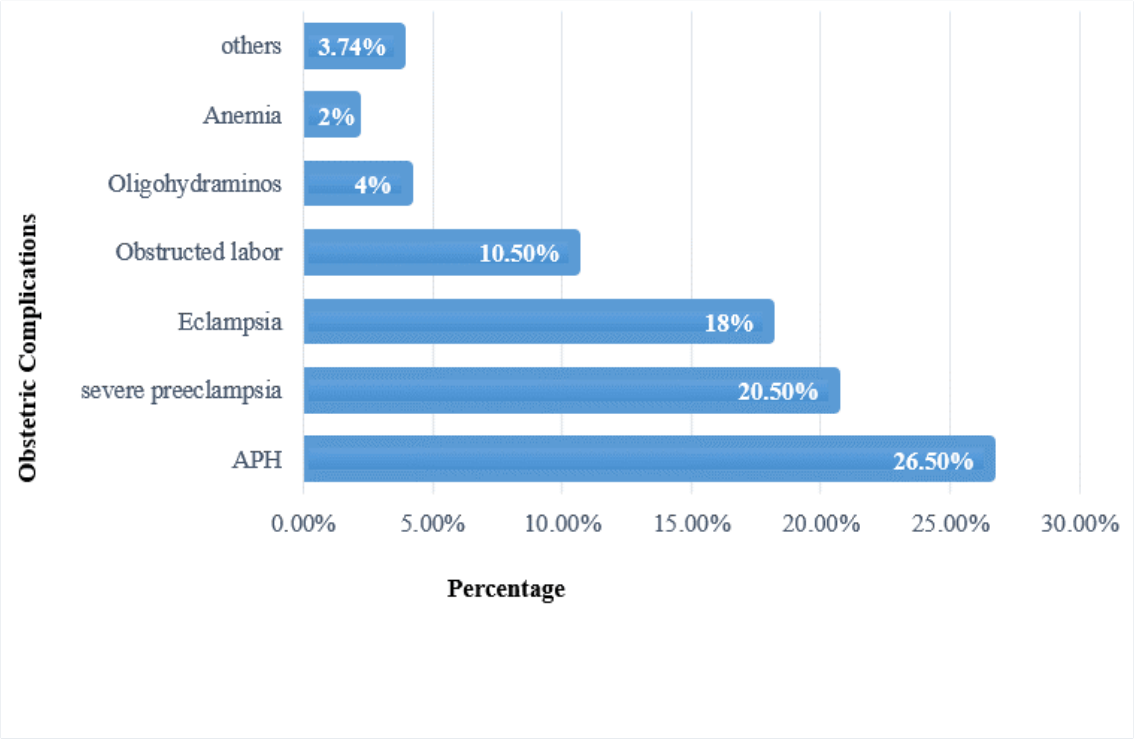
Table 1: Socio-demographic and Obstetrics-related characteristics of the mothers who gave birth to neonates admitted to HFCSH and DCRH, Eastern Ethiopia, 2020 (n=640).

Variable	Category	Frequency	Percent (%)
Age of the mother (by year)	15-19	70	10.9
	20-24	208	32.5
	25-29	192	30.0
	30-34	116	18.1
	≥35	54	8.4
Residence of mother	Urban	218	34.1
	Rural	422	65.9
Parity	Primiparous	284	44.4
	Multiparous	356	55.6
Type of pregnancy	Singleton	571	89.2
	Multiple	69	10.8
Chronic Medical Illness	Yes	13	2.0
	No	627	98
Mode of delivery	SVD	456	71.2
	C/S	130	20.3
	Instrumental	54	8.4
Place of delivery	Home	49	7.7
	Health center	77	12
	Hospital	514	80.3
Time of delivery	Day	368	57.5
	Night	272	42.5
ANC follow-up	Yes	467	73
	No	173	27
Number of ANC visits (n=467)	< 4	344	73.7
	≥4	123	26.3
	Preterm	193	30.1
Gestational age at delivery	Term	406	63.4
	Post-term	41	6.4
Prolonged duration of labor	Yes	105	16.4
	No	535	83.6
PROM	Yes	225	35.2
	No	415	64.8

SVD; Spontaneous Vaginal delivery, C/S; Caesarean Section, ANC; Antenatal care, PROM; Premature Rupture of the membrane, HFCSH; Hiwot Fana Comprehensive Specialized University Hospital, DCRH; Dil Chora Referal Hospita

Obstetric Complications during Pregnancy and Labor

A total of 203 (31.7%) mothers experienced a complication during pregnancy and labor. The three most commonly reported complications were antepartum hemorrhage (APH) (26.5%), severe preeclampsia (20.5%), and eclampsia (18%) (Figure 2).



Others; Chorioamnionitis, Meconium stained amniotic fluid, Nonreassuring fetal heart rate pattern, Mal-presentation, Previous cesarean scar, polyhydramnios, failed induction, APH: Antepartum hemorrhage

Figure 2: Obstetrical complications during pregnancy and labor of mothers who gave birth to Neonates admitted to HFCSH and DCRH, Eastern Ethiopia, 2020 (n=203).

Neonatal Characteristics

In this study, the median age of neonates at admission was 24 hours with an interquartile range of 92 hours. About 48.9% of neonates' age at admission lies between 24-168 hours. The majority of neonates were male (61.3%). The mean birth weight was 2596g (SD+/- 718g). Moreover, a low Apgar score was recorded for 94 (29.7%) neonates in the 5th minute. About 58 (9.1%) of neonates had birth trauma. In addition, 218 (34.1%), 123 (19.2%), and 18 (2.8%) of them had neonatal sepsis birth asphyxia, and polycythemia, respectively **(Table 2).**

Neonatal blood group, Rhesus Factor Incompatibility, and level of Serum Bilirubin

In this study around 88 (13.8%), 36 (5.6%), and 205(32%) encountered ABO blood group incompatibility, RH factor, and total serum bilirubin level > 12 g/dl, respectively (Table 3).

Table 2: Characteristics of neonates admitted at HFCSH and DCRH, Eastern Ethiopia, 2020 (n=640)

Variable	Category		Frequency	Percent
Age of the neonates at admission (hour(s)	< 24		233	36.4
	24- 168		313	48.9
	≥ 168		94	14.7
Neonatal sex	Male		392	61.2
	Female		248	38.8
Birth weight recorded (g) (n=612)	>/=2500		376	60.5
	<2500		236	38.6
5th minute APGAR score documented	Yes		317	49.5
	No		323	50.5
APGAR score on 5th minute (n=317)	<6		94	29.7
	7-10		223	70.3
Birth Trauma	Yes		58	9.1
	No		582	90.9
Neonatal sepsis	Yes		218	34.1
	No		422	65.9
Birth Asphyxia	Yes		123	19.2
	No		517	80.8
Neonatal Hypothermia	Yes		166	25.9
	No		474	74.4
Neonatal	Yes		94	14.7
Hypoglycemia	No		546	85.3
Polycythemia	Yes		18	2.8
	No		622	97.2
Feeding options	Breastfeeding	Yes	468	73.1
		No	172	26.9
	Formula	Yes	63	9.8
	feeding	No	577	90.2
	Mixed	Yes	36	5.6
		No	604	94.4
Neonatal Outcome	Improved		544	85
	Dead		87	13.6
	Referred to other health facilities		9	1.4
Length of stay at the hospital (day(s))	<7		414	64.7
	≥7		226	35.3

LBW; Low Birth weight, APGAR= Appearance Pulse Grimace Activity Respiration

Table 3: Blood grouping, RH, and level of serum bilirubin among neonates admitted at HFCSH and DCRH, Eastern Ethiopia, 2020 (n=640)

Variable	**Category**	**Frequency**	**Percent**
ABO incompatibility	Yes	88	13.8
	No	552	86.3
RH incompatibility	Yes	36	5.6
	No	604	94.4
Total serum bilirubin recorded (g/dl)	<12l	435	67.9
	>/= 12	205	32.0

Magnitude of Neonatal Jaundice

The magnitude of neonatal jaundice was 32 % (205/640), (95% CI: 28.8, 35.8).

Factors associated with neonatal Jaundice

The age of the mother, history of maternal chronic medical illness, type of pregnancy, obstetric complication, mode of delivery, gestational age, neonatal hypoglycemia, neonatal sepsis, neonatal sex, ABO blood group incompatibility, and history of birth trauma were associated with neonatal jaundice in the bivariable model at P-value 0.2 and were a candidate for multivariable logistic regression analysis.

In multivariable logistic regression factors like mode of delivery, gestational age, neonatal hypoglycemia, neonatal sepsis ABO blood group, and history of birth trauma were significant factors associated with neonatal jaundice at P-value <0.05. Neonates born with the mother, the age category of 25-29 years was 2.26 more likely to develop jaundice (AOR =2.26; 95% CI: 1.08, 4.75). The neonates with hypoglycemia were 2.27 times more likely (AOR=2.27; 95% CI: 1.35, 3.82) to develop jaundice compared to their counterparts. In addition, neonates born with the instrumental mode of delivery were 2.23 times more likely (AOR=2.23; 95% CI: 1.31, 4.48) to develop jaundice compared to neonates born by spontaneous vaginal delivery. Neonates with sepsis were 2.13 times (AOR =2.13; 95%CI: 1.83, 4.38) more likely to develop jaundice compared to neonates without sepsis. On the other hand, preterm neonates were 2.21 times (AOR = 2.21; 95% CI 1.45, 3.38) more likely to develop jaundice compared to term neonates. Furthermore, neonates with birth trauma and ABO blood group were 2.23 and 5.16 times more likely to develop jaundice compared to their counterparts respectively (Table 4).

Table 4: Factors associated with neonatal jaundice at HFCSH and DCRH, Eastern Ethiopia, 2020 (n=640).

Variable	Category	Neonatal jaundice		COR (95% CI)	AOR (95% CI)
		YES (%)	NO (%)		
Age of mother	15-19	13 (18.6)	57 (81.4)	1	
	20-24	69 (33.2)	139 (66.8)	2.17 (1.11, 4.27)	1.59 (0.75, 3.37)
	25-29	73 (38)	119 (62)	2.69 (1.37, 5.25)	2.26 (1.08, 4.75)*
	30-34	33 (28.4)	83 (71.6)	1.74 (0.84, 3.59)	1.29 (0.57, 2.89)
	≥35	17 (31.5)	37 (58.5)	2.01 (0.87, 4.63)	1.11 (0.43, 2.87)
History of maternal	Yes	8 (61.5)	5 (38.5)	3.49 (1.12, 10.8)	2.87 (1.75, 10.8)
chronic medical illness	No	19 7(31.4)	430 (68.6)	1	
Type of pregnancy	Single	174 (30.5)	397 (69.5)	1	
	Multiple	31 (44.9)	38 (55.1)	1.86 (1.12, 3.08)	1.20 (0.66, 2.18)
Obstetric complication	Yes	79 (39.1)	123 (60.9)	1.59 (1.12, 2.25)	1.24 (0.79, 1.94)
	No	126 (28.8)	312 (71.2)	1	
Mode of delivery	SVD	141 (30.1)	315 (69.9)	1	
	C/S	39 (30)	91 (70.0)	0.95 (0.62, 1.46)	0.84 (0.49, 1.43)
	Instrumental	25 (46.3)	29 (53.7)	1.92 (1.08, 3.47)	2.23 (1.11, 4.48)*
Gestational age	Term	111 (27.3)	295 (72.7)	1	
	Preterm	78 (40.4)	115 (59.6)	1.80 (1.25, 2.58)	2.21 (1.45, 3.38*)
	Post-term	16 (39.0)	25 (61.0)	1.70 (0.87, 3.30)	1.33 (0.57, 3.10)
Neonatal	Yes	47 (50.0)	47 (50.0)	2.45 (1.57, 3.83)	2.27 (1.35, 3.82*)
Hypoglycemia	No	158 (28.9)	388 (61.1)	1	
Neonatal Sepsis	Yes	83 (38.0)	135 (62.0)	2.38 (1.60, 3.44)	2.13 (1.83, 4.38)*
	No	87 (20.4)	335 (79.3)	1	
Sex of neonate	Male	142 (36.2)	250 (63.8)	1.66 (1.17, 2.37)	0.72 (0.48, 1.09)
	Female	63 (25.4)	185 (74.6)	1	
ABO incompatibility	Yes	62 (70.5)	26 (29.5)	6.82 (4.15, 11.19)	5.16 (4.50,13.71)*
	No	143 (25.9)	409 (74.1)	1	
Birth trauma	Yes	25 (43.1)	33 (56.9)	1.69 (1.29, 2.92)	2.23 (1.14, 4.34)*
	No	205 (32)	435 (68.0)	1	

CI; Confidence Interval, COR; Crude Odds Ratio, AOR; Adjusted Odds ratio, SVD; Spontaneous Vaginal delivery, C/S; Caesarean Section

Discussion

In this study, the magnitude of neonatal jaundice was 32% (95 CI: 28.8, 35.8). Hypoglycemia mode of delivery, gestational age, hypoglycemia, neonatal sepsis, ABO incompatibility, and history of birth trauma were significantly associated factors with jaundice.

This study indicated the overall magnitude of neonatal jaundice to be 32%. This means one out of three neonates in NICU admission is complicated by neonatal jaundice. The finding from this study was consistent with studies done in Ghana 32.9% (Oppong, 2019), Nigeria 35% (OnyearughaCN, 2011), and Gondar referral hospitals 31.7% (Kokeb and Desta, 2016), But it was lower than studies conducted in Bloemfontein, South Africa (55.2%) (Brits *et al*., 2018), Rwanda (44.3%) (Murekatete Claudin, 2020) and Addis Ababa (44.9%) (Gudeta, 2017). The finding was also higher than studies conducted in Nigeria (19.6%) (Oteikwu Ochigbo, 2016), Southern Nigeria (17.9%) (Omekwe *et al*., 2014), and Addis Ababa (13.3%) (Girma and Haile, 2020). This discrepancy might be due to the difference in sample size, level of health facility, and variation in coverage of neonatal and obstetrics care.

This study identified preterm neonates were 2.21 times more likely to develop neonatal jaundice compared to term neonates. A similar finding was reported in a study conducted at Jimma medical center (Asaye *et al*., 2022). This is because, in comparison to neonates born at term, preterm newborns have immature hepatic, gastrointestinal, and red blood cell development. When bilirubin reaches the liver, it binds and travels through the bile duct into the digestive system to be excreted. Bilirubin excretion requires mature hepatic cells and the gastrointestinal tract. Preterm newborns are likely more likely to have immature hepatic cells and gastrointestinal tracts, which further adds to the buildup of bilirubin. On the other hand, preterm neonates are more likely to suffer sepsis, which may also contribute to neonatal jaundice. (Amin and Wang, 2018).

In addition, this study showed that neonates with hypoglycemia were 2.27 times more likely to develop jaundice when compared to neonates without hypoglycemia. This finding was supported by the study conducted in Addis Ababa, Ethiopia (Gudeta, 2017). This might be due to the fact, that neonates with hypoglycemia can develop cholestasis with conjugated hyperbilirubinemia. It is known liver plays an important role in the maintenance of the blood sugar level. The impairment of hepatic function could have resulted in increasing serum bilirubin levels (Machado *et al*., 2011).

On the other hand, this study found neonates who had sepsis were 2.13 times more likely to develop neonatal jaundice compared to those neonates who had no sepsis diagnosis. This finding is in line with studies reported in Nigeria, Ghana, Rwanda, India, and Ethiopia (Omekwe *et al*., 2014; Oppong, 2019; Murekatete *et al.*, 2020; Lake *et al*., 2019; Girma and Haile, 2020; Gutta *et al*., 2019). This might be because sepsis might cause hemolysis of red blood cells and hepatic dysfunction that leads to the accumulation of serum bilirubin in the body. Moreover, neonates who have sepsis are expected to develop high levels of bilirubin from increased hemolysis and defective conjugation of bilirubin. A cytokine which is a response from the inflammatory response can also lead to disruption in bilirubin regulation (Williams and Wilkins, 2005).

Moreover finding from this study revealed that neonates with the ABO blood group were 5.16 times more likely to develop neonatal jaundice. This was supported by the finding from studies conducted in Iran, India, Nigeria, Mekelle, Addis Ababa, and Gonder (Oteikwu Ochigbo, 2016; Lake *et al*., 2019; Gudeta, 2017; Bogale *et al*., 2019; Ali and Tomar, 2015; Najib *et al*., 2013). Blood group incompatibility between the mother and baby is also a reason to track the newborn's jaundice more closely. This exists when a mother has the blood type O (which means having antibodies against A and B cells) and her newborn is of blood type A or B. This may lead to the newborn's red blood cells breaking down more quickly due to maternal antibodies that have leaked into the baby's bloodstream (Chib and Bhandari, 2016).Furthermore, this study revealed that neonates who were born by instrumental mode of delivery were 2.3 times more likely to develop neonatal jaundice compared to those neonates who were born by spontaneous vaginal delivery. This is caused by bruise when a blood leaks out of blood vessels. This might be because of instrumental delivery, especially vacuum extractor

risk of trauma to the fetal head compared to spontaneous vaginal birth. However, a study from Iran showed that delivery by caesarian section was highly associated with neonatal jaundice compared to spontaneous vaginal delivery (Naghipour *et al*., 2020).

This study also found that birth trauma was another significant factor for neonatal jaundice. This finding is in line with studies conducted in Japan, Gonder, and Addis Ababa (Shinohara and Kataoka, 2021; Bogale *et al*., 2019; Girma and Haile, 2020). This occurs as a result of red blood cell lysis in these extravascular spaces secondary to cephalohematoma and subgaleal hemorrhage (Boskabadi *et al*., 2020). This might be attributed to bruising and swelling of the scalp of newborns due to the excessive pressure applied by birth attendants as management for prolonged labor which in turn increases the risk of jaundice by increasing bilirubin levels in the blood (Shinohara and Kataoka, 2021).

The study tried to utilize an adequate sample size to ensure representativeness. However, it was difficult to detect the contribution of Glucose-6-phosphate dehydrogenase deficiency to neonatal jaundice due to the lack of routine screening for this enzyme deficiency in both hospitals. In addition due to the nature of the study design which is cross-sectional, the study might not show a cause-and-effect relationship.

Conclusion

This study showed that the magnitude of neonatal jaundice was found to be high. Obstetric and neonatal factors like gestational age, neonatal hypoglycemia, neonatal sepsis, delivery mode, birth trauma, and ABO group incompatibility were factors associated with neonatal jaundice. Therefore clinicians should provide careful intrapartum and postpartum care which helps to prevent neonatal jaundice secondary to the birth process. Early identification and intervention on neonatal factors like neonatal sepsis, birth trauma, and neonatal hypoglycemia can minimize the chance of neonatal jaundice occurrence. A blood test during pregnancy could have helped to delineate jaundice secondary to blood group incompatibility for neonates who were born from “O” blood type mothers. Further studies involving Glucose-6-phosphate dehydrogenase deficiency tests also recommended

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Competing interests

The authors declare that they have no competing interests.

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Authors' Contributions

MYG: conceptualization, methodology, software, formal analysis, writing the original draft. TAY, YE, and HB provided general guidance on the overall study progress and participated in reviewing the proposal, reviewing the analysis, and manuscript writing. SH, BB, and AD participated in reviewing the whole document and preparation of the manuscript. All authors read and approved the final manuscript and are accountable for all aspects of the work.

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