ADDIS ABABA UNIVERSITY
COLLEGE OF HEALTH SCIENCES
SCHOOL OF NURSING AND MIDWIFERY
DEPARTMENT OF NURSING

SURVIVAL STATUS AND PREDICTORS OF MORTALITY AMONG NEONATES ADMITTED WITH HYPERBILIRUBINEMIA IN NEONATAL INTENSIVE CARE UNITS OF PUBLIC HOSPITALS IN ADDIS ABABA, ETHIOPIA, 2023.

BY: TEREFE KETO (BSc)

A THESIS SUBMITTED TO ADDIS ABABA UNIVERSITY, COLLEGE OF HEALTH SCIENCES, SCHOOL OF NURSING AND MIDWIFERY, DEPARTMENT OF NURSING IN PARTIAL FULFILLMENT OF MASTERS OF SCIENCE DEGREE IN PEDIATRICS AND CHILD HEALTH NURSING.

MAY 2023
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APPROVAL SHEET

ADDIS ABABA UNIVERSITY

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SCHOOL OF NURSING AND MIDWIFERY

DEPARTMENT OF NURSING

I, the undersigned MSc student, declare that I have submitted my original work on a title survival status and predictors of mortality among neonates admitted with hyperbilirubinemia in neonatal intensive care units of public hospitals in Addis Ababa, Ethiopia, 2023 for the examination.

Submitted by:

Terefe keto _____ _____

Name of student Date Signature

This thesis work has been submitted for examination with my approval as an advisor.

Approved by:

1. Dr. Fekadu Aga _____ _____

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APPROVAL BY THE BOARD OF EXAMINATION

This thesis by Terefe Keto Malo is accepted in its present form by the board of examiners as satisfying the thesis requirement for the degree of master in pediatrics and child health Nursing.

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STATEMENT OF DECLARATION

By my signature below, I declare and affirm that this thesis is my own work. I have followed all ethical principles of scholarship in the preparation, data collection, data analysis and completion of this thesis. All scholarly matter that is included in the thesis has been given recognition through citation. I affirm that I have cited and referenced all sources used in this document. Every effort has been made to avoid plagiarism in the preparation of this thesis.

This thesis is submitted in partial fulfillment of the requirement for a graduate degree from the Addis Ababa University at College of Health Sciences, School of Nursing and Midwifery, department of Nursing. The thesis is deposited in the Addis Ababa University Digital Library and is made available to local, national and international scientific community. I solemnly declare that this thesis has not been submitted to any other institution anywhere for the award of any academic degree, diploma or certificate.

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ACRONYMS AND ABBREVIATION

AAU	Addis Ababa University
AHR	Adjusted Hazard Ratio
ABE	Acute bilirubin encephalopathy
ABO	Blood groop A, B, AB and O
ANC	Antenatal care
AOR	Adjusted Odd Ratio
APGAR	Appearance, pulse, grimace, activity, respiration
BMI	Body mass index
CFR	Case fatality rate
CI	confidence interval
EDHS	Ethiopian Demographic and Health Survey
FMOH	Federal ministry of health
G-6PD	Glucose-6-Phosphate Dehydrogenate
HDN	Hemolytic Disease of New Born
HMIS	Health Management Information System
IQR	Inter-quartile range
Mg/dl	milligram per deciliter
NH	Neonatal hyperbilirubinemia
NICUs	Neonatal Intensive Care Units
NMR	Neonatal Mortality Rate
NNJ	Neonatal jaundice
PI	principal investigator
Rh	Rhesus factors
RR	Relative Risk
SDG	Sustainable Development goal
TASH	Tikur Anbesa Specialized Hospital
TSB	Total serum bilirubin

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ABSTRACT

Background: Neonatal jaundice is a major cause of neonatal intensive care unit admission and is one of the leading causes of morbidity in neonate. However, little is known about the time to death and its predictors among neonates with hyperbilirubinemia. Therefore, this study aimed to assess survival status and predictors of mortality among neonates admitted with hyperbilirubinemia in neonatal intensive care units of public hospitals in Addis Ababa.

Methods: This retrospective cohort study was conducted in public hospitals in Addis Ababa, Ethiopia, and included 380 neonates admitted with hyperbilirubinemia from January 2021 to December 2022. The data was collected from patient cards using a simple random sampling method with a pretested checklist between March 16 and April 16, 2023. Data entry was performed using Kobo toolbox, and analysis was conducted using SPSS version 26. Kaplan Meier analysis was used to estimate the median survival time and cumulative probability of survival, while the logrank test was used to compare survival curves among different predictor groups. The relationship between independent and outcome variables was analyzed using the Cox proportional hazard regression model, with statistical significance set at a p-value of <0.05 and a 95% confidence interval.

Results: The overall incidence density of mortality was 18 per 1000 person-day observations (CI: 13-25) with 1980 follow-up days. Several factors were identified as significant predictors of mortality, including maternal age below 20 years (AHR = 18.2, 95% CI: 3.2–102.7), living in a rural area (AHR = 4.16, 95% CI: 1.64-10.52), premature rupture of membranes (AHR = 3.49, 95% CI: 1.14-10.66), gestational age below 37 weeks (AHR = 7.3, 95% CI: 1.84-28.8), birth weight below 2500gm (AHR = 15.1, 95% CI: 3.85-59.5), requiring both phototherapy and exchange blood transfusions (AHR = 48.6, 95% CI: 7.30-323.4), and presence of sepsis (AHR = 3.03, 95% CI: 1.17-7.9).

Conclusion: The neonatal mortality among neonates admitted with hyperbilirubinemia in Addis Ababa hospitals is high. This suggests that there is a room for improvement in order to meet the 2030 WHO target of 12 or less deaths per 1,000 live births. Therefore, special emphasis should be given for neonates who were born from mother whose age is <20 years and from rural settings, present with PROM and neonates with GA <37 weeks, Birth weight <2500gm and neonates with sepsis.

Keywords: Addis Ababa, Neonatal hyperbilirubinemia, Neonate, Survival Status, Neonatal Jaundice, Predictors

CHAPTER ONE: INTRODUCTION

1.1. BACKGROUND INFORMATION

Hyperbilirubinemia is a prevalent condition affecting a significant proportion of newborns, with approximately 60% of term and 80% of preterm neonates being affected(1). Bilirubin is produced as a byproduct when red blood cells undergo breakdown. Because bilirubin is difficult for newborns to eliminate, it can accumulate in their blood and other body fluids and tissues, leading to hyperbilirubinemia(2). Jaundice, or neonatal hyperbilirubinemia, is characterized by the yellowish discoloration of the skin, sclera, and mucous membranes due to bilirubin accumulation. This condition occurs when bilirubin level in the blood exceeds 85 μmol/L (5 mg/dl)(3).

Bilirubin is not just an insignificant molecule causing severe outcomes; rather, bilirubin, including uric acid, plays a crucial role as an antioxidant in the biological system of newborns(4). However, as bilirubin levels increase, there is a potential risk of neurological toxicity or bilirubin encephalopathy, which encompasses acute and chronic forms of brain dysfunction(5).

Acute bilirubin encephalopathy can range from mild symptoms such as weak suction to severe neurological involvement characterized by deep stupor and opisthotonos. Conversely, chronic encephalopathy or kernicterus is a severe neurological disorder distinguished by athetoid cerebral palsy, oculomotor paresis, dental enamel dysplasia, and auditory neuropathy(6).

Neonatal hyperbilirubinemia can result from various causes, including blood group incompatibility (most commonly Rhesus or ABO incompatibility), hemolysis (breakdown of red blood cells), sepsis (infection), liver disease, bruising, and metabolic disorders. In certain ethnic groups, a hereditary deficiency of the enzyme glucose-6-phosphate-dehydrogenase can also lead to severe neonatal hyperbilirubinemia. Consequently, severe newborn jaundice risk factors are potentially modifiable, particularly in developing nations(7).

Neonatal jaundice can be categorized into two forms: conjugated and unconjugated. Unconjugated jaundice further categorizes into physiological and pathological jaundice. The physiological jaundice generally appears around the 2nd or 3rd days of life, peaks around the 5th day, and

resolves within 10 days. In physiological jaundice, the serum bilirubin levels are usually below 12 mg/dL (204 μmol/L)(4).

Pathological jaundice, however, manifests in sick infants who exhibit jaundice in the 1st 24 hours of life. In pathological jaundice, the TSB levels exceed 12 mg/dL (204 μmol/L) in term infants or increase by greater than 5 mg/dL (85 μmol/L) per day in preterm neonates. The characteristic feature of pathological jaundice are high levels of conjugated bilirubin, clinical jaundice lasting more than 2 weeks, and evidence of hemolysis. Risk factors for pathological jaundice include a sibling history of neonatal jaundice, maternal diabetes, maternal use of certain medications, prematurity, birth weight(low), male gender, specific ethnicities, and geographical location(4).

The degree of jaundice visibility differs based on an individual's skin tone and specific body area. Typically, jaundice becomes visible in the sclera at bilirubin levels of 2-3 mg/dL and on the face at around 4 to 5 mg/dL. Jaundice tends to progress from the head to the feet as bilirubin levels rise, first at the umbilicus at bilirubin levels of approximately 15 mg/dL and reaching the feet at around 20 mg/dL(8). Neonates with hyperbilirubinemia typically exhibit prominent symptoms such as yellowing of the skin and sclera, along with hepatosplenomegaly, which refers to the enlargement of the liver and spleen(9).

Phototherapy & exchange transfusion has significantly reduced the occurrence of acute & chronic bilirubin encephalopathy. Preventive measures for Rh isoimmunization, such as the use of immunoglobulin, along with the effectiveness of phototherapy, have greatly reduced the necessity for exchange transfusion, an invasive and not entirely risk-free procedure(4, 10).

1.2. STATEMENT OF THE PROBLEMS

During 2016, globally 2.6 million newborns were died and a notable portion of these occurred in Pakistan, India, Democratic Republic of Congo, Nigeria and Ethiopia. Among the causes, bilirubin encephalopathy and Rh disease were responsible for over 22% of these fatalities, with and South Asia and Sub-Saharan Africa facing the greatest burden at 39% and 35% respectively (11, 12).

Neonatal jaundice (NNJ) is a major reason for hospital admissions to neonatal intensive care units (NICUs), comprising 75% of readmissions within the 1st week of lives (13, 14), and it is a leading cause of morbidity in neonatal intermediate care units(15). It affects approximately 50%-60% of full-term newborns & 80% of preterm newborns during the 1st week of lives(8).

Severe neonatal jaundice contributes to a significant percentage of neonatal mortalities in various countries, including 30.8% in the India, 14% in Kenya, 34% in Nigeria, 2.8% in UK, and 6.7% in Egypt(16). Each year, approximately 1.1 million babies worldwide suffer from severe hyperbilirubinemia, whether accompanied by bilirubin encephalopathy or not. These cases mainly occur in sub-Saharan Africa & South Asia, where severe hyperbilirubinemia ranks as the 7th and 8th leading cause of neonatal mortalities, respectively(17). The mortality rate associated with severe neonatal hyperbilirubinemia/jaundice is 1.19/1000 live births in LMICs, but significantly lower at 0.01 in high-income countries(18).

Approximately 24 million neonates are born each year worldwide are at risk of complications due to hyperbilirubinemia. Despite the preventability of kernicterus with timely treatment, 114,000 infants die annually from hyperbilirubinemia, and over 63,000 infants live with permanent neurological impairments. According to a systematic review and meta-analysis, a significant portion of the morbidity and mortality associated with severe neonatal jaundice is occurs in the Sub-Saharan Africa and South Asia regions(19).

Jaundice-related complications contribute to a substantial burden of neonatal deaths in Ethiopia(18). A study done at Gonder University revealed that jaundice accounted for 103 (31.7%) neonatal admissions and 33 (32%) deaths(20). In a study conducted in Tikur Anbessa Hospital, out of 356 neonates, 160 (44.9%) had hyperbilirubinemia as their primary diagnosis. Eleven

(6.9%) of the newborns out of these experienced bilirubin encephalopathy(21). In another study conducted to determine the survival status and predictors of mortality among preterm neonates at the teaching hospital of Mizan Tepi University, Jaundice has contributed to 24.3% of neonatal deaths among jaundiced neonates(22). Developed countries have established robust systems for identifying, investigating, and managing the issue. However, in economically disadvantaged nations, further studies and development are necessary to tackle the problem effectively(8).

The WHO's Sustainable Development Goal (SDG3.2) aims to eliminate preventable deaths among newborns by 2030. As part of this goal, it is recommended that all countries work towards reducing the neonatal mortality rate (NMR) to a level no higher than 12 deaths per 1000 live births(23). Currently, the Ethiopian government targeted to decrease the NMR and to end all preventable child deaths by 2035(24). To succeed in this plan, data related to the survival status & predictor of mortality among neonates with hyperbilirubinemia are crucial. However, little is known about the time to death & its predictors among neonates with hyperbilirubinemia. Therefore, this aimed to study was to assess the survival status & predictor of mortality among neonates with hyperbilirubinemia admitted in the NICU of government hospitals in Addis Ababa.

1.3. SIGNIFICANCE OF THE STUDY

The main objective of this study was to evaluate the survival status and identify factors that predict neonatal mortality in infants diagnosed with hyperbilirubinemia. The findings of the study will serve as valuable information for healthcare professionals, enabling them into the identification of common predictors of neonatal mortality associated with hyperbilirubinemia. This knowledge will help address the challenges of early diagnosis & management.

Additionally, these results will aid in the development of appropriate interventions and strategies. Furthermore, this study will contribute to the advancement of nursing knowledge, practice, and promote nursing education and research.

Moreover, decision-makers, program implementers, monitors, and evaluators in the healthcare sector will benefit from the findings, as they can utilize them to enhance maternal and newborn care practices. Additionally, it will serve as a scientific reference for future research endeavors in related fields.

CHAPTER TWO: LITERATURE REVIEW

2.1. The magnitude of neonatal mortality among neonates with hyperbilirubinemia

According to the data from the 2016 Global Burden of Disease report, jaundice was identified as the seventh highest burden in SA, eighth in SSA, and ninth globally among various causes of child mortality. In specific regions, it ranked 13th in North America, 15th in Western Europe, and 21st in North America as a main cause of mortality in children under 5 years. These rankings were based on an analysis of over 100 causes of child mortality worldwide(25).

In a prospective cohort study conducted in Bangladesh, it was found that 15.7% of infants presented with neonatal jaundice (NJ). Among these infants, 2.8% developed kernicterus, a severe form of bilirubin-induced brain damage. Tragically, 5 infants with kernicterus died, resulting in a case fatality rate (CFR) of 55.6%(26). A similar study conducted in Bangladesh found that among the admitted neonates, 5.9% developed severe jaundice, and a small proportion (0.2%) experienced jaundice-associated deaths, resulting in a case fatality rate (CFR) of 3.9% (27).

According to hospital statistics in Myanmar in 2013, neonatal hyperbilirubinemia accounted for 46% of hospital admissions and was a significant contributor to neonatal morbidity and mortality(18). A prospective cohort study conducted in Brazil examined the short-term survival of neonates diagnosed with hyperbilirubinemia. In this study, the incidence rate of hyperbilirubinemia during the follow-up period was 82, with a relative risk (RR) of 90.1% and a daily incidence rate of 34.17% (28). Out of the total cases (n = 97), the majority occurred during the initial three days, with a median diagnostic survival time of 2 days (95% CI: 2-2)(34)(28).

During the follow-up period, the highest prevalence of neonatal hyperbilirubinemia was observed on the third days of life, followed by a gradual decline until the seventh day. Newborns diagnosed with hyperbilirubinemia had lower gestational ages than those without the diagnosis (243.2 vs. 259.8). The study also reported a survival probability of 4.1% for newborns diagnosed with neonatal hyperbilirubinemia. The risk ratios (RR) in relation to neonatal jaundice indicated that yellow-orange skin color had the highest associated risk (RR = 8.08), followed by yellow mucous membranes (RR = 2.05). Additionally, female gender was also identified as a factor associated with a slightly increased risk (RR = 1.36)(28).

An observational cohort study conducted in Turkey between 2017-2018 found that among 3200 infants admitted in the NICU, 115 suffered from severe hyperbilirubinemia and 7% of them have died (29). In Thailand, a study involving 1,710 neonates revealed that 22% of them developed neonatal hyperbilirubinemia (NH), with 83% of cases occurring in preterm infants and 19% in term infants. This resulted in an overall incidence rate of 249/1,000 live births (95% CI: 225, 403). Among those with severe NH, reaching the threshold of 5.3%, the mortality rate from acute bilirubin encephalopathy was 10%. Additionally, it was found that around one-quarter (26.3%) of NH cases occurred within the 1st 24 hours(29).

A study conducted in Pakistan at a tertiary care hospital revealed that out of 300 neonates with hyperbilirubinemia, only 42 (14.0%) were diagnosed with Acute Bilirubin Encephalopathy (ABE). Among these cases, 17 (5.7%) had mild ABE and 25 (8.3%) had moderate ABE(30). Another study done Egypt l reported a CFR of 22.4% among infants with ABE (31). A separate study in a Kenyan hospital reported a CFR of 14.3% among infants with SNJ (32).

In a study conducted in Uganda, the prevalence of significant hyperbilirubinemia was 22.7% with a CFR of 20% (33). In Nigeria, a study reported an incidence rate of 25 per 1000 admitted newborns for severe hyperbilirubinemia, with various signs and symptoms observed (34). The result of this study showed that, the earliest indications of severe hyperbilirubinemia in newborns were; refusal to suck (15.2%) and depressed primitive reflexes (24.5%). Additionally, the most commonly observed signs were a high-pitched cry (11.9%), stiffness (6.9%), vomiting and convulsions(6.3%)(34). In Gonder city, 28.8% of neonates died, and jaundice was significantly associated with the preterm neonates death(35).

A systematic review and meta-analysis conducted in Ethiopia revealed that the prevalence of neonatal Jaundice was 30.96%[95% CI: 16.61%–45.31%] (36). Another study conducted in Ethiopia to assess hyperbilirubinemia in preterm infants admitted to NICUs found that among a total preterm neonates who developed hyperbilirubinemia, 25 were <28weeks and of these, 40.0% survived and 60.0% of them were died (37).

In a prospective cohort study conducted in northwest Ethiopia, to determine the incidence and predictors of neonatal jaundice, the length of follow-up time during the admission period, ranges from 3 hours to 28 days. The overall rate of neonatal jaundice was 4.5 per 100 person-hours. All

admitted neonates received phototherapy as a treatment method, while none of them required blood transfusion exchange(38).

2.2. CONCEPTUAL FRAMEWORK

The researcher developed this conceptual framework after reviewing literature sources in the topic area (39-46). The diagram shows the hypothesized relationship between maternal medical factors, maternal obstetric factors, socio-demographic factors, neonatal factors and survival of hyperbilirubinemia.

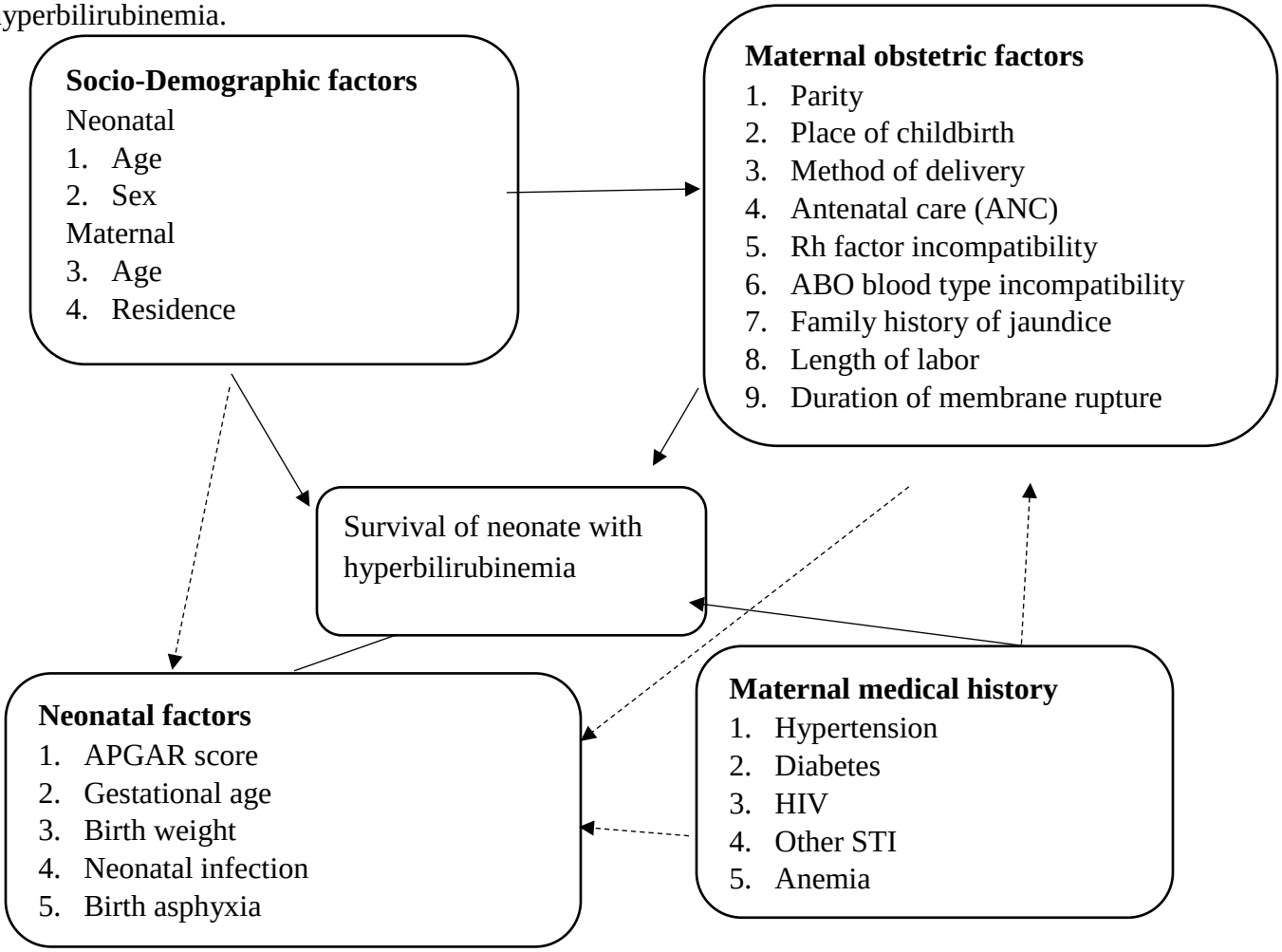


Figure 1: Conceptual framework of neonatal hyperbilirubinemia among neonates hospitalized in NICUs of Public hospitals in Addis Ababa, Ethiopia, 2023.

CHAPTER THREE: OBJECTIVES

3.1. General objective

- To determine the survival status and predictors of mortality among neonates admitted with hyperbilirubinemia in neonatal intensive care units in public hospitals of Addis Ababa, Ethiopia, 2023.

3.2. Specific objectives

- To determine survival status of neonates admitted with hyperbilirubinemia in NICUs from January 2021- December 2022 in public hospitals of Addis Ababa.
- To identify predictors of time to death among neonates admitted with hyperbilirubinemia in NICUs from January 2021- December 2022 in public hospitals of Addis Ababa.

CHAPTER FOUR: METHODS AND MATERIAL

4.1. Study area and period

This study was done in Addis Ababa city, the political, economic, and cultural center of Ethiopia. The current estimated population of city in 2023 stands at 5,460,591. Addis Ababa city is one of the rapidly growing cities in Africa & serves as the primate city of Ethiopia, representing about 25% of the country's urban population. Emperor Menelik II played a significant role in establishing Addis Ababa as the permanent capital city of Ethiopia in 1886(47).

Within the city, there are 13 public hospitals, with six being owned by the Addis Ababa Health Bureau, four by the Ministry of Health (FMOH), one under Addis Ababa University, and two by the defense force(48). The study took place from March 16 to April 16, 2023, and focused on selected governmental hospitals in the city, namely Yekatit 12 Hospital, Gandhi Memorial Hospital, Zewditu Memorial Hospital, & Tikur Anbessa Specialized Hospital.

4.2. Study design

A health institution based retrospective cohort study design was used.

4.3. Source population

All neonates admitted in Addis Ababa public hospital NICUs with the diagnoses of hyperbilirubinemia from January 2021 to December 2022.

4.4. Study population

All neonates admitted in selected Addis Ababa public hospital NICUs with the diagnoses of hyperbilirubinemia from January 2021 to December 2022.

4.5. Eligibility criteria

4.5.1. Inclusion criteria

All neonates admitted in NICUs of selected public hospitals of Addis Ababa due to hyperbilirubinemia.

4.5.2. Exclusion criteria

Neonates with incomplete charts, including those without recorded admission and discharge dates, and those lacking documentation of treatment outcomes, were excluded from the study.

4.6. Sample size determination

For the first objective, the sample size was determined using the single population formula, taking into account a death rate of 32% reported in a previous study done on the general characteristics, disease spectrum and common causes of Neonatal morbidity and mortality at Gondar University Hospital Neonatal Unit(20), 95% CI and 5% margin of error.

$$N = \frac{(Z_{\alpha/2})^2\, p\,(1-p)}{d^2} = \frac{(1.96)^2 * 0.32 * (1-0.32)}{(0.05)^2} = 334$$

For the second objective, the sample size was determined using Epi-info version 7.2.2.6 and taking into account; a confidence interval (CI) of 95%, a statistical power of 80%, a ratio of unexposed to exposed neonates of 1:1, and the parameters P1 and P2 representing the percent of death outcomes among exposed and unexposed neonates respectively.

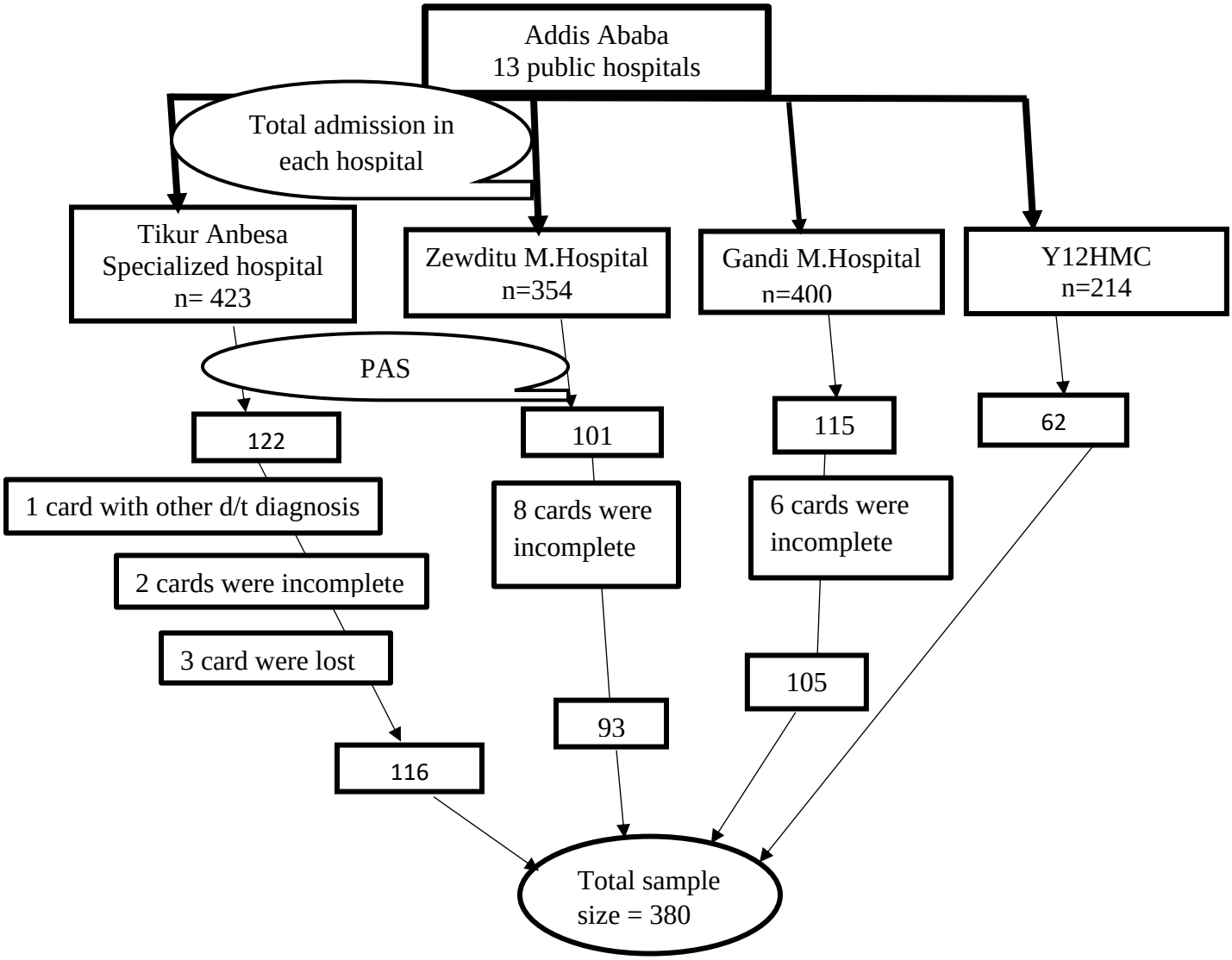
***Table 1*: Sample size for specific objective two by double population proportion formula**

Variables		Proportion of outcome	Risk ratio [HR]	Sample size	References
ANC	No	P1=49	1.9	320	(22)
	Yes	P2=33.6			
Sepsis	Yes	P1= 35.5	1.62	400	(48)
	No	P2= 22.8			
Asphyxia	Yes	P1=30.7	0.87	194	(49)
	No	P2=14			

By comparing the sample sizes of both objectives, it was determined that the largest sample size of 400 participants was chosen for this study.

4.7. Sampling procedure

A computer generated simple random sampling method was used to select four hospitals from 13 public hospitals in Addis Ababa. Cards of neonates with hyperbilirubinemia in each selected hospitals was selected by using computer generated simple random sampling techniques after proportional allocation of the total sample size for each hospitals according to their total neonates with hyperbilirubinemia admission in NICUs.



*Where: **PAS**: Proportionally allocated sample.*

Figure 2: Schematic sampling procedure

Out of 400 Neonates with hyperbilirubinemia enrolled in the study, the record of 16 neonates were incomplete, one neonate's record were found with different diagnosis and three neonates record were lost. Finally, 380 neonates record were reviewed.

4.8. Operational definition

Neonate: An infant from birth to 28 days of age.

Neonatal hyperbilirubinemia - Serum bilirubin level greater than 85μmol/l (5mg/dl) in newborns.

Survival status - Outcome of neonates with hyperbilirubinemia, which can be either death or being censored.

Survival - Absence of death, indicating that the neonate is alive and did not experience hyperbilirubinemia-related death during their hospitalization period.

Event - Neonates with hyperbilirubinemia who experienced the outcome of death within the study period.

Death - Neonate that passed away while under in-patient care, and the information is recorded in their patient card.

Censored - Neonates with hyperbilirubinemia who had an outcome other than death (lost to follow-up, surviving beyond the study period, being referred to other health facilities, or being discharged against medical advice.

Survival time is the duration in days from the date of hospitalization to the NICUs until the occurrence of the outcome (event or censored). The time scale is measured in days.

Incomplete charts - Medical records that are missing one or more of the following variables: admission date, discharge date, or records of neonates whose treatment outcomes (status) were not recorded.

4.9. Variables

4.9.1. Outcome variables

Time to death

49.2. Independent variable

Socio-demographic: The variables in this category were residence, which were coded into Addis Ababa and Out of Addis Ababa, and later recoded to "Addis Ababa to urban"/"Out of Addis Ababa to rural" during analysis. In a similar manner, the mother's age was classified into <20 and ≥20year categories.

Maternal obstetrical: This category contains gestational age (GA), which was initially coded into preterm (<37 weeks), term (37-42 weeks), and post-term birth (> = 42 weeks), but because of the low observations of post-term births, it was recorded as term birth during analysis. Prior history of sibling jaundice (Yes/No), Duration of rapture of membrane and prolonged duration of labor (Yes/No). In the present study, parity was determined by counting all previous full-term births by a woman, including stillbirths but excluding miscarriages or early abortions. It was classified into "multi-para" (>1 full-term birth) and "prmi-para" (just the current child). Antenatal follow up(ANC) was assessed by coding it into 'Yes', if she had ever undergone at least 1 ANC visits, 'No' if she had never undergone ANC visit.

The maternal **history of chronic medical disease** was assess based on the mother's response to any of the following conditions: STIs, HIV/AIDS, diabetes mellitus, Hypertension, or any other medically diagnosed disease. The response options were classified as "Yes" if the mother had any of these conditions and "No" if she did not have a medically diagnosed disease. Place of birth (Home, hospital or health center) and later during analysis it was classified in to Health institution and out of health institution. Mode of delivery is classified into 'SVD, 'operative or 'cesarean section' and instrumentalvaginal delivery' and. Instrumental delivery is defined as the utilization of either forceps or a vacuum device to aid the mother in achieving vaginal delivery of the fetus.

The category of **neonatal/clinical predictors** consists of birth weight which is categorized as low (<2500 gm), normal (≥2500- ≤4000 gm), overweight≥4000 gm, and later grouped into low (<2500 gm), and normal birth weight (≥2500 gm) for analysis purposes. Other factors include the Gender of the neonate (male/female), age at admission (1 day, 2-7 days, and >=8 days), presence of neonatal infection/Sepsis (Yes/No), birth asphyxia (Yes/No), subgeleal hemorrhage (Yes/No), APGAR score (<7, ≥7), type of management provided (phototherapy, exchange blood transfusion, or both) but later during analysis it was coded to phototherapy, both phototherapy & exchange blood transfusion , Rh-incompatibility (Yes/No), and ABO-incompatibility (Yes/No).

4.10. Data Collection Method and Tools

The medical registration numbers(MRN) of all neonates with hyperbilirubinemia were obtained from the NICUs of selected public hospitals by reviewing two-year data from the NICU registration book.

The selected medical cards were obtained from the medical record office of each chosen public hospital. Data retrieval was conducted using a pretested checklist, which was prepared in English based on the Health Management Information System (HMIS) registration format and patient's cards. Four BSc nurses under the supervision of two MSc nurses retrospectively reviewed the required data.

The study's follow-up period commenced on the date of NICU admission and extended until one of the subsequent events took place: death, censoring, or the conclusion of the study period, which was December 30, 2022. To confirm deaths, medical death certificates were reviewed at each selected hospitals hospital. Experienced researchers and physicians carefully evaluated the data abstraction checklist. Both the data supervisors and collectors trained on the data abstraction tool and the entire data collection process to ensure accuracy and consistency.

The entire reviewed data was downloaded from the Kobo Toolbox website and subsequently exported to SPSS software version 26 and STATA version 13 for data cleaning and analysis.

4.11. Data quality control

The data abstraction checklist was pretested on 5% (n=18) of the final sample at Minilik II Hospital in Addis Ababa. The pretest aimed to assess language clarity, appropriateness of data collection tools, estimated time for completion, and identify any necessary amendments. Based on the pretest findings, the maternal sociodemographic variables such as religion, marital status, occupation, and educational status were removed from the final data abstraction.

To ensure standardized data collection, a procedural guide for data abstraction was prepared (Annex III). The guide was used during the training of supervisors and card reviewers, and used

as a reference during the actual data collection. The supervisors and card reviewers received a two-day training session to familiarize themselves with the Kobo Collect app and enhance their data collection skills, ensuring consistency in using the data abstraction tool.

The supervisors were specifically oriented on their role in supervising the data collectors, which included checking for completed data abstraction checklists and addressing any issues or problems that arose. On-site checks were conducted daily during data collection to ensure the completeness of the collected data. Prompt feedback was provided by the supervisor and principal investigator to the data collectors to maintain data quality and accuracy.

4.12. Data analysis

The data entry and collection was done simultaneously using kobo collect, which is a mobile data collection app, and then exported to SPSS software version 26 for cleaning and STATA version 13 for Analysis.

Survival probabilities after admission at different time intervals were estimated using the actuarial life table. The presence of differences in survival among covariate categories was assessed using the Kaplan-Meier survival curve and the log-rank test. Descriptive statistics were provided for numerical variables, presenting medians with interquartile ranges, while categorical data were presented as frequency distributions.

The outcome of each participant was categorized as censored or death. A Cox proportional hazards regression analysis was conducted to identify predictors of mortality. During bivariate analysis, variables that showed associations with the outcome at a $p<0.25$ were included in the final multivariable analysis. Hazard ratios (HR) with 95% CIs were calculated, and statistical significance was determined at $p<0.05$. The final model among the variables was fitted using the backward selection methods, and the log likelihood ratio were utilized to select the best model.

The proportional hazard assumption was graphically tested (log-log plot) for categorical variables, and global goodness-of-fit tests or Schoenfeld residuals were used for testing the proportional hazard assumption for both categorical and continuous variables. The overall goodness of fit of

the proportional hazard model was assessed using the Cox-Snell residual plot. Finally, the study findings were presented using text, graphs, and tables.

4.13. Ethical considerations

A Multi-center ethical letter/clearance was obtained to conduct this study. Initially, an ethical letter/clearance was obtained from the IRB of the nursing department, Addis Ababa University (AAU). Following the proposal's approval, a letter of support, together with the ethical clearance letter, was submitted to the Pediatrics department at TASH (Tikur Anbesa Specialized Hospital) & the Addis Ababa Public Health Research and Emergency Management Directorate. Separate ethical letter was obtained from TASH and the Addis Ababa Public Health Research and Emergency Management Directorate, then it was disseminated to each selected public hospital where data collection took place. Each chosen public hospital provided formal approval for the study to be carried out and access records before data collection commenced.

4.14. Communication (Dissemination and Utilization of results)

The study findings will be submitted and presented to the Nursing department, School of Nursing and Midwifery, College of Health Sciences, Addis Ababa University.

Additionally, the results will be shared with the AAHB, TASH, Y12HMC, ZMH, GMH, and Minilik Hospital.

Efforts will be made to present the study results in local or international seminars, workshops, conferences, and meetings. Furthermore, the findings will be published in well-regarded international journals.

CHAPTER 5: RESULTS

5.1. Description of the study

There were 1391 neonates diagnosed with hyperbilirubinemia from 1 January 2021 to 30, Dec 2022. Among 400 neonate charts reviewed, 380(95%) met the enrollment criteria, and 20 were excluded. Thus, the records of 380 neonates were reviewed. The outcome of all (380) neonates diagnosed with hyperbilirubinemia was confirmed; 283(74.5%) were alive, 36(9.5%) were died), 47(12.4%) neonates with hyperbilirubinemia were lost follow up or discharged against medical advice (AMA) & 14(3.7%) neonates were referred to other hospitals.

5.2. Maternal socio-demographic characteristics

Among 380 study participants, more than two-third of their mothers, 316(83.2%), came from the urban area (Addis Ababa city). Almost all mothers of the neonates 367(96.6%) were found within the age range of 20-35 years with mean of 26.9(SD±4) years with minimum 18 and maximum 39 years (Table 2).

Table 2: Maternal socio demographic characteristics of neonates with hyperbilirubinemia admitted in Public hospital NICUs in Addis Ababa, Ethiopia, 2023.

Covariates (n=380)	Category	Event category		Total
		Censored	Death	Number (%)
Maternal age	<20	10(76.9 %)	3(23.1%)	13(3.4%)
	≥20	334(91.0 %)	33(9%)	367(96.6%)
	Total	344(90.5%)	36(9.5%)	380(100%)
Residence	Addis Ababa	292(92.4%)	24(7.6%)	316(83.2%)
	Out of Addis Ababa	52(81.3%)	12(18.7%)	64(16.8%)
	Total	344(90.5%)	36(9.5%)	380(100%)

5.3. Maternal obstetrics characteristics

In terms of ANC follow-up, 360 (94.7%) of them attended at least one ANC visit, and approximately 363 (95.5%) gave birth at health institutions. Among the neonatal mothers, 94 (24.7%) experienced PROM. The mode of delivery varied, with 196 (51.6%) mothers undergoing SVD, 29 (7.6%) instrumental delivery, and 155 (40.8%) undergoing cesarean section.

The length of time it takes for a woman to give birth ranged from zero to 48 hours and 319 (83.9%) had a normal length of labor. The blood group and Rh factor of the mothers were also assessed,

revealing that approximately two-thirds (61.6%) had blood group O, and (83.9%) were Rh positive.

Concerning maternal history of chronic medical diseases, 82 (21.6%) had a history of chronic medical conditions. The most common chronic diseases among them were hypertension, accounting for 36 (43.9%) cases, and HIV, accounting for 10 (12.2%) cases (Table 3).

Table 3: Obstetrics characteristics of mothers of neonates with hyperbilirubinemia admitted in NICUs of Public hospitals in Addis Ababa, Ethiopia, 2023.

Covariates	Category	Event category		Total Number (%)
		Censored	Death	
Maternal parity (n=380)	Multi Para	204(90.3%)	22(9.7%)	226(59.5%)
	Prmi Para	140(90.9%)	14(9.1%)	154(40.5%)
	Total	344(90.5%)	36(9.5%)	380(100%)
Blood group of the mother(n=380)	A	68(93.2%)	5(6.8%)	73 (19.2%)
	B	63(97%)	2(3%)	65 (17.1%)
	AB	7(87.5%)	1(12.5%)	8 (2.1%)
	O	206(88%)	28(22%)	234 (61.6%)
	Total	344(90.5%)	36(9.5%)	380(100%)
Maternal RH (n=380)	RH Positive	289(90.6%)	30(9.4%)	319(83.9%)
	RH Negative	55(90.2%)	6(9.8%)	61(16.1%)
	Total	344(90.5%)	36(9.5%)	380(100%)
Mode of delivery (n=380)	SVD	175(89.3%)	21(10.7%)	196(51.6%)
	C/S	145(93.5%)	10(6.5%)	155(40.8%)
	Instrumental	24(82.8%)	5(17.2%)	29(7.6%)
	Total	344(90.5%)	36(9.5%)	380(100%)
Place of delivery(n=380)	Out of health institution	13(76.5%)	4(23.5%)	17(4.5%)
	Health institution	331(91.2%)	32(8.8%)	363(95.5%)
	Total	344(90.5%)	36(9.5%)	380(100%)
Prolonged length of labor (n=380)	No	287(89.9%)	32(10.1%)	319(83.9%)
	Yes	57(93.4%)	4(6.6%)	61(61%)
	Total	344(90.5%)	36(9.5%)	380(100%)
PROM (n=380)	No	263(92.0%)	23(8.0%)	286(75.3%)
	Yes	81(86.2%)	13(13.8%)	94(24.7%)
	Total	344(90.5%)	36(9.5%)	380(100%)
	No	236(94.8%)	13(5.2%)	249(65.5%)

History of NNJ in the family (n=380)	Yes	108(82.4%)	23(17.6%)	131(34.5%)
	Total	344(90.5%)	36(9.5%)	380(100%)
ANC follow up(n=380)	No	16(80%)	4(20%)	20(5.3%)
	Yes	328(91.1%)	32(8.9%)	360(94.7%)
	Total	344(90.5%)	36(9.5%)	380(100%)
Any maternal medical problem(n=380)	No	267(89.6%)	31(9.4%)	298(78.4%)
	Yes	77(93.9%)	5(6.1%)	82(21.6%)
	Total	344(90.5%)	36(9.5%)	380(100.0%)
Specific types of medical problems (n=82)	HIV	9(90%)	1(10%)	10(12.2%)
	Hypertension	35(97.2%)	1(2.8%)	36(43.9%)
	Anemia	5(83.3%)	1(16.7%)	6(7.3%)
	DM	6(85.7%)	1(14.3%)	7(8.5%)
	Other STI	8(100.0%)	0	8(9.8%)
	Others	14(93.3%)	1(6.7%)	15(18.3%)
	Total	77(90.7%)	5(9.3%)	82(100.0%)

5.4. Neonatal characteristics

The age of the neonates ranges from 1 to 26 days with a mean age of 7.14 (SD±4.5). Two hundred forty two (63.7%) neonates were males; 333(87.6%) neonates were delivered at term and about three-fifth (85.3%) weighted ≥ 2500g at birth. In this study, the five-minute APGAR score of ≥7 was recorded for 353 (92.9%) neonates, indicating a favorable health condition. The blood group of the neonates was also determined, and the results showed that approximately one-third of the neonates (31.8%) had blood group "A," followed by blood group "B" (38.9%), blood group "O" (27.4%), and the least common blood group was "AB" (1.8%).

The almost all 368 (96.8%) neonates were Rh positive, indicating compatibility with the mother's Rh factor. However, 54 (14.2%) of the study participants had Rh incompatibilities, which may require further attention and interventions to ensure their well-being. Seventy three(19.2%) of them developed bilirubin encephalopathy, of whom 30(41.1%) were died. Regarding the type management given for the neonates presented with hyperbilirubinemia, phototherapy 314(82.6%) followed by both photo therapy and exchange transfusion 66(17.4%) (Table 4).

Table 4: Characteristics of neonates with hyperbilirubinemia admitted in Public hospital NICUs in Addis Ababa, Ethiopia, 2023.

Characteristics **(n=380)**	Category	**Event category**		Total
		Censored	Death	Number (%)
Gender	Female	123(89.1%)	15(10.9%)	138(36.3%)
	Male	221(91.3%)	21(8.7%)	242(63.7%)
	Total	344(90.5%)	36(9.5%)	380(100.0%)
Gestational age	<37	34(72.3%)	13(27.7%)	47(12.4%)
	≥37	310(93.1%)	23(6.9%)	333(87.6%)
	Total	344(90.5%)	36(9.5%)	380(100.0%)
Birth weight	<2500	39(69.4%)	17(30.6%)	56(14.7%)
	≥2500	305(94.1%)	19(5.9%)	324(85.3%)
	Total	344(90.5%)	36(9.5%)	380(100.0%)
Neonatal age at onset of jaundice (Days)	<2	152(89.4%)	18(10.6%)	170(44.7%)
	2-7	174(90.6%)	18(9.4%)	192(50.5%)
	>7	18(100.0%)	0	18(4.7%)
	Total	344(90.5%)	36(9.5%)	380(100.0%)
Bilirubin Encephalopathy	No	301(98%)	6(2%)	307(80.8%)
	Yes	43(58.9%)	30(41.1%)	73(19.2%)
	Total	344(90.5%)	36(9.5%)	380(100.0%)
Types of management given to the neonates for jaundice	Photo therapy	309(98.4%)	5(1.6%)	314(82.6%)
	Exchange blood transfusion and phototherapy	35(53%)	31(47%)	66(17.4%)
	Total	344(90.5%)	36(9.5%)	380(100.0%)
Five minutes APGAR score	More than 7	321(90.9%)	32(9.1%)	353(92.9%)
	Less than 7	23(85.2%)	4(14.8%)	27(7.1%)
	Total	344(90.5%)	36(9.5%)	380(100.0%)
Birth Asphyxia	No	321(90.9%)	32(9.1%)	353(92.9%)
	Yes	23(85.2%)	4(14.8%)	27(7.1%)
	Total	344(90.5%)	36(9.5%)	380(100.0%)
Neonatal Sepsis	No	164(93.2%)	12(6.8%)	176(46.3%)
	Yes	180(88.2%)	24(11.8%)	204(53.7%)
	Total	344(90.5%)	36(9.5%)	380(100.0%)
Neonates Blood group	A	108(89.3%)	13(10.7%)	121(31.8%)
	B	130(87.8%)	18(12.2%)	148(38.9%)
	AB	7(100.0%)	0	7(1.8%)
	O	99(95.2%)	5(4.8%)	104(27.4%)
	Total	344(90.5%)	36(9.5%)	380(100.0%)

Neonates RH group	RH positive	334(90.8%)	34(9.2%)	368(96.8%)
	RH negative	10(83.3%)	2(16.7%)	12(3.2%)
	Total	344(90.5%)	36(9.5%)	380(100.0%)
Rh-incompatibility	No	295(90.5%)	31(9.5%)	326(85.8%)
	Yes	49(90.7%)	5(9.3%)	54(14.2%)
	Total	344(90.5%)	36(9.5%)	380(100.0%)
ABO incompatibility	No	187(92.1%)	16(7.9%)	203(53.4%)
	Yes	157(88.7%)	20(11.3%)	177(46.6%)
	Total	344(90.5%)	36(9.5%)	380(100.0%)
Sub-galeal hemorrhage	No	338(92.9%)	26(7.1%)	364(95.8%)
	Yes	6(37.5%)	10(62.5%)	16(4.2%)
	Total	344(90.5%)	36(9.5%)	380(100.0%)

5.5. Survival status of neonates

During the follow-up period, a total of 1980 person-day observations or time at risk were recorded. The minimum follow-up time was 1 day, while the maximum follow-up time was 26 days. The overall proportion of neonatal mortality was 36, accounting for 9.5% of the total cases. Out of the 344 censored neonates with hyperbilirubinemia, the majority (283, 74.5%) were discharged with improvement, 47 neonates (12.4%) were against medical advice or were lost to follow-up, while 14 neonates (3.7%) were referred to other health institutions(Figure 3).

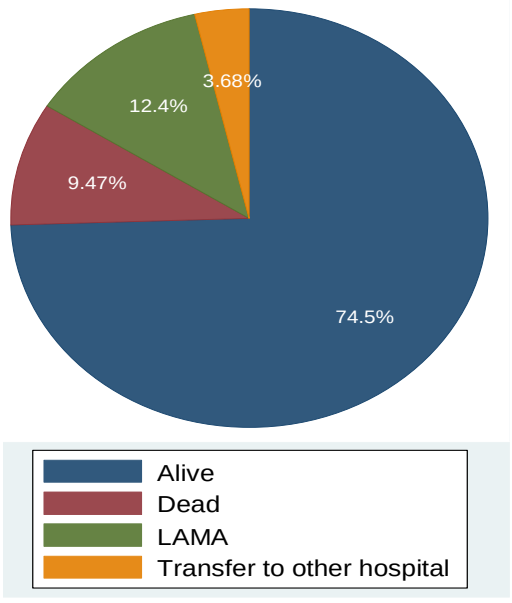


Figure 3: Outcome of neonates with hyperbilirubinemia admitted in NICUs of Public hospitals in Addis Ababa, Ethiopia, 2023.

The overall death incidence rate in this cohort was 18 per 1000 person-days (95% CI: 13-25). The median survival of the cohort was 24 (95% CI: 12-36) days and the median follow up time is 4 (95% CI: 4.8-5.6) days. The overall estimated survival rate after the treatment of hyperbilirubinemia was 38.2% at 24 months of follow-up. The incidence rates of mortality among neonates with hyperbilirubinemia in 1–7 days, 7-14 days and 14–21 days and >21day were 16.3(95% CI: 11.3-23.7), 29.4(95% CI: 14.02-61.7), 14.5 (95% CI: 2.04-102.9), 66.7(95% CI 9.4-473.3) per 1000 person-days observation, respectively.

Similarly, the incidence rate of mortality for low birth weight (LBW), Pre-term neonates, neonates with RH incompatibility, and neonates with ABO incompatibility were 60.3, 51.4, 17.4 and 21.3 per 1000 person-days observation, respectively. The above data reveals that when neonates present with LBW and Preterm, the incidence of mortality increases (Table 5)

Table 5: Incidence Density by different covariate among neonates with hyperbilirubinemia admitted in NICUs of Public hospitals in Addis Ababa, Ethiopia, 2023.

Variable	Category	PDOs	Death	Rate [95% CI] per 1000
Birth weight	<2500	282	17	60.3(37.4-96.9)
	≥2500	1698	19	11.2(7.1- 17.5)
Gestational age	<37	253	13	51.4(29.8-88.4)
	≥37	1727	23	13.3(8.9-20.0)
RH incompatibility	No	1692	31	18.3(12.9-26.0)
	Yes	288	5	17.4(7.2-41.7)
ABO incompatibility	No	1042	16	15.4(9.4-25.0)
	Yes	938	20	21.3(13.8-33.0)
TID		**1980**	**36**	**18(13-25)**

TID: total incidence density; PDOs: person day observations

5.3. Overall Survival of neonates with hyperbilirubinemia

Kaplan-Meier estimation technique were used to estimate the survival time. The overall Kaplan-Meier survivor function graph displayed a gradual decline in the number of events observed over the the follow-up period. According to the graph, the incidence of death was particularly high during the 1st week of the neonatal period.

The estimated cumulative survival rates were as follows: 89.4% (95% CI: 84.8, 92.6) at 7 days, 80.9% (95% CI: 71.4, 87.5) at 14 days, 57.8% (95% CI: 35.7, 74.6) at 21 days, and 43.3% (95% CI: 15.8, 68.5) at 28 days. These values indicate the proportion of neonates who were still alive at each respective time point (Figure 4).

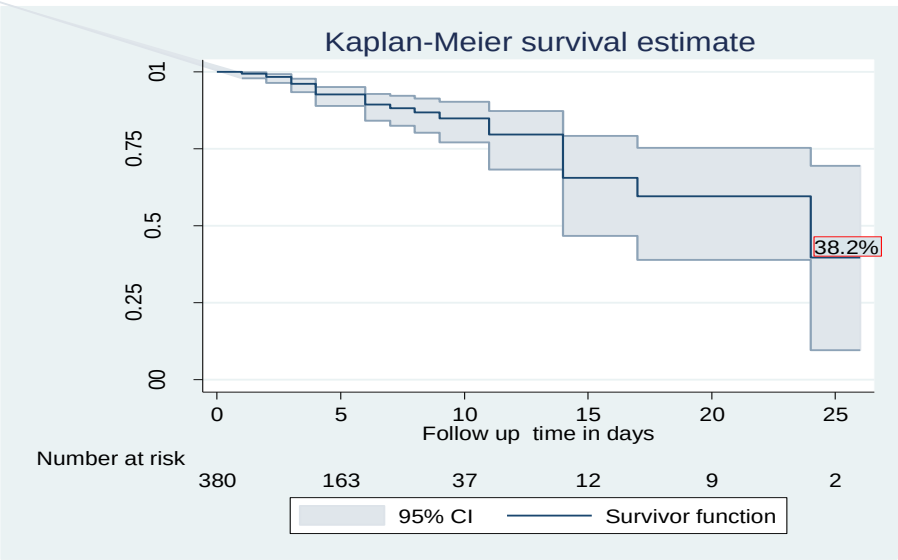


Figure 4: Kaplan-Meir curve showing time to death among neonates with hyperbilirubinemia admitted in NICUs of Public hospitals in Addis Ababa, Ethiopia, 2023.

5.4. Survival experience among different groups of neonates with hyperbilirubinemia

The Kaplan Meier plot for neonates born from a mother who had history of Neonatal jaundice in the family, GA <37week, BW <2500grams, Bilirubin encephalopathy, treated with both phototherapy and exchange blood transfusion and Sub-galeal hemorrhage had a lower survival probability than their counterpart. Similarly neonates with hyperbilirubinemia born from mothers who had history of neonatal hyperbilirubinemia had lower survival time with a Median Survival Time (MST) of 17(95%CI: 9.8-24.2), P=0.000 and overall survival rate of 37.9% (95% CI: 12.3-63.8) compared to their counterpart (Fig 5).

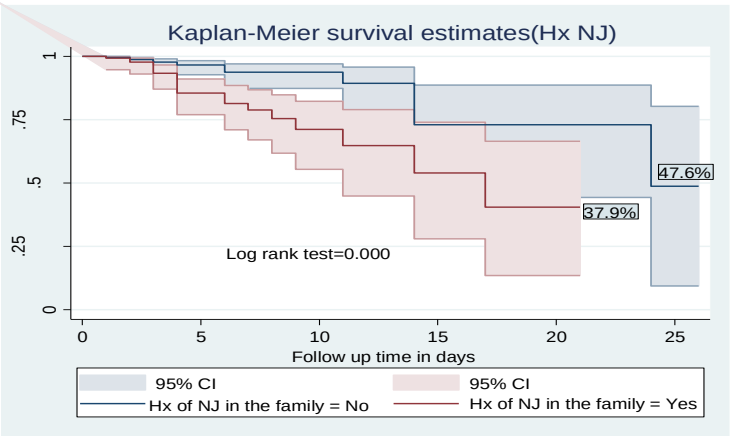


Figure 5: Kaplan-Meir curve estimates among neonates with hyperbilirubinemia in the family admitted in NICUs of Public hospitals in Addis Ababa, 2023.

In this study, Preterm neonates (<37weeks) had lower survival rate than their counterpart. The median survival time for pre-term neonates were 11(95% CI: 6.7-15.3). None of preterm neonates (GA<37wks) survived until the end of study period but term neonates were survived until the end of study period with the overall survival rate of 44.5% (95% CI: 9.8-75.4). This disparity in survival rates between the two groups was statistically significant at a p-value of 0.0000 (Fig 6).

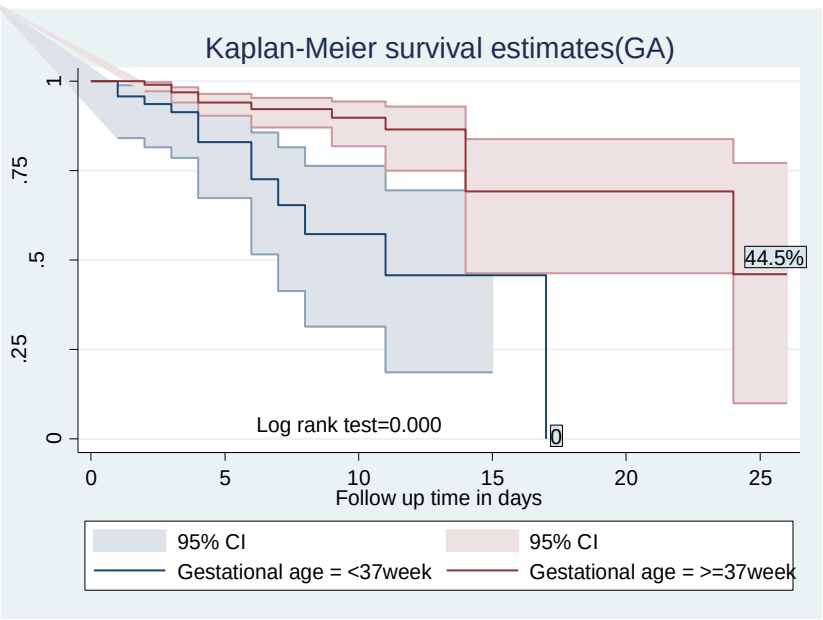


Figure 6: Kaplan-Meir curve estimates among neonates with hyperbilirubinemia admitted in NICUs of Public hospitals in Addis Ababa from 2021-2022 for Gestational age on Log-rank test.

Neonates diagnosed with hyperbilirubinemia who had birth weight less than 2500g, bilirubin encephalopathy, Sub-galeal hemorrhage had lower survival time than their counterpart. The MST for neonates diagnosed with hyperbilirubinemia who had birth weight(BW) less than 2500g and bilirubin encephalopathy, Sub-galeal hemorrhage was 11(95% CI: 3.0-19.0), 11(95% CI: 8.5-13.5) respectively. The overall probability of survival for both LBW and NBW was 20.7% and 43.9%, bilirubin encephalopathy (none/0.00%) and without bilirubin encephalopathy (96.6 %) respectively. This indicates that LBW neonates, neonates with bilirubin encephalopathy and Sub-galeal hemorrhage died during the early neonatal period (p value= 0.000) (Figure 7 A-B).

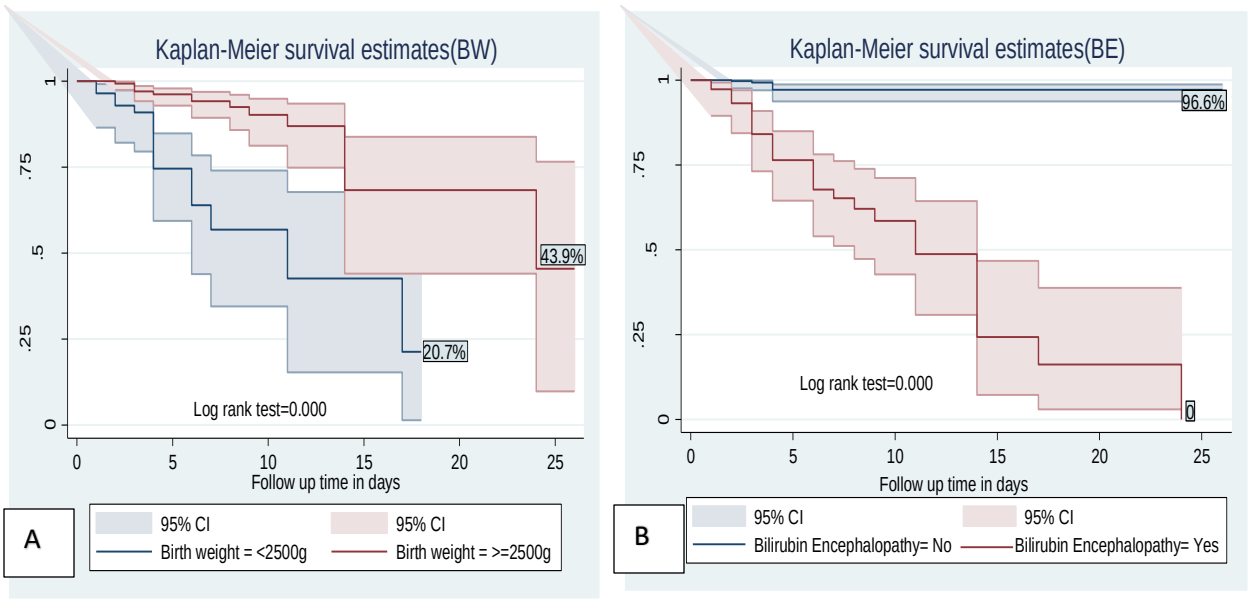


Figure 7: Kaplan-Meir curve estimates among neonates with hyperbilirubinemia admitted in NICUs of Public hospitals in Addis Ababa from 2021-2022 for significant covariates on Log-rank test, Figure 6A: Birth weight, B: Bilirubin Encephalopathy.

Similarly the MST for neonates diagnosed with hyperbilirubinemia who had Sub-galeal hemorrhage were 7 (95% CI: 1.3-12.7) and managed with phototherapy alone were 11days (95%CI: 7.2-14.8(Figure 8 A-B)). The overall probability of survival for neonates managed with phototherapy alone were 97.1% (95%CI: 93.2-98.8).

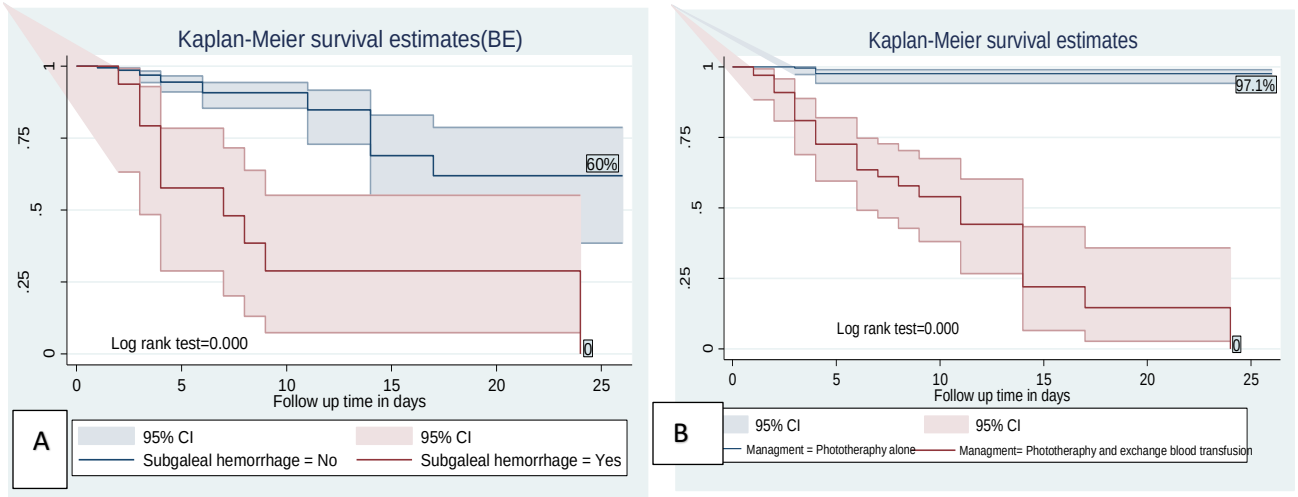


Figure 8:Kaplan-Meir curve estimates among neonates with hyperbilirubinemia admitted in NICUs of Public hospitals in Addis Ababa from 2021-2022 for significant covariates on Log-rank test, Figure 6A: Sub-galeal Hemorrhage and B:Management of hyperbilirubinemia

5.5. Predictors of neonatal mortality

During the bivariate analysis, variables that showed a significant association at a significance level of $p<0.25$ was considered as candidates for further analysis. However, in a Cox proportional hazard model, the assumption tests were not met by the maternal & neonatal blood group variables.

Finally, maternal age, residence, place of deliver, PROM, history of hyperbilirubinemia in the family, ANC follow up, maternal medical problem(comorbidity), Gestational age, birth weight, bilirubin encephalopathy, type of management given for hyperbilirubinemia, sepsis and Subgaleal hemorrhage were considered for the multivariable Cox regression and are fitted to the final model. PROM, residence, type of management given for hyperbilirubinemia, maternal age, maternal medical problem (comorbidity), birth weight, Gestational age, sepsis were independent predictors of time to death.

Neonates born from mother aged <20 years had 18.2 times higher hazard of mortality than neonates born from mother aged ≥20 years (AHR=18.2, 95%CI: 3.2-102.7). Similarly, neonates delivered by mothers from rural areas (outside Addis Ababa) had a 4.16 times higher hazard of neonatal mortality than neonates from mothers residing in urban settings (Addis Ababa) (AHR = 4.16, 95%CI: 1.64-10.52).

Neonates delivered by mothers who experienced PROM had a 3.49 times higher hazard of neonatal mortality compared to those born to mothers without this condition (AHR = 3.49, 95%CI: 1.14-10.66). Likewise, the hazard of neonatal mortality was 3.12 times higher among neonates born from mothers who had maternal comorbidity than mothers who didn't had maternal comorbidity (AHR = 3.12, 95%CI: 1.02-9.93).

Birth weight and gestational age are significant predictors of neonatal survival. LBW neonates had a 15.1 times higher hazard compared to their counterparts (AHR= 15.1, 95% CI: 3.85-59.5). Similarly, preterm neonates had a 7.3 times higher hazard of neonatal mortality compared to full-term neonates (AHR = 7.3, 95%CI: 1.84-28.8). Neonates who underwent both exchange blood transfusion & phototherapy had a 48.6 times higher hazard of mortality than those who received phototherapy alone (AHR = 48.6, 95% CI: 7.30-323.4). Additionally, the hazard of mortality

among neonates present with sepsis was 3.03 times higher than their counterparts (AHR = 3.03, 95% CI: 1.17-7.9).

Table 6: Multivariable cox regression analysis for survival of neonates with hyperbilirubinemia admitted of NICUs in Public hospitals of Addis Ababa, Ethiopia, 2023.

Covariate	Category	Event category		AHR **(95%CI)**	P-value
		Censored	Death		
Maternal age	<20	10(76.9 %)	3(23.1%)	**18.2(3.2-102.7)**	**0.001**
	≥20	334(91.0 %)	33(9%)	1	
Residence	Urban	292(92.4%)	24(7.6%)	1	
	Ural	52(81.3%)	12(18.7%)	**4.16(1.64-10.52)**	**0.003**
Place of delivery	Out of health	13(76.5%)	4(23.5%)	1.16(0.30-4.39)	0.83
	Health institution	331(91.2%)	32(8.8%)	1	
PROM	No	263(92.0%)	23(8.0%)	1	
	Yes	81(86.2%)	13(13.8%)	**3.49(1.14-10.66)**	**0.03**
Hx of NJ in the family	No	236(94.8%)	13(5.2%)	1	
	Yes	108(82.4%)	23(17.6%)	2.02(0.83-4.88)	0.12
ANC follow up	No	16(80%)	4(20%)	0.98(0.24-3.99)	0.972
	Yes	328(91.1%)	32(8.9%)	1	
Maternal comorbidity	No	267(89.6%)	31(9.4%)	1	
	Yes	77(93.9%)	5(6.1%)	**3.12(1.02-9.93)**	**0.047**
Gestational age(week)	<37	34(72.3%)	13(27.7%)	**7.3(1.84-28.8)**	**0.005**
	≥37	310(93.1%)	23(6.9%)	1	
Birth weight(Gram)	<2500	39(69.4%)	17(30.6%)	**15.1(3.85-59.5)**	**0.000**
	≥2500	305(94.1%)	19(5.9%)	1	
Bilirubin Encephalopathy	No	301(98%)	6(2%)	1	
	Yes	43(58.9%)	30(41.1%)	2.73(0.48-15.35)	0.27
Management for jaundice	Photo therapy	309(98.4%)	5(1.6%)	1	
	Phototherapy & exchange blood transfusion	35(53%)	31(47%)	**48.6(7.30-323.4)**	**0.000**
Neonatal Sepsis	No	164(93.2%)	12(6.8%)	1	
	Yes	180(88.2%)	24(11.8%)	**3.03(1.17-7.9)**	**0.023**
Sub-galeal hemorrhage	No	338(92.9%)	26(7.1%)	1	
	Yes	6(37.5%)	10(62.5%)	2.24(0.78-6.45)	0.13
Global test = 0.768					

CHAPTER 6: DISCUSSION

Several studies have examined the prevalence and risk factors of hyperbilirubinemia; however, there are limited evidence exists about neonatal survival rates and factors contributing to mortality among neonates with hyperbilirubinemia. Thus, this study identified predictors of mortality among neonates with hyperbilirubinemia to aid in clinical decision-making.

During the follow-up period of 1980 person-day observations (PDOs), the overall incidence rate of death among neonates was 18 deaths per 1,000 PDOs. The WHO has set a target of reducing the global NMR to less than 12/1,000 live births by the year 2030, as part of the SDGs. Therefore, an incidence rate of 18 per 1000 neonate-days' observation would be considered high and it suggest that there is a room for improvement(50).

The findings from this study indicated that approximately 9.5% of newborns experienced mortality, which is lower than the rates reported in studies done at Mizan Tepi University Teaching Hospital(63.49%)(22), Felege Hiwot Comprehensive specialized Hospital(10.7%)(51), observational clinical study conducted in five hospitals in Ethiopia (11.0%)(52), and Gondar University Hospital (32.0%)(20). This disparity might be due to sources of data; this study reviewed data from both term and preterm neonates, and it might be due to the quality of health care service given. This study collected data from the hospital which are being serving as a referral hospital and tertiary hospital (TASH), were better diagnosis & treatment services were given.

The MST was 24 (95% CI: 12-36) days and the overall estimated survival rate after the treatment of hyperbilirubinemia was 38.2% at 26 days of follow up. These relatively low overall survival rates with short median survival time suggests that hyperbilirubinemia is a serious condition that may require prompt and effective treatment.

The Principal investigators made a comprehensive literature search, but no studies found reporting a predictor of neonatal mortality among neonates diagnosed with hyperbilirubinemia. However, this study identified maternal place of residence and Age, PROM, maternal comorbidity, birth weight, gestational age, types of hyperbilirubinemia management and sepsis as an independent predictor of neonatal survival among neonates diagnosed with hyperbilirubinemia.

Neonates born from mother aged <20 years had 18.2 times higher hazard of mortality than neonates born from mother aged ≥20 years (AHR=18.2, 95%CI: 3.2-102.7). This disparity might be due to young mothers may be less likely to receive adequate prenatal care, which can arise the risk of late diagnosis or poorly managed hyperbilirubinemia in their newborns. Additionally, young mothers may be more likely to have risk factors for hyperbilirubinemia, which can increase the risk of severe jaundice. Moreover, young mothers may be less experienced in caring for a newborn and may not recognize the signs of severe jaundice, such as lethargy, poor feeding, and high-pitched crying. Failure to promptly recognize and treat severe jaundice can elevate the risk of kernicterus and neonatal mortality.

Additionally, neonates whose mothers were from rural areas exhibit a four-fold higher hazard of neonatal mortality compared to their urban counterparts. This might be due to lack of access to healthcare, limited resources and differences in maternal behavior and health among mothers in rural settings. Mothers in rural areas may have limited access to healthcare facilities and trained medical personnel, making it more difficult for pregnant women and neonates to receive timely and appropriate medical care(53). Additionally, rural areas may have longer travel times to healthcare facilities, leading to delayed diagnosis & management of hyperbilirubinemia, which can increase the risk of neonatal mortality(19). Alternatively, it may be women living in rural areas may have different health behaviors and risks compared to urban counterparts, which can impact neonatal health outcomes.

The hazard of neonatal mortality was 3.49 times higher among neonates delivered from mothers who have PROM during the current pregnancy than mothers who do not have PROM (AHR = 3.49, 95%CI: 1.14-10.66). The contributing factor might be the risk of neonatal jaundice and its related complications among mothers who experienced PROM. PROM can elevate the risk of infection, which, in turn, can contribute to heightened production of bilirubin in neonates. Infection can also damage the liver, which can affect bilirubin metabolism. Moreover. Infection can also damage the liver, which can affect bilirubin metabolism.

Birth weight was identified as another predictor for the survival of neonates with hyperbilirubinemia. The hazard of neonatal mortality was 15.1 times higher among LBW neonates compared to their counterparts (AHR= 15.1, 95% CI: 3.85-59.5). This might be due to a higher risk of hyperbilirubinemia, and increased susceptibility to the toxic effects of bilirubin on the developing brain among low birth neonates. Hyperbilirubinemia is more common in LBW neonates because they have a smaller volume of blood and a faster turnover of RBCs. This means that bilirubin can accumulate more quickly in their bloodstream, leading to jaundice. In addition, LBW neonates may be at increased risk of kernicterus and neonatal mortality because their immature liver may not be able to handle the high bilirubin level in the blood(32, 54). Additionally, LBW neonates may be less able to tolerate the stress of phototherapy, a treatment used to lower bilirubin levels, due to their fragile health status(55).

The hazard of neonatal mortality was 7.3 times higher among preterm neonates than term neonates (AHR = 7.3, 95%CI: 1.84-28.8). This might be due to preterm neonates increased susceptibility to hyperbilirubinemia, which can lead to the occurrence of kernicterus and subsequent neonatal mortality(55). The main contributing factors may be their decreased ability to process bilirubin(19). The liver of a preterm neonate is not fully developed and may not be able to clear bilirubin from the bloodstream as efficiently as a full-term neonate(32, 54). Additionally, preterm neonates may have a higher RBC turnover rate, leading to high bilirubin production(19). Furthermore, the immature blood-brain barrier in preterm neonates allows bilirubin to cross into the brain more easily, leading to the toxic effects of bilirubin on the developing brain(19).

The hazard of neonatal death was 48 times higher among neonates who received both phototherapy and exchange blood transfusions than those who received only phototherapy(AHR = 48.6, 95% CI: 7.30-323.4). This might be due to the severity of hyperbilirubinemia, underlying medical conditions, risks associated with exchange blood transfusions(56), and delay in treatment. Neonates who require both phototherapy and exchange blood transfusions typically have more severe hyperbilirubinemia than those who only receive phototherapy. High bilirubin levels can cause significant damage to the brain and other organs, leading to a higher risk of mortality. Additionally, Neonates who require exchange blood transfusions are often sicker and have underlying medical conditions that contribute to their hyperbilirubinemia. These underlying conditions may also increase their risk of mortality. Likewise, Exchange blood transfusions are

more invasive than phototherapy and carry additional risks, including infection, transfusion reactions, and complications related to vascular access(19, 56).

Those who had neonatal sepsis at the time of admission were more hazardous to die than those who did not have sepsis (AHR = 3.03, 95% CI: 1.17-7.9).This might be due to synergetic effect of hyperbilirubinemia and sepsis, increased bilirubin production, impaired bilirubin elimination and the effects of sepsis. Sepsis can increase the production of bilirubin in neonates, leading to a more severe hyperbilirubinemia(57). High levels of bilirubin can cause brain damage and other complications that can be life threatening. Furthermore, sepsis can also impair the liver's ability to eliminate bilirubin from the blood, further exacerbating the effects of hyperbilirubinemia. This can lead to a more rapid onset of complications and a higher risk of mortality. Additionally, Sepsis can cause systemic inflammation and damage to organs, including the liver, which can worsen the effects of hyperbilirubinemia. Neonates with sepsis may also be more vulnerable to other complications of hyperbilirubinemia, such as brain damage.

CHAPTER 7: STRENGTH AND LIMITATION

7.1. Strength

The data was collected using digital data collection platform (kobo toolbox) and the data itself was digitally recorded. The study also included data from 30% of Addis Ababa public hospital, which is scientifically representative of the study area. Furthermore, the study utilized readily available data from records, which can make the study easier and less expensive to conduct than prospective studies.

This study represents the pioneering research conducted in both the study area, Ethiopia, and globally, as there is no prior study of its kind.

7.2. Limitation

- Absence of reference studies.
- Incomplete or missing information was the challenge.
- Data on maternal socioeconomic status, Education, and access to healthcare not obtained. Those variable may be a significant predictor of time to death.

CHAPTER 8: CONCLUSION AND RECOMMENDATION

8.1. Conclusion

Thirty three (9.5%) neonates died during the follow-up period. The overall cumulative survival probability was 38.2% at the end of the follow-up period. Maternal age, gestational age, residence, PROM, maternal comorbidity, low birth weight, sepsis and type of hyperbilirubinemia management were predictors of death among neonates with hyperbilirubinemia.

8.2. Recommendations

Based on the findings of this study, the following recommendations forwarded;

1. **For the public**
    - Parents should follow up their neonates for symptoms of hyperbilirubinemia and seek early diagnosis & treatment.
2. **Health care providers**
    - Healthcare providers should provide education to parents about the signs and symptoms of hyperbilirubinemia and the importance of early detection and treatment. This can improve parents and caregivers understanding of the disease and the importance of seeking medical attention if their baby develops jaundice. Furthermore, this can help prevent serious complications and improve outcomes for infants with hyperbilirubinemia.
3. **Policymakers and program planners**
    - The responsible body should prioritize raising public awareness about the early signs and symptoms of hyperbilirubinemia. Additionally, they should focus on providing training to first-line health professionals, including health extension workers, to enhance their knowledge and skills in detecting and managing hyperbilirubinemia. Emphasis should be placed on promoting early referral procedures to ensure timely and accurate diagnosis, and improving access to treatment for individuals with hyperbilirubinemia.

4. **To TASH, Y12HMC, ZMH and GMH**
    - Inclusion of detailed patient characteristics, full implementation of digital record keeping, and establishing a database will be beneficiary for quality of care, treatment, and better researches
    - All newborns should undergo screening for hyperbilirubinemia before leaving the hospital. This can help identify infants who are at risk of developing severe jaundice and allow for early treatment.
5. **To researchers**
    - To address the limitations of this study, future studies should consider using prospective designs with a larger sample size, more comprehensive data collection, and statistical analyses that can account for potential confounding factors.

Overall, a collaborative effort from healthcare providers, policymakers, and researchers is needed to address the problem of neonatal hyperbilirubinemia and improve the outcomes for affected neonates.

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ANNEX

Addis Ababa University

College of Health Sciences

School of Nursing and Midwifery

Department of Nursing

Annex I: Information sheet

Title of the research project; Survival status and predictors of mortality among neonates admitted with hyperbilirubinemia in neonatal intensive care units in public hospitals in Addis Ababa, Ethiopia, 2023.

Name of principal investigator: Terefe Keto

Name of the organization: Addis Ababa University, College of health science.

Introduction: This information sheet is prepared for administration and NICU coordinating offices of selected public hospitals in Addis Ababa. The aim of the form is to make the above-concerned offices clear about the purpose of research, data collection procedures and get permission to conduct the research.

Purpose of research project

The goal of this study is to assess the survival status and predictor of mortality among neonates with hyperbilirubinemia admitted in the NICU in public hospitals in Addis Ababa. The study results will be useful for health professionals in identifying predictors of time to death of neonates and to take intervention accordingly. Findings from this study will also offer input to decision-makers, program implementers, monitors, and evaluators to advance better maternal and newborn care. The result of this study will also help as a scientific reference for further related studies.

Procedure: In order to achieve the above objective, information which is necessary for the study will be collected from medical record of neonates with hyperbilirubinemia admitted in each randomly selected public hospitals in Addis Ababa.

Risk and /or Discomfort: Since the study will be conducted by taking appropriate information from medical chart, it does not inflict any harm on the patients. The name or any other identifying information will not be recorded on the questionnaire and all information taken from the chart will be kept strictly confidential and in a safe place.

Benefits: The research have no direct benefit for one whose document/ record is included in this research. But if program planners are preparing predicted plan, there will be a benefit for clients in the program of getting appropriate care and treatment services for those survived and other newly born neonates. In all, the research work will have a paramount direct benefit for health care planners and managers.

Confidentiality: To reassure confidentiality, the data on the chart will be collect without the name of the clients and the information collected for this research project will be kept confidential. In addition, it will not been revealed to anyone except the investigator and it will kept in a key and locked system with computer pass ward.

Persons to contact

In case if you want to know more information about the research and its undertakings, you can contact the investigator as well as the advisors through the address below.

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የዋናው ተመራማሪ ስም፡ ተረፈ ኬቶ

የድርጅቱ ስም፡- አዲስ አበባ ዩኒቨርሲቲ፣ ጤና ሳይንስ ኮሌጅ

መግቢያ፡ ይህ የመረጃ ወረቀት የተዘጋጀው በአዲስ አበባ ውስጥ ላሉ የተመረጡ የሕዝብ ሆስፒታሎች አስተዳደር እና የአራስ ሕፃናት ከፍተኛ እንክብካቤ ክፍል አስተባባሪዎች ነው። የቅጹ ዓላማ ከላይ የተመለከቱት አካላት ስለ የምርምሩ ዓላማ፣ የመረጃ አሰባሰብ ሂደቶት ለማብራራትና እና ጥናቱን ለማካሄድ ፈቃድ ለማግኘት ነው።

የፕሮጀክቱ ዓላማ፡ የዚህ ጥናት ዓላማ በአዲስ አበባ በሚገኙ የህዝብ ሆስፒታሎች በሕፃናት ከፍተኛ እንክብካቤ ክፍሎች ውስጥ ሃይፐርቢሊሩቢኒሚያ ያለባቸው አራስ ሕፃናት የመዳን ሁኔታ እና የሚችነት ትንበያ መገምገም ነው። የጥናቱ ውጤት የተሻለ የእናቶች እና አራስ ሕፃናት ግልጋሎትን ለማሳደግ ለውሳኔ ሰጪዎች፣ ለፕሮግራም ፈጻሚዎች፣ ተቆጣጣሪዎች እና ገምጋሚዎች ግብአት ይሰጣል። የዚህ ጥናት ውጤት ለተጨማሪ ተዛማጅ ጥናቶች እንደ ሳይንሳዊ ማጣቀሻ ሆኖ ያገለግላል።

የአሰራር ሂደት፡- ከላይ የተጠቀሰውን አላማ ለማሳካት ለጥናቱ አስፈላጊ የሆኑ መረጃዎችን በአዲስ አበባ በሚገኙ በእያንዳንዱ በተመረጡ የህዝብ ሆስፒታሎች ውስጥ ሃይፐርቢሊሩቢኒሚያ ያለባቸው አራስ ሕፃናት ህክምና መዝገብ ላይ ይሰበሰባሉ።

ስጋት ፡- ጥናቱ የሚካሄደው ተገቢውን መረጃ ከህክምና መዝገብ ላይ በመውሰድ ስለሆነ በበሽተኞች ላይ ምንም አይነት ጉዳት አያስከትልም። ስም ወይም ሌላ መለያ መረጃ በመጠይቁ ላይ አይመዘገብም እና ከህክምና መዝገብ ላይ የተወሰዱት መረጃዎች በሙሉ በሚስጥር እና በአስተማማኝ ቦታ ይቀመጣሉ።

ጥቅማ ጥቅሞች፡ በዚህ ጥናት ላይ ስነዱ/ መዝገቡ ለተካተተ ሰው ቀጥተኛ ጥቅም የለውም። በአጠቃላይ የምርምር ስራው ለጤና አጠባበቅ እቅድ አውጪዎች እና አስተዳዳሪዎች ከፍተኛ የሆነ ቀጥተኛ ጥቅም ይኖረዋል።

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Annex II: Data abstraction tool

This is a data abstraction tool to assess the Survival status and predictors of mortality among neonates admitted with hyperbilirubinemia in neonatal intensive care units in public hospitals in Addis Ababa, Ethiopia from March 16 to April 16/2023.

Name of Data collector_____

Data Collector agreement

"I certify that I have filled the data abstraction tool in accordance with the training that is given to me and instructions stated in it. I have confirmed that the information "filled is correct."

Signature_____**Date**_____

Name of hospital_____

Neonatal Medical Record number (code) _____

Checked by supervisor for completeness: **Supervisors Name**_____ signature _____

Question for mother

Part I:Socio-Demographic Characteristics			
S.No.	Questions	Choice for response	Skip To
101	Age of the mother in years	_____years	
102	Residence	1. Urban 2. Rural	
103	Date of admission	_____	
104	Age of neonate in days	----------days	
105	Neonate's sex	Male 2. Female	
106	Gestational age at birth (weeks)	_____Weeks	
107	Birth weight at birth (grams)	_____Grams.	

Part II:-Maternal obstetric Factors			
S.No.	Question	Choice for response	Skip To
201	Maternal parity	1. Prmi Para 2. Multi Para	
202	Maternal blood group & RH Factor	----------	
203	Mode of delivery	1. SVD 2. C/S 3. Instrumental	
204	Place of delivery	1. Home 2. Health center 3. Hospital	
205	Did she have Prolonged Duration of labor	1. Yes 2. No	
207	What is the Duration of labor in hours	_____hours	

208	Did she have history prolonged rupture of membrane	1. Yes 2. No	
209	Previous history of NNJ in on the family	1. Yes 2. No	
210	Did she have ANC follow up for the current pregnancy	1. Yes 2. No	If No skip to Q 212
211	Frequency of ANC follow up	_____	
Part II:- Maternal Medical factor			
301	Has she been diagnosed with any medical problems	1. Yes 2. No	If no, skip to Q401
302	If yes for question no 301, what was the diagnosis	1. HIV 2. Hypertension 3. Anemia 4. DM 5. STI 6. Other, specify……	

Part IV: Neonatal risk factor of jaundice

401	Neonatal age at onset of jaundice (Days).	----------Days	
402	What is the level of bilirubin	----------mg/dl	
403	Did the Neonate develop Bilirubin Encephalopathy?	1. Yes 2. No	
404	What management is given to the neonates for jaundice?	1. Photo therapy 2. Blood transfusion 3. Both phototherapy and exchange blood transfusion 4. other(specify)_____	
405	Did the neonate have birth asphyxia	1. Yes 2. No	
406	What is the Five minute APGAR score	1. More than 7 2. Less than 7	
407	Did the neonate have Neonatal Sepsis	1. Yes 2. No	
408	Did the neonate have subgeleal hemorrhage ?	1. Yes 2. No	
409	What is the Blood Group and RH factor for the neonate	----------	
410	Did the neonate have Rh-incompatibility?	1. Yes 2. No	
411	Did the neonate have ABO incompatibility?	1. Yes 2. No	
412	Date of discharge	----------	
413	Current status of the Neonate	1. Alive 2. Dead 3. Lost follow up 4. Transfer to other hospital	

Annex III: A guide for medical record data abstraction

A guide for medical record data abstraction for assessment of survival status and predictors of mortality among neonates admitted with hyperbilirubinemia in neonatal intensive care units in public hospitals of Addis Ababa, Ethiopia.

1. **Introduction**

First of all, potentially challenging areas during data collection are identified and this data abstraction guide is developed to overcome the challenge. Therefore, this guide will be used for training of data collectors, supervisor and as a reference when data collectors are abstracting data from the medical records in selected neonatal intensive care units in public hospitals of Addis Ababa. This guide will explain; how to use kobo collect app, how to sink data, source of data for every variable, the most frequently used abbreviations by physicians in the hospital, protocols and steps for data collection from records. Therefore, data collectors will easily perform their tasks with this reference.

2. **Objective of the study**

To assess survival status and predictors of mortality among neonates admitted with hyperbilirubinemia in neonatal intensive care units in public hospitals of Addis Ababa, Ethiopia, 2023.

3. **Eligibility criteria**

Inclusion criteria: Records of all neonates admitted in selected public hospitals of Addis Ababa neonatal intensive care units (NICUs) due to hyperbilirubinemia.

Exclusion criteria: Incomplete records of neonates with hyperbilirubinemia admitted in selected public hospitals NICUs of Addis Ababa (records of neonate's whose admission date and discharge date was not recorded) and records of neonate whose treatment outcome was not recorded.

4. **Time required** a maximum of 30 minutes for every patient chart.
5. **Sources of data:** Medical records and computer based database

Section 1: Data collection from Medical records

How each variable is extracted?

Part I: Maternal socio-demographic variables

- ✓ **Place of residence**: this can be fully or partially available on the cover page of patient chart.
- ✓ **Age of the mother**: this can be fully or partially available on the HPI or referral paper of patient chart.
- ✓ **Date of admission**: this can be found on admission summary or discharge summary. If the date of admission was written in E.C, carefully convert it to GC by using app
- ✓ **Age of neonate in days**: this can be usually found in HPI or cover page of the neonates chart.
- ✓ **Neonate's sex**: this can be usually found on delivery summary or HPI or cover page of the neonates chart.
- ✓ **Gestational age at birth (weeks) and Birth weight at birth (grams)**: this can be usually found on delivery summary or in HPI or cover page of the neonates chart or get it from referral paper, if any.

Part II:-Maternal obstetric Factors

The following information's are found on delivery summary or get them from referral paper, if any.

- ✓ Maternal parity, Maternal blood group & RH Factor, Mode of delivery
- ✓ Place of delivery, Duration of labor, History prolonged rupture of membrane
- ✓ ANC follow up for the current pregnancy and Frequency of ANC follow up
- ✓ Maternal medical diagnosis/complication during the current px
  Neonatal age at onset of jaundice (Days).

Part III: **Neonatal risk factor of jaundice**

- ✓ **Neonate's age at the onset of jaundice**: this is obtained from chief complaint of patient history on the first hospital visit.
- ✓ **Bilirubin level at admission**: this can be obtained from the patients lab investigation chart. You should record the level bilirubin examined on the first day of hospital visit and it should be Total serum bilirubin(TSB).
- ✓ **Bilirubin encephalopathy, Neonatal Sepsis, subgeleal hemorrhage, Rh-incompatibility, ABO incompatibility**: this is partially or fully obtained from physician Assessment or Diagnosis. They usually write their diagnosis as **Neonatal hyperbilirubinemia 2^0 ABO incompatibility or ENOS** …etc. so that you can easily identify here weather the neonate have the above comorbidities or not. In addition to this, for ABO and RH incompatibility, carefully check the maternal and neonates blood group and RH factors carefully.
- ✓ **Type of management given to the neonates for jaundice**: this can be found on discharge summary or read carefully the patient chart to get the most specific management given for hyperbilirubinemia.
- ✓ **APGAR score and Birth asphyxia**: this can be obtained from delivery summary or referral paper, if any.
- ✓ **Blood Group and RH factor for the neonate**: look at the lab summary of the neonate.
- ✓ **Date of discharge and status of the Neonate**: this is obtained from discharge summary. If there is no discharge summary attached with neonates record, this can be considered as lost to follow up..

Commonly used Abbreviations on patients' chart

- ✓ Dx (diagnosis), Ass (assessment), NNJ/NJ (Neonatal jaundice), STI (Sexually transmitted infection), HIV (Human immune deficiency virus), HPN (Hypertension), DM (Diabetes Mellitus), TSB (Total serum bilirubin).

Medical name synonyms

- ✓ Neonatal jaundice: hyperbilirubinemia

Section 2: **Introduction to kobo collect app**

2.1. What is kobo collect?

- ✓ Kobo Collect is an online or offline data collection platform. It is used for primary data collection in any setting.

2.2. How to install KoBo Collect?

Please Note:

1. Installation is much smoother if you use Wi-Fi connection (versus mobile data).
2. KoBo functions only with Android phones.

2.3. Installations steps

Install KoBo Collect on your mobile device

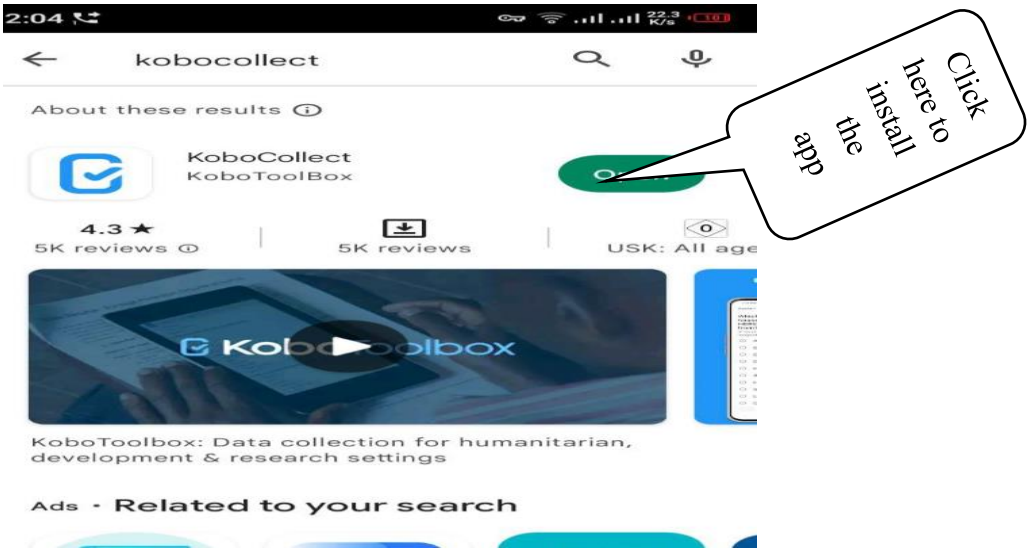
1. Go to Google Play store (in Applications).
2. Search for 'KoBoCollect'.
3. Download and Install the application.
4. Configure and set up the mobile phone with the KoBo server configuration using the passcode and username as well as the URL given to you.

2.4. How to get started

- ✓ Get a blank from
- ✓ Fill a form and submit it
- ✓ Send data to server

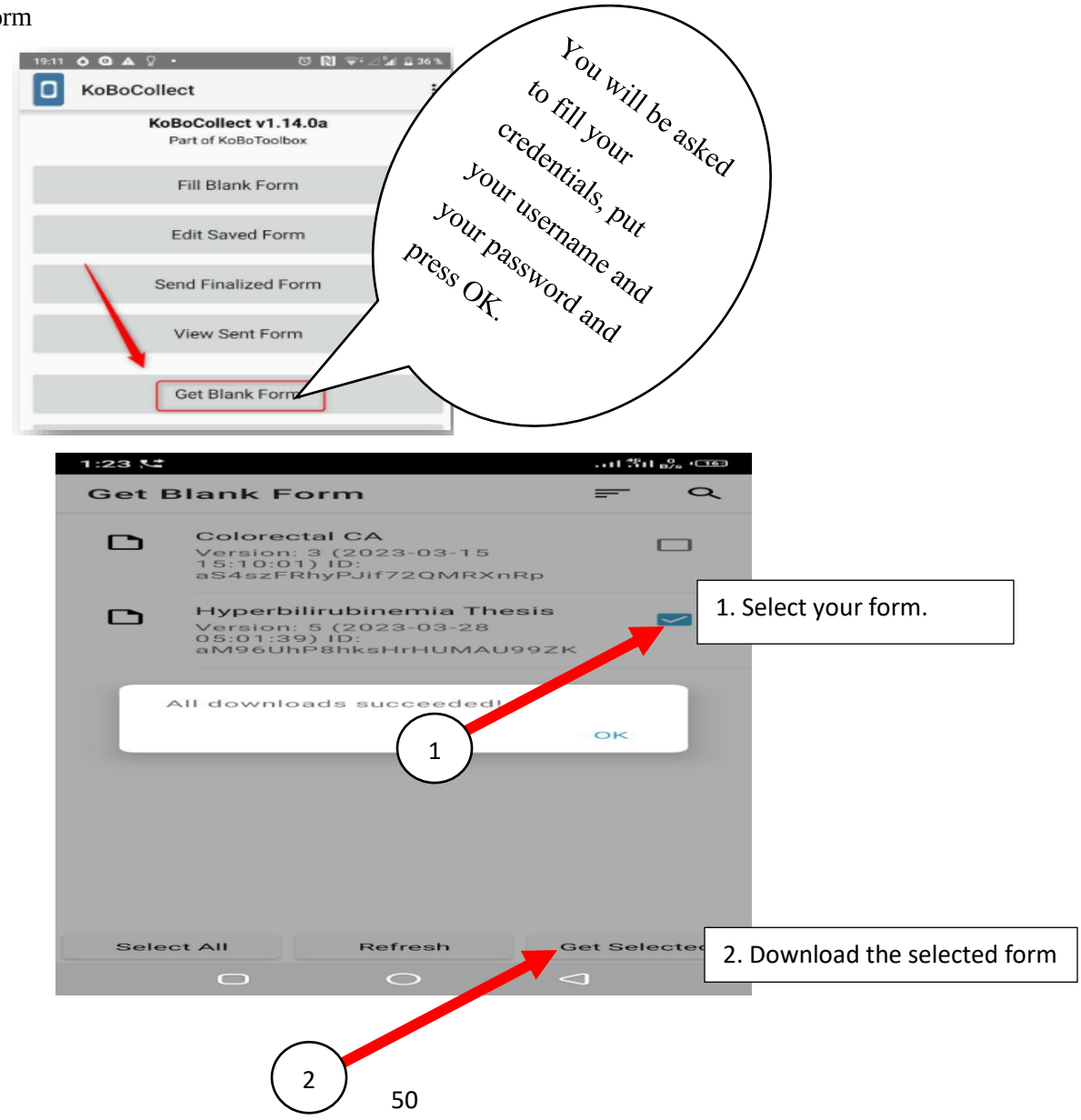
Steps

1. Install Kobo on your android device

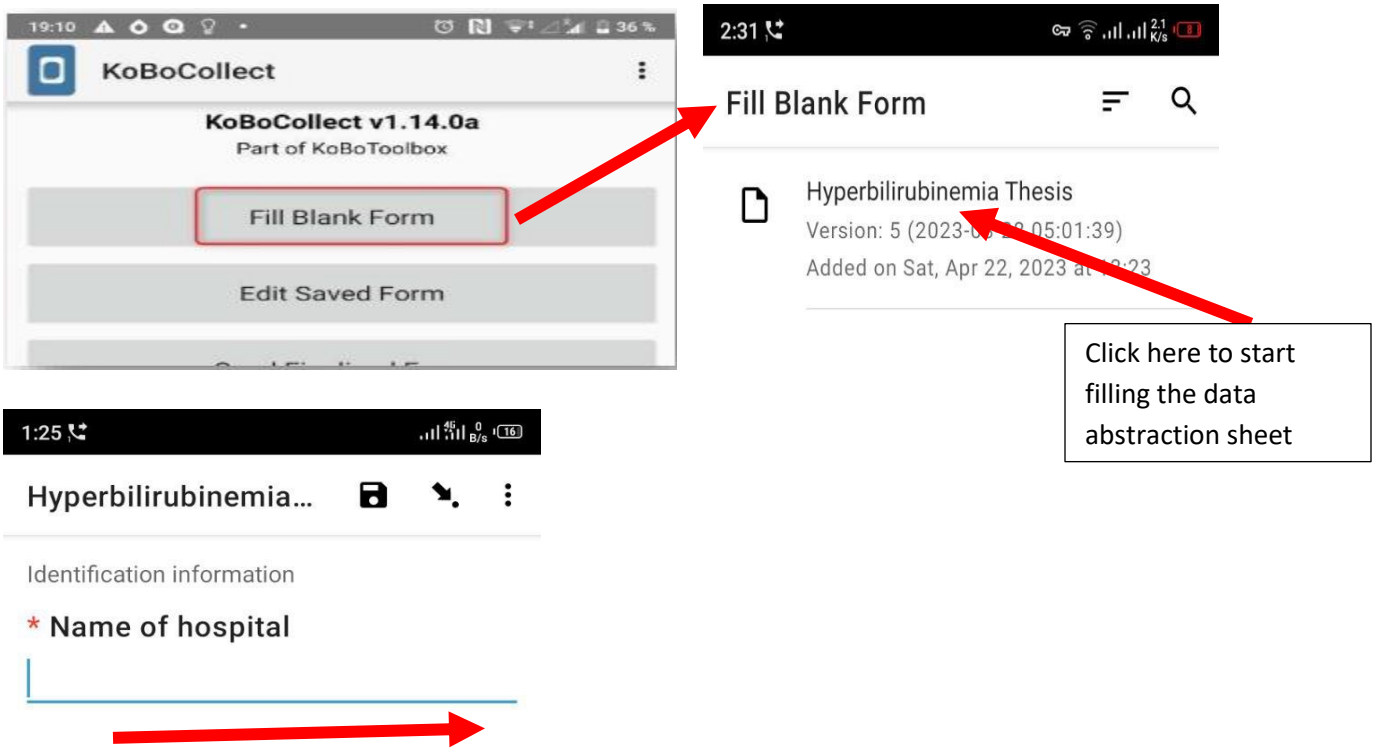


2. Set your login credentials

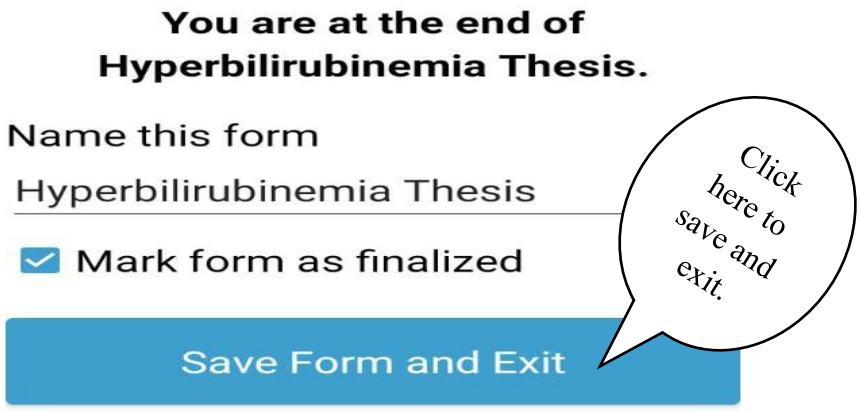
c. Download form



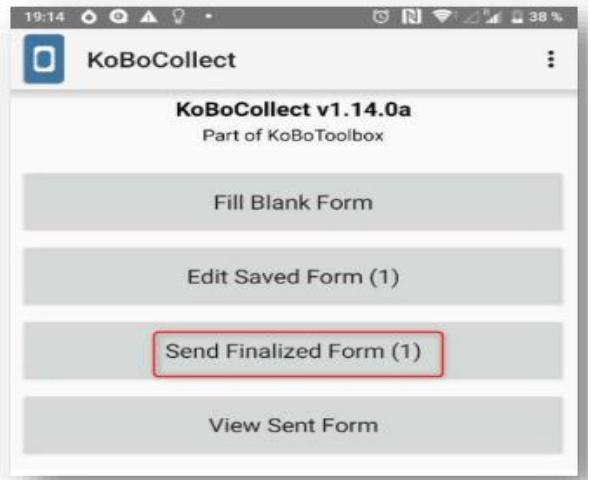
d. Open, fill form and submit

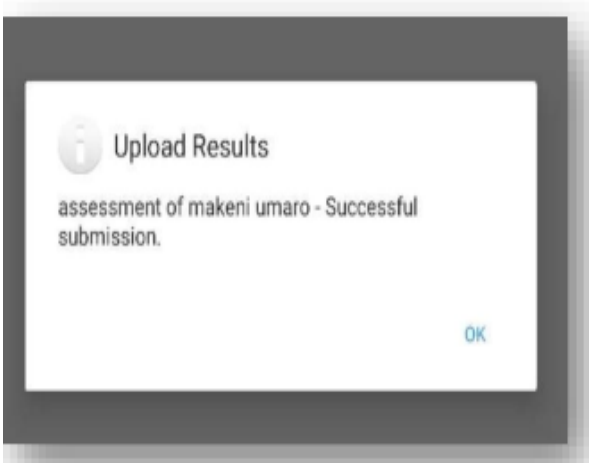


Swipe to move to the next question until you reach the end.



E. Send submitted data to the server





Remarks

1. Complete the form, by answering the questions. **All the questions with an (*) asterisk are mandatory and required questions.**
2. While completing the form you must note that you have different types of answers that you can submit.
3. Please note that you are requested to submit the same day activity for each of the single day data abstraction of the patient records.

2.5. The types of questions in the KoBo collect form

In the KoBo Collect form you have different options to answer the questions. Here you will find the explication to all of the different options.

1. **Open answer (figure 1)**: You are welcome to answer this question with an open answer, by typing in directly your reply to the question.
2. **Single choice answer (figure 2):** You are requested to choose only one answer, by ticking the round circle.
3. Date and time: select the date and time by scrolling down or upward from the given calendar **(figure 3)**.

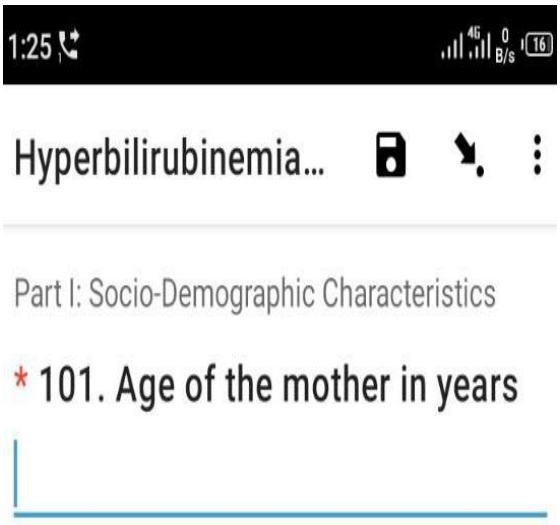


Figure 1: Open answer Question

Figure 2: Single choice answer Question

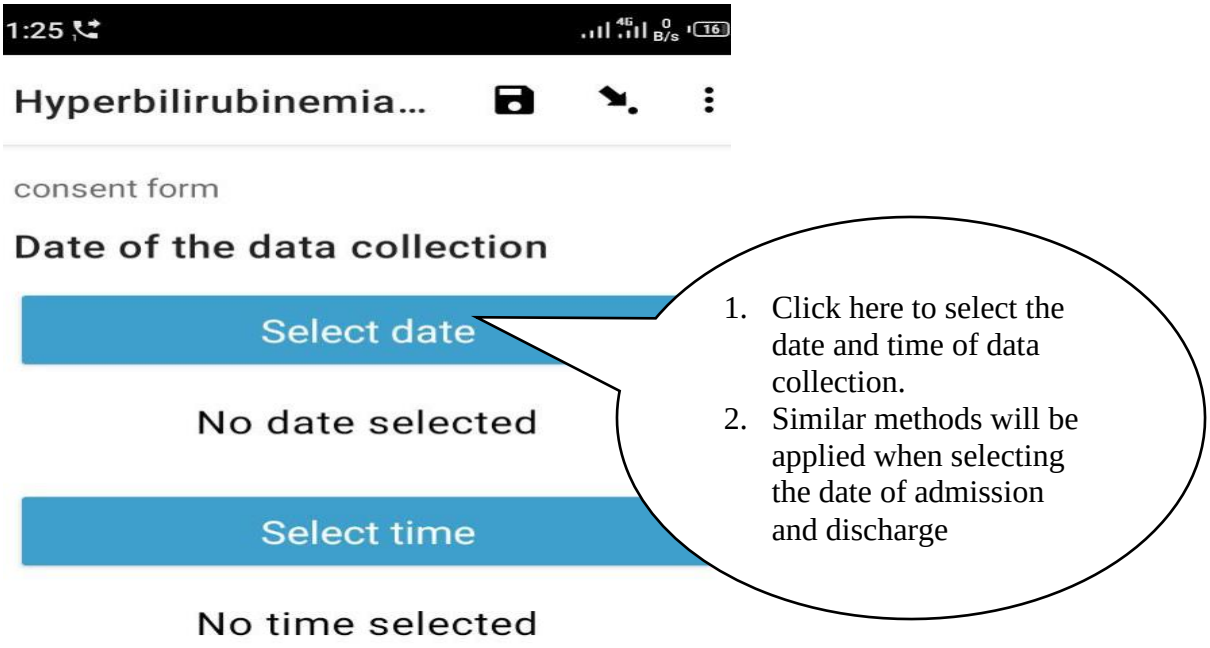


Figure 3: Date and time

ANNEX IV: Plagiarism Report

 determine the survival status and predictors of mortality among neonates admitted with hyperbilirubinemia in neonatal intensive care units in public hospitals of Addis Ababa, Ethiopia, 2023.

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