THE EFFECT OF PHOTOTHERAPY ON SERUM CALCIUM LEVEL IN TERM NEONATES WITH JAUNDICE AT KENYATTA NATIONAL HOSPITAL: A PROSPECTIVE OBSERVATIONAL STUDY

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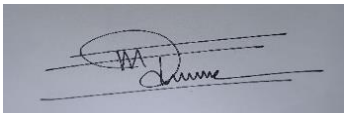
A RESEARCH DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF MASTERS OF MEDICINE, DEPARTMENT OF PEDIATRICS AND CHILD HEALTH, FACULTY OF HEALTH SCIENCES, UNIVERSITY OF NAIROBI.

2023

DECLARATION

This dissertation is my original work and has not been submitted for any academic award or published in any other university or any other institution of higher learning for the award of a degree.

Dr. Mohamednoor Ismail Omar

Signature:  **Date:**29th September, 2023

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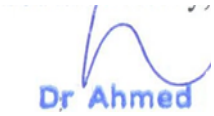
Signature:  **Date**: 29th September, 2023

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AAP: America Academy for Pediatrics

ANC: Antenatal care

HIE: Hypoxic Ischemic Encephalopathy

IQR: Inter-Quartile Range

KNH: Kenyatta National Hospital

NICU: Neonatal Intensive care unit OR: Odds ratio

PI: Principal Investigator

SD: Standard Deviation

SPSS: Statistical Package for Social Sciences

TSB: Total Serum bilirubin

UDPGT: Uridine diphosphate glucuronyl transferase

UoN: University of Nairobi

WHO: World Health Organization

DEFINITION OF TERMS

Hypocalcaemia: is defined as total serum calcium concentration of <7mg/dl (1.75mmol/L) in preterm and serum calcium <8mg/dl(2mmol/L) in term neonates.

Jaundice: is a condition in which the skin, whites of the eyes and mucous membranes turn yellow because of a high level of bilirubin, a yellow-orange bile pigment.

Neonate: An infant less than four weeks old.

Phototherapy: is treatment with a special type of light and it is commonly used to treat new-born jaundice by lowering the bilirubin levels in the neonate's blood.

ABSTRACT

Background: Jaundice in neonates occurs when the bilirubin level rises above 85µmol/L, and it is common in more than half of term neonates. Phototherapy is a common intervention for neonates with jaundice. However, phototherapy has been associated with complications such as hypocalcaemia.

The purpose of the study: The prevalence of phototherapy-induced hypocalcaemia among term neonates with jaundice on phototherapy after 48 hours at Kenyatta National Hospital.

Materials and methods: This study was a prospective observational study. A consecutive sampling technique was used to recruit 91 Newborns. Data collection was done using a data a standardized questionnaire.

Data analysis: Both descriptive and inferential data analysis were performed. A Paired sample t-test was used to compare serum calcium and bilirubin levels before and after phototherapy. Binary logistic regression was done to investigate factors associated with hypocalcaemia after phototherapy. Data was analyzed using Statistical Package for Social Sciences (SPSS version 26). The level of significance was evaluated at $p<0.05$.

Results: The prevalence of hypocalcaemia after phototherapy was 19.8%, 95%CI: 12.2% - 29.5%. There was statistically significant difference between serum calcium levels before (M = 2.27, SD±0.2) mmol/l and after phototherapy (M = 2.14, SD±0.22) mmol/l, t (90) =6.355, $p<0.001$. There was also significant difference in bilirubin levels before (M = 314.14, SD±65.57) µmol/L and after phototherapy (M = 179.0, SD±42.69), t (90) = 22.71, $p<0.001$. Multivariable analysis revealed that, less than four visits (AOR =8.91, 95%CI:2.01 – 23.11, p=0.006), female neonate (AOR =15.01, 95%CI:5.01 – 39.11, p =0.004), and referral status (AOR =13.11, 95%CI:4.01 – 23.11, p =0.002) were independent factors associated with hypocalcaemia after phototherapy.

Conclusion and recommendations: The findings have established that there was significant reduction in serum calcium level and bilirubin levels after phototherapy although <4 ANC visits, female neonates and referral status were found to be associated.

CHAPTER ONE: INTRODUCTION

1.1.Background

Neonates are a vulnerable group at high risk of morbidity and mortality. One of the major complications in the first week of life among neonates is jaundice (1). This condition occurs when the bilirubin level rises to more than 85µmol/L, and it is observed in approximately 60% of term babies and around 80% of preterm neonates (2). In most cases of jaundice, the condition is benign, and thus no management is required, although around 5% of neonates with jaundice are clinically severe, requiring management (3). Phototherapy is a key modality used in managing hyperbilirubinemia among neonates, and it is easily accessible compared to other advanced techniques (4). Despite phototherapy being a key intervention, it has been associated with complications including dehydration, diarrhoea, skin rashes, hyperthermia, bronze baby syndrome and hypocalcaemia (5).

Hypocalcaemia has been significantly associated with neonatal complications such as convulsion, apnea, laryngospasm and jitteriness (6). Calcium forms a fundamental component in many biochemical processes such as cell membrane integrity, blood coagulation, and neuromuscular excitability. It is also essential in homeostasis and nerve conduction (7). Although calcium is transferrable from mother to fetus during the third trimester of gestation, the abrupt cessation of placental transfer of calcium that occurs after birth is considered a major factor in the development of neonatal hypocalcaemia (8). Hypocalcaemia in neonates occurs in approximately 8.7% of term new-borns. Further, 90 percent of the preterm and 75 percent of term neonates experience hypocalcaemia after the phototherapy process (9).

In Africa, there are limited studies on the effect of phototherapy on serum calcium levels, with only studies from Egypt showing a statistically significant decrease in serum calcium levels after phototherapy. The difference was found to be statistically significant (10). The effect of

phototherapy on serum calcium levels has not been fully investigated in Sub-Saharan Africa, prompting the need to bridge this gap in understanding and managing jaundice among neonates.

CHAPTER TWO: LITERATURE REVIEW

2.1.Pathophysiology of neonatal jaundice.

Jaundice is a common condition in neonates characterized by a yellow appearance of the eyes. The presence of bilirubin in the dermal and subcutaneous tissue causes this. Bilirubin is mostly metabolized in the liver, where the enzyme uridine diphosphate glucuronyl transferase converts it to glucuronic acid (UDPGT). The saturated form of bilirubin is subsequently released into the bile and excreted via the intestine. The amount of bilirubin in the body increases when this clearance process is ineffective or overwhelmed by the amount of endogenously produced bilirubin after birth, resulting in hyperbilirubinemia and jaundice (11). Neonatal jaundice is a common condition in neonates occurring in more than half of term neonates. This condition might occur as a result of either physiological or pathological mechanisms (12).These mechanisms can be increased or decreased bilirubin production and elimination and an increase in enterohepatic circulation. The majority of neonatal jaundice occurs as a result of physiological conditions (13).

Physiological jaundice is the outcome of an increase in unconjugated bilirubin level, also referred to as indirect hyperbilirubinemia. The severe form of bilirubin can lead to kernicterus, a neurologic syndrome from the release of indirect bilirubin in the basal ganglia. This increases the risk of mortality and morbidity (12). Pathological jaundice has some characteristics, such as jaundice appearing on the first day of life, chronic jaundice signs lasting more than two weeks, and is mostly conjugated (14). The clinically diagnosed jaundice and indirect hyperbilirubinemia are mainly managed through exposure to high-intensity phototherapy light, a visible spectrum, and exchange transfusion.in addition, bilirubin maximises light in the blue range between 420 to 470nm (15).

Phototherapy involves the use of a specific type of light in the management of jaundice. The light in this context decreases serum bilirubin levels through the oxidation process (16).The

photo-oxidation process allows the addition of oxygen, which then dissolve easily in water (17). This process makes it simple for the liver to break down bilirubin in the blood and remove it through excretion in urine. Phototherapy integrates two main approaches, which include conventional phototherapy and fibreoptic phototherapy. Conventional phototherapy occurs when the neonate is exposed to a halogen or fluorescent lamp. Fibreoptic phototherapy, on the other hand, occurs when the neonate lies on a blanket that includes fibreoptic cables and the light travel through this cable and shines on the back of the neonate (1).

After phototherapy begins, bilirubin levels are checked to determine effective treatment. Bilirubin levels are monitored every 6 to 12 hours to see if the intervention works (12). When the bilirubin level lowers to a safe level, phototherapy is terminated. Although infants experience transient rash, diarrhoea, and other few side effects, phototherapy is an inexpensive and non-invasive method of successfully managing neonatal jaundice (14).

2.2.Phototherapy on serum calcium levels in term neonates

Phototherapy has significantly influenced the serum calcium level among neonates with jaundice. A semi-experimental study by Shahriarpanah et al. published in 2018 in Iran revealed that the average serum calcium level significantly decreased from 2.46 mmol/l to 2.38 mmol/l after 48 hours of phototherapy (18). These findings, therefore, reveal that phototherapy could effectively reduce serum calcium levels. Another cross-sectional study conducted by Kale et al. in assessing the effect of phototherapy among term neonates in 2020 in India revealed that there was a significant difference in mean difference in serum calcium level before (M =2.33 mmol/l) and after (M = 2.20 mmol/l) (19). Thus, it has been noted in the study that phototherapy causes hypocalcaemia in neonates with hyperbilirubinemia.

In a prospective study conducted in India by Goyal et al. in 2018, neonates were assessed for clinical features of hypocalcaemia among 100 neonates with hyperbilirubinemia after 48 hours of phototherapy. The results showed that 35% of neonates had hypocalcaemia after

phototherapy, and the difference between pre and post-phototherapy was significant (20). Thus, it is essential to consider calcium supplementation in neonates on phototherapy considering the increased risk of hypocalcaemia.

A case-control study in Egypt by Elshenawi et al. in 2021 was conducted to investigate whether the change in serum calcium level could be attributed to phototherapy after 48 hours and at the end of phototherapy among the cases compared to controls. This study investigated hypocalcaemia as a complication of phototherapy in term newborns with jaundice. The findings revealed that mean calcium was 2.16 ± 0.39 mmol/l pre-phototherapy and 2.06 ± 0.41 mmol/l post-phototherapy. The difference was statistically significant ($p < 0.001$). Calcium level was lower after phototherapy. Pre-phototherapy, 12 (24.0%) showed hypocalcaemia (< 2 mmol/l) and 38 (76.0%) showed normal calcium (> 2 mmol/l). Post-phototherapy, 19 (38.0%) showed hypocalcaemia (< 2 mmol/l) and 31 (62.0%) showed normal calcium (> 8 mmol/l). The difference was as statistically significant ($p = 0.039$). Hypocalcaemia was higher after phototherapy (21). Hypocalcaemia is a common complication of phototherapy.

Another longitudinal descriptive study conducted in Bangladesh by Yeasmin et al. in 2020 revealed total serum bilirubin and calcium levels fall significantly among all groups after phototherapy. The findings revealed that the mean serum level decreased significantly after phototherapy from (M =2.36 mmol/l) to (M =2.31 mmol/l) (5).

A prospective study conducted in India by Balamkar et al. in 2021 found a significant difference in serum calcium levels before and after phototherapy (3). In Nepal, a prospective cross-sectional study conducted by Bahbah et al. in 2021 found that pre-phototherapy and post-phototherapy levels of total serum bilirubin was 248.46 µmol/l ± 49.76 µmol/l and 175.96 µmol/l ± 36.42 µmol/l respectively. In contrast, serum calcium level before and after initiating phototherapy was 2.31 ± 0.28 mmol/l and 2.09± 0.17 mmol/l respectively (2).These findings

have shown that phototherapy is the mainstay of treating hyperbilirubinemia in neonates, decreases serum calcium levels in jaundiced neonates.

A cross-sectional study with controls conducted by Gupta et al. in 2018 in North India revealed that, after 48 hours of phototherapy, there was a significant decrease in serum calcium level in the intervention group (M =4.58 mg/dl) compared to the control group (M =4.94 mg/dl (22). Phototherapy causes the pineal gland to be inhibited by transcranial illumination, resulting in drop-in melatonin levels and enhanced calcium absorption by the bones resulting in hypocalcaemia.

It is hypothesized that phototherapy inhibits pineal secretion of melatonin due to transcranial illumination which in turn blocks the effect of cortisol on bone calcium. So cortisol increases bone uptake of calcium and induces hypocalcaemia as shown in the diagram below.

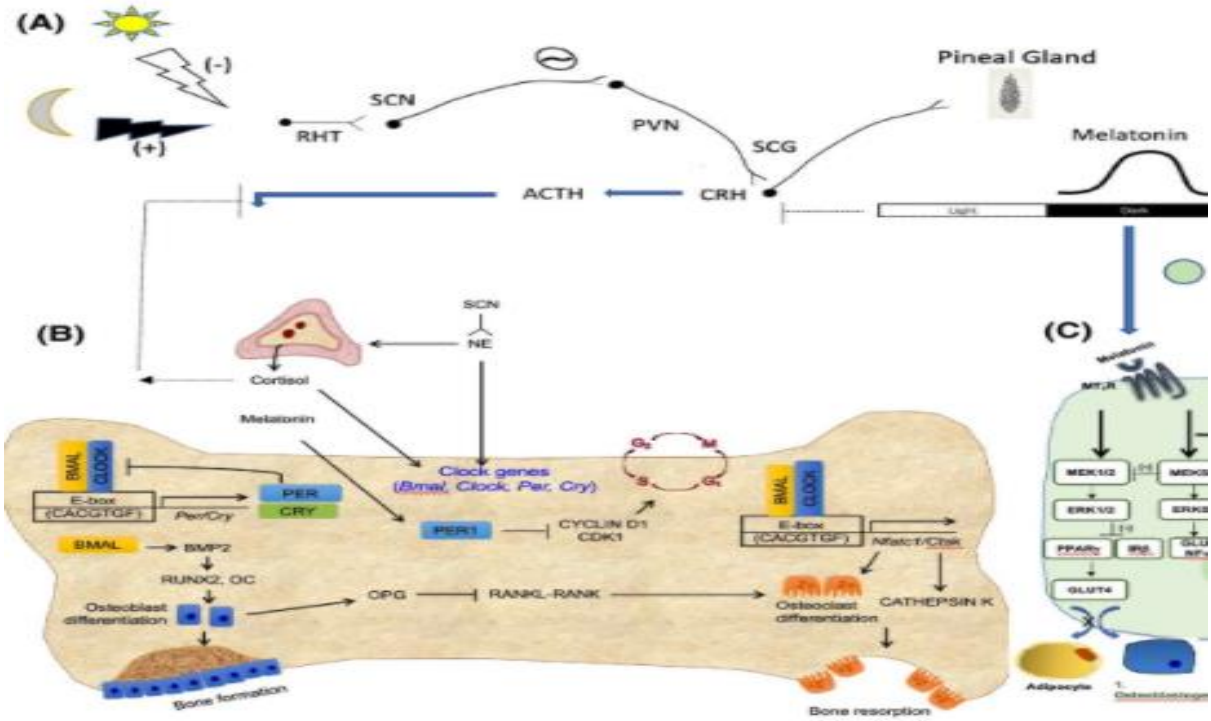


Figure 1: How phototherapy causes hypocalcaemia

2.3.Factors associated with phototherapy-induced hypocalcaemia among term neonates with jaundice on phototherapy

Maternal and obstetric factors

Phototherapy-induced hypocalcaemia is a common complication among jaundiced neonates undergoing phototherapy. Phototherapy-induced hypocalcaemia is associated with different factors such as covering the head and duration of phototherapy, maternal illness during pregnancy and the mother's history of anaemia. In a hospital-based prospective study conducted by Shawky et al in 2021, phototherapy-induced hypocalcaemia was found to be substantially linked with mother illness during pregnancy, mother history of anemia, mother history of oligohydramnios, taking dexamethasone, birth by caesarean section, and physiologic removal efficiency. The results established a difference between those with and without hypocalcaemia when considering gestational age, body weight, heart rate after phototherapy, and abdominal circumference (11)

Gupta et al. in a study conducted in India established that mode of delivery and history of anaemia were significantly associated with phototherapy-induced hypocalcaemia (17).Mothers who had caesarean section delivery were more likely to develop phototherapy-induced hypocalcaemia compared to those who had vaginal deliveries. Further, the findings also asserted that low blood levels were associated with increased risk of phototherapy-induced hypocalcaemia (22). These findings illustrate the need to effectively manage neonates born of mothers with low blood levels and caesarean section delivery to manage the complications associated with phototherapy.

Neonatal factors

A case-control study conducted by Karim et al. in 2018 found that neonates who had their head covered while undergoing phototherapy had lower levels of hypocalcaemia at 15% compared

to those who did not cover their head while undergoing phototherapy at 42% occurrence (23). A randomized controlled trial was conducted in Egypt by Mansi et al. investigating how using a stockinet hat to cover the head reduces phototherapy-induced hypocalcaemia after 48 hours. The study's findings revealed a significant reduction in the incidence of neonates with hypocalcaemia in the group with a hat compared to the group without a hat with 9.7% compared to 24.2% (24). The findings have shown that controlling hypocalcaemia after phototherapy phototherapy by covering the head during phototherapy. This appears to be a safe, effective, and inexpensive means of preventing hypocalcaemia and its sequelae without requiring calcium prophylaxis. Comparable findings were also found in a comparative cross-sectional study conducted in Iran by Karamifar et al. which found that after 48 hours, there was a significantly lower level of hypocalcaemia in a group with hat, 14% compared to 38% in the group of neonates without hat undergoing phototherapy (25).

Another study conducted in Karachi, Pakistan investigating the frequency of hypocalcemia revealed that the neonates had a mean age of 8.35 days, with a standard deviation of 6.74 days. The average length of gestation at birth was 39.08 weeks, with a standard deviation of 1.37 weeks. The duration of jaundice ranged from 2.4 to 1.20 days on average. The length of phototherapy ranged from 1.74 to 0.98 days on average. Before beginning phototherapy, the serum calcium level was 2.18 ± 0.17 mmol/l, however it dropped to 1.86 ± 0.20 mmol/l after 24 hours. The incidence of hypocalcemia in term newborns with jaundice who were treated with phototherapy was found to be 22.76 percent (28/123) of the time (1).

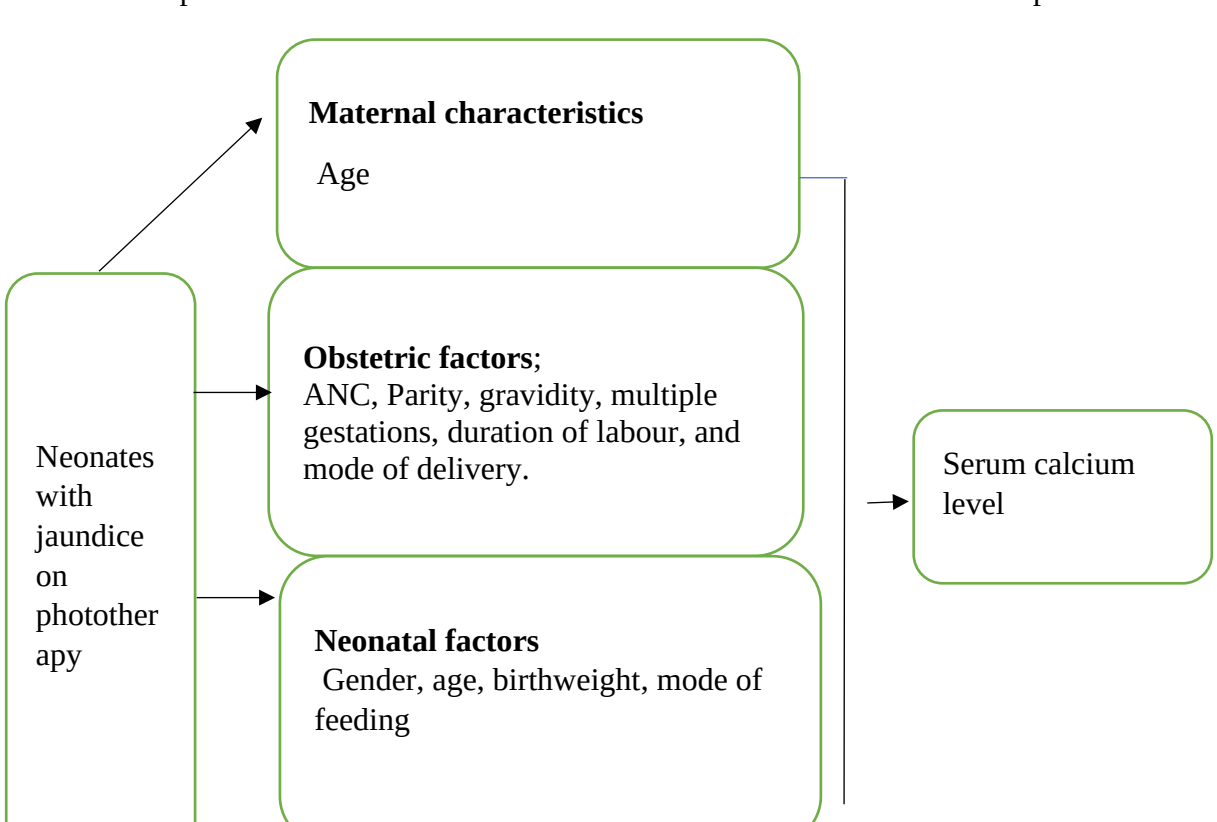
Similarly, a study in Tehran revealed that hypocalaemia among neonates on phototherapy was higher among male neonates (10.4%) compared to female neonates (4.2%) (26).

2.4.Conceptual framework

2.4.1. Narrative

The study seeks to investigate whether there is any significant difference in the serum calcium level in neonates undergoing phototherapy and neonates without jaundice. Therefore, the independent variables investigated in this context include maternal characteristics, obstetric factors and neonatal factors. The maternal characteristics will integrate maternal age. The obstetric characteristics investigated in this case include ANC, Parity, gravidity, multiple gestations, duration of labour, and mode of delivery. In contrast, neonatal characteristics will include gender, age, birthweight and mode of feeding. Studies have found that the use of hats has been associated with increased calcium levels hence use of hats during phototherapy will be a confounding variable. The dependent variable is serum calcium level, from which we will be able to determine the presence of hypocalcemia.

2.4.2. Conceptual framework diagram



2.5.Justification of the study

Phototherapy is a commonly used technique in the management of neonatal jaundice. However, despite its importance in controlling jaundice, it has also been associated with complications, including hypocalcaemia. Hypocalcaemia has been associated with serious conditions such as convulsions, apnea, laryngospasm, irritability, jitteriness and even death. Findings from the literature have shown a significant difference in the serum calcium level before and after phototherapy. However, there is less understanding of whether the difference is attributed to phototherapy or other mechanisms. Thus, based on limited data on this concept. This study seeks to effectively investigate the effect of phototherapy on the serum calcium level of term neonates with jaundice.

2.6.Research question

Is there a significant difference in serum calcium level after 48 hours among term neonates with jaundice before and after phototherapy?

2.7.Objectives of the study

2.7.1. Primary objective

The prevalence of phototherapy - induced hypocalcaemia among term neonates with jaundice on phototherapy after 48 hours at Kenyatta National Hospital.

2.7.2. Secondary objectives

To compare serum calcium levels before and after 48 hours among term neonates with jaundice on phototherapy.

To determine factors associated with phototherapy-induced hypocalcaemia among term neonates with jaundice on phototherapy after 48 hours at Kenyatta National Hospital.

CHAPTER THREE: METHODOLOGY

3.1.Research design

This was a prospective observational study. The serum calcium levels were compared before and 48 hours after phototherapy. The difference in serum calcium levels before and after phototherapy were used to determine if the change in serum calcium levels after phototherapy is due to phototherapy. Only neonates with jaundice (indirect hyperbilirubinemia) requiring on phototherapy were recruited into the study.

3.2.Study site and setting

The study was conducted at Kenyatta National hospital's New Born Unit and Paediatric Wards. Kenyatta National hospital is the largest referral hospital in Kenya, with a bed capacity of 1,800 and approximately 6,000 staff. The hospital is located in Nairobi County in the upper hill region of Kenya. The department of obstetrics has four post-natal wards. Mothers post-delivery are admitted to these wards depending on their entry point. The post-natal wards include GFA, GFB 1A and a critical care unit (CCU). On average, 25 caesarean and 30 normal deliveries are conducted daily. Most post-natal mothers who stay longer than one week have newborns admitted to the Newborn Unit.

3.3.The study Population

The study included term neonates (37 completed weeks) admitted to the New-born Unit at Kenyatta National Hospital. Term neonates might be admitted for varied reasons which include but not limited to jaundice, breathing problems and birth injuries. In this case, neonates with jaundice admitted were investigated.

3.4.Inclusion Criteria

- Term neonates 0-14 days of age.
- Agree to consent

3.5.Exclusion criteria

- Birth asphyxia
- Preterm neonates
- Severe Respiratory distress requiring oxygen supplementation
- congenital malformations
- Hyperbilirubinemia in the range requiring exchange transfusion
- The mother took phenobarbitone during the antenatal period
- History of hyperthyroidism in mother
- Infant of diabetic mother.
- Low calcium at baseline (<2 millimoles/L)
- Neonates given Vitamin D
- Incomplete diagnostic tests
- Decline to consent

3.6.Case definition

Hypocalcaemia in our study was defined as a total serum calcium of <2 millimoles/L

3.7.Sample size determination

The sample size was determined using Fischer's formula.

$$n = \frac{Z\alpha^2 p(1-p)}{d^2}$$

n= estimated minimum sample size

p= proportion of characteristics in the population of interest (0.38) A study by Elshenawi et al. in 2021 revealed that after 48 hours of phototherapy, 38% of the neonates developed hypocalcemia (21).

d= 10% margin of error

$Z\alpha = 1.96$,)

Thus, substituting the formula,

Minimum required sample size = **91**

3.8.Sampling technique

A consecutive sampling technique was used. With the help of 2 research assistants, the principal investigator consecutively sampled the target population while identifying those who meet the inclusion criteria until the sample population was achieved.

3.9.Study variables

Independent variables: The maternal characteristics: Maternal age. The obstetric characteristics: Parity, gravidity, multiple gestations, duration of labour, and mode of delivery, while neonatal characteristics will include gender, age and birth weight.

Dependent variables: Serum calcium level

3.10. Data collection tool

A research questionnaire was used to collect information from the participants to ensure that the findings are unbiased and accurate based on the underlying research objectives being evaluated.

3.11. Research assistants

The principal investigator recruited two qualified clinical officers to help in data collection processes. The clinical officers had a minimum of diploma level qualification and worked in a clinical setting and for at least six months in post-natal wards. The research assistants provided consent to mothers who delivered. They were also tasked with drawing blood from the neonates. The research assistants who were recruited were required to have experience in data collection to make it easier to approach and handle the study participants with a high level of

professionalism. This was aimed at controlling conflict of interest and breach of confidentiality. All research assistants must abide by the study's ethical guidelines.

As the principal investigator, I oversaw the data collection and ensure that my research assistants collect quality data through successful engagement with participants in the study. I drew blood samples from the neonates. I reviewed the filled questionnaire to ensure completeness. The research assistants were present at the Newborn Unit and the wards daily, engaging potential participants and ensuring they consent before enrolment.

3.12. Consenting process

The principal investigator (PI), with the help of the recruited research assistants, approached mothers who delivered live-term neonates that have completed 37 weeks, are within 0 to 14 days after delivery and have indirect hyperbilirubinemia to seek consent. The consent was requested before initiation of the phototherapy session to ensure that blood sample is collected and serum calcium levels before phototherapy are captured. The PI familiarized the study to all those potential respondents with key emphasis on the purpose of the study, the benefits of participating in the study, the risks involved, and the level of privacy and confidentiality that were accorded to them if they agree to participate. Only those who agreed to consent were recruited into the study. After consenting, a copy of the consent was produced and given to the participant for their reference.

3.13. Data collection procedure

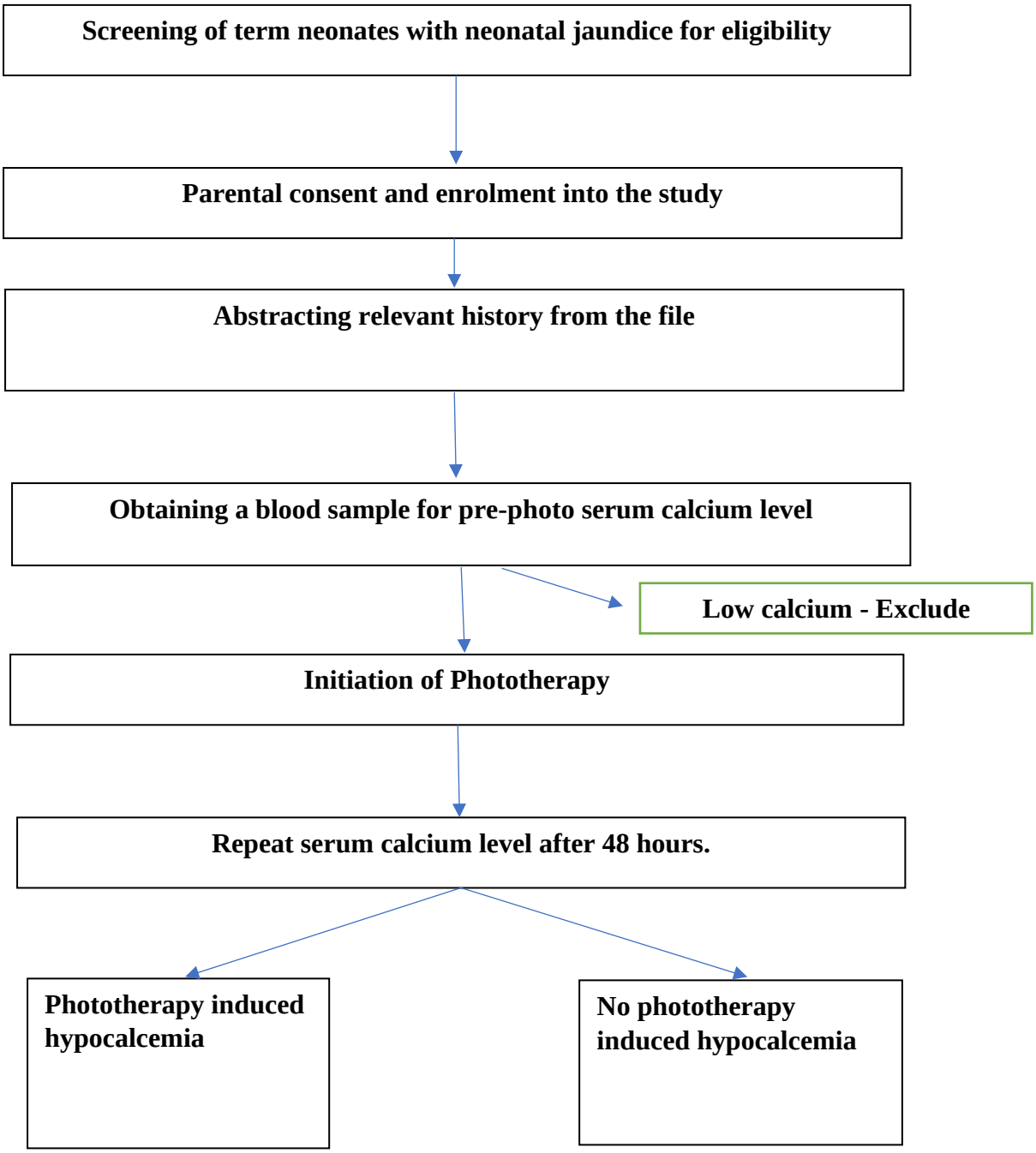
The data collection process began after approval from KNH – UoN Ethics Committee and permission to conduct the study from the KNH administration. With the help of research assistants, the PI engaged the potential participants. For the cases, once the consent was obtained, the PI got the baseline serum calcium level before phototherapy. The mother was also required to fill out the study questionnaire, and the information provided by the respondent

were verified from the patient admission file. The PI again obtained the measurement of serum calcium after 48 hours.

A phototherapy equipment containing blue light fluorescent lamps with a wavelength between 410 and 470nm was placed at a distance of between 30 to 40 cm. The America Academy for Pediatrics (AAP) guidelines was used for phototherapy. The irradiance during phototherapy was measured and maintained as to whether the neonate required standard or intensive phototherapy. However, this was not possible for all the subjects as not all the phototherapy machines had light meter. The primary outcome was to determine the prevalence of hypocalcaemia after 48 hours of phototherapy.

The secondary outcome was to compare serum calcium level before and after phototherapy and factors associated with phototherapy-induced hypocalcaemia among term neonates with jaundice on phototherapy before and after 48 hours at Kenyatta National Hospital.

3.14. Flowchart



3.15. Quality assurance

The placement of the phototherapy equipment was maintained at the same wavelength within 410 to 470nm for all neonates included in the study. The placement distance was between 30 to 40cm for all study subjects undergoing phototherapy using machines that did not have light meter while those that had light meter had irradiance measured. Thus, the irradiance dose and the standard placement distance of the phototherapy was used for standardization of this treatment. The measurement of 48 hours was maintained for all the neonates included in the study. On the same note, 2 ml of venous blood is withdrawn before initiation of phototherapy and after 48 hours of phototherapy. The samples were delivered to the Lab within an hour, where it is centrifuged and separated. The sample was run using HUMA STAR 600 machine, which operates using a closed system. The machine was serviced with the next service due in April 2023. This is machine that is used at Kenyatta National Hospital for patient care. It is calibrated daily, and controls run daily. Quality control in Lab assured by experienced technicians, timely centrifuging, prompt separation, storage at the recommended temperature, and availability of results promptly.

3.16. Data analysis

Data was analysed objectively. The SPSS version 26 program was used to analyze the data. All comparisons were made at a significance level of 0.05. Both descriptive and inferential analysis were used in the analysis. Categorical data was examined and depicted in graphs and pie charts using frequencies and percentages. The mean (SD) or median was used to assess continuous data (IQR). This was represented in tables. A paired t-test will be conducted to investigate the presence of significant difference between pre and post calcium values. Thus, a p-value<0.05 indicated a significant difference between the two calcium values.

3.17. Ethical Consideration

This proposal got the approval of both the KNH-UoN Ethics Committee for and Kenyatta National Hospital for permission to collect data. Participation in the study was purely voluntary; thus, only those who consented to participate were recruited. The researcher did not coerce anyone to participate in the study but focussed on the willingness of the respondent to participate.

The purpose of the study was explained to the respondents, including an assessment of the benefits and potential risks of participation in the study. There were no major risks associated with participation in the study apart from obtaining blood samples for serum calcium before and 48 hours after phototherapy. Thus, the mothers who met the inclusion criteria and agreed to participate in the study were recruited.

This study strongly emphasised on confidentiality and anonymity, which is the foundation of ethical research. The researcher also maintained anonymity and confidentiality by using none identifiers such as codes that cannot link a participant with the information provided during the study. The information obtained was solely for this study to improve care and not divulge personal information to the public. Recorded data was under the custody of the principal researcher until validation within one year, after which the data will be destroyed.

3.18. Dissemination of findings

The findings from the study was presented to the paediatric and child health department, University of Nairobi. The findings will also be published in a peer-reviewed journal to provide knowledge on phototherapy and serum calcium.

CHAPTER FOUR: RESULTS

4.1.Introduction

The study sought to examine the effect of phototherapy on calcium level after 48 hours among term neonates diagnosed with jaundice. A total of 91 patients were followed up for 48 hours at Kenyatta National Hospital. Ninety-eight patients were approached, five mothers declined follow up. Two of the patients were lost to follow up. Therefore, seven participants were excluded from the study.

4.1.1. Study flowchart

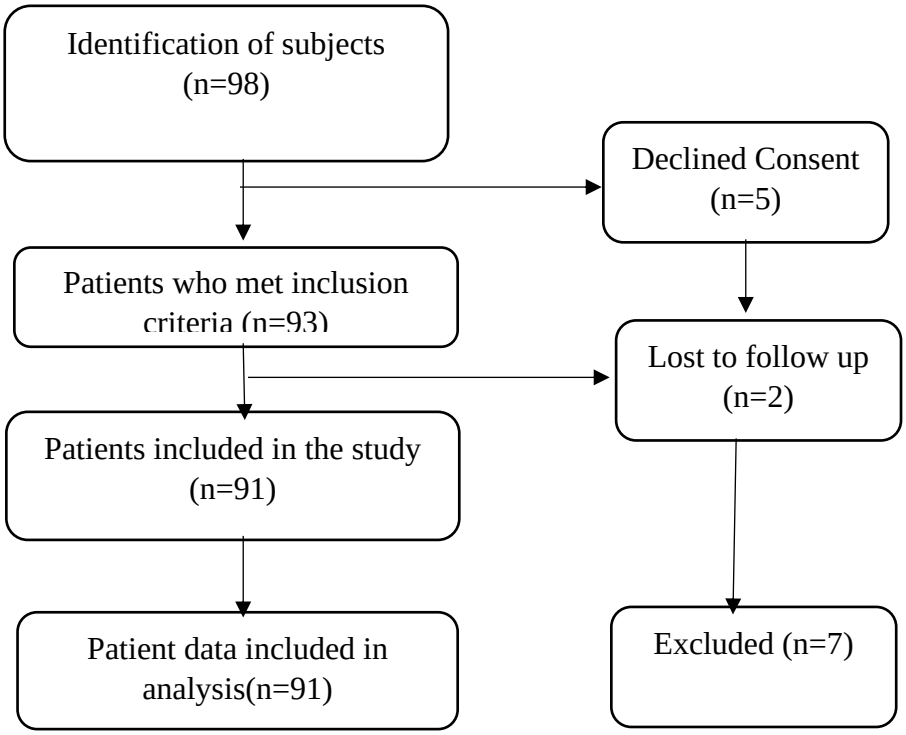


Figure 2: Study flowchart

4.1.2. Maternal characteristics of mothers of neonates diagnosed with jaundice admitted at Newborn Unit at KNH.

More than half, 58.2%(53) of mothers were aged between 25 and 34 years, 54.9%(50) had secondary level education. Majority, 84.6%(77) of the mothers were married, 63.7%(58) were multiparous, 71.4%(65) of the mothers had four or more antenatal visits as shown in Table 1.

Table 1: Maternal characteristics of mothers of neonates diagnosed with jaundice admitted at Newborn Unit at KNH.

	Frequency	Percent
Age		
<=24 years	14	15.4
25 - 34 years	53	58.2
35 years and above	24	26.4
Education		
Primary level	2	2.2
Secondary level	50	54.9
Tertiary	39	42.9
Marital status		
Single	14	15.4
Married	77	84.6
Residence		
Urban	54	59.3
Rural	37	40.7
Parity		
Nulliparous	33	36.3
Multiparous	58	63.7
Number of ANC visits		
<4	26	28.6
4 or more	65	71.4
Multiple pregnancy		
Yes	8	8.8
No	82	90.1
Mother blood group		
A+	21	23.1
AB+	3	3.3
B-	1	1.1
B+	20	21.9
O-	1	1.1
O+	45	49.5

4.1.3. Characteristics of term neonates diagnosed with jaundice and admitted at Kenyatta National hospital new-born unit

Fifty-three (58.2%) of the children were female, 51.6%(47) were born at Kenyatta national hospital.. Child age was investigated, 84.6%(77) were less than seven days old. Caesarean section was the common mode of delivery, 60.4%(55) as shown in Table 2.

Table 2:Characteristics of term neonates diagnosed with jaundice and admitted at Kenyatta National hospital new-born unit

	Frequency	Percent
Gender		
Male	38	41.8
Female	53	58.2
Place of birth		
KNH	47	51.6
Referral	44	48.4
Child age		
<7 days	77	84.6
>=7 days	14	15.4
Mode of delivery		
SVD	36	39.6
Caesarean section	55	60.4
HB levels		
<14 g/dL	10	11.0
>14 g/dL	81	89.0
Blood group (n = 43)		
A+	12	27.9
AB+	3	7.0
B-	1	2.3
B+	8	18.6
O-	1	7.0
O+	18	41.9

4.2.Prevalence of hypocalcaemia after phototherapy

The prevalence of hypocalcaemia after phototherapy was 19.8%, 95%CI: 12.2% - 29.5% as shown in Figure 3.

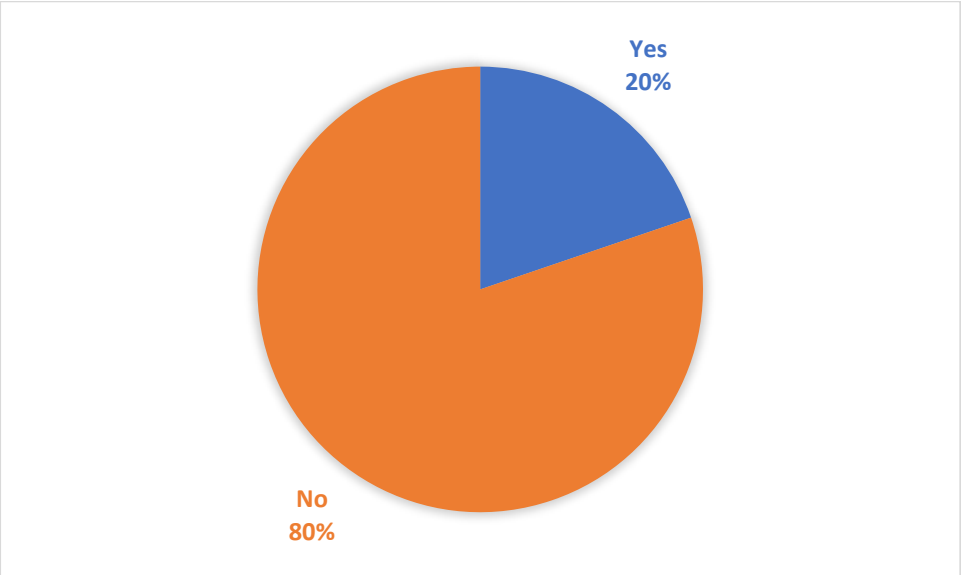


Figure 3:Prevalence of hypocalcaemia after 48 hours of phototherapy

4.3.Comparison of serum calcium and bilirubin levels before and after 48 hours among term neonates with jaundice on phototherapy

A paired sample t-test was conducted to investigate whether there was significant difference in serum calcium and bilirubin levels before and after 48 hours. The findings showed that there was statistically significant difference between serum calcium levels before (M = 2.27, SD±0.2) mmol/l and after phototherapy (M = 2.14, SD±0.22) mmol/l, *t* (90) =6.355, p<0.001. There was also significant difference in bilirubin levels before (M = 314.14, SD±65.57) umol/l and after phototherapy (M = 179.0, SD±42.69), *t* (90) = 22.71, p<0.001 as shown in Table 3.

Table 3: Comparison of serum calcium and bilirubin levels before and after 48 hours among term neonates with jaundice on phototherapy

Parameters	Before	After	t-statistic	p-value
Bilirubin	314.14±65.57	179±42.69	22.71	<0.001
Calcium	2.27±0.2	2.14±0.22	6.355	<0.001

4.4.Factors associated with hypocalcaemia after 48 hours of phototherapy among term neonates with jaundice on phototherapy after 48 hours at Kenyatta National Hospital.

Mothers who were nulliparous were five time likely to have hypocalcaemia after phototherapy compared to those who were multiparous, OR =4.95, 95%CI: 1.64 – 14.93, p =.005. The odds of mothers who had less than four ANC visits were 12 times higher than those who had 4 or more, OR =12.0, 95%CI: 3.61 – 39.56, p<0.001. Those who were referred were eight times likely to have hypocalcaemia compared to those who were born in KNH, OR =7.59, 95%CI:2.02 – 28.55, p=0.003. (Table 4).

Table 4: Factors associated with hypocalcaemia after 48 hours of phototherapy among term neonates with jaundice at Kenyatta National Hospital.

	Hypocalcaemia			
	Yes n(%)	**No n(%)**	**95%CI**	**P-value**
Age				
<=24 years	4(22.2)	10(13.7)	0.50(0.10 - 2.43)	0.390
25 - 34 years	10(55.6)	43(58.9)	0.86(0.24 - 3.08)	0.817
35 years and above	4(22.2)	20(27.4)	Ref	
Marital status				
Single	4(22.2)	10(13.7)	1.80(0.49 - 6.58)	0.465
Married	14(77.8)	63(86.3)	Ref	
Residence				
Urban	7(38.9)	47(64.4)	0.35(0.12 - 1.02)	0.063
Rural	11(61.1)	26(35.6)	Ref	
Parity				
Nulliparous	12(66.7)	21(28.8)	4.95(1.64 - 14.93)	0.005
Multiparous	6(33.3)	52(71.2)	Ref	
ANC				
<4	13(72.2)	13(17.8)	12.0(3.64 - 39.56)	<0.001
4 or more	5(27.8)	60(82.2)	Ref	
Gender of child				
Male	2(11.1)	36(49.3)	Ref	
Female	16(88.9)	37(50.7)	7.78(1.67 – 36.31)	0.009
Place of birth				
KNH	3(16.7)	44(60.3)	Ref	
Referral	15(83.3)	29(39.7)	7.59(2.02 – 28.55)	0.003
Child age				
<7 days	16(88.9)	61(83.6)	1.57(0.32 - 7.76)	0.728
>=7 days	2(11.1)	12(16.4)	Ref	
Mode of delivery				
SVD	5(27.8)	31(42.5)	0.52(0.17 - 1.62)	0.294
Caesarean section	13(72.2)	42(57.5)	Ref	
HB level				
<14 g/dL	1(5.6)	9(12.3)	0.42(0.05 - 3.53)	0.680
>14 g/dL	17(94.4)	64(87.7)	Ref	

4.4.1. Multivariable analysis of risk factors associated with hypocalcaemia after phototherapy

Significant variables in bivariable analysis ($p<0.05$) were included in multivariable analysis as shown in Table 5. The findings established that mothers who had less than four visits were nine times likely to have hypocalcaemia as compared to those who had four or more visits, AOR =8.91, 95%CI:2.01 – 23.11, p=0.006. Female children were 15 times more likely to have hypocalcaemia after phototherapy compared to male patients, AOR =15.01, 95%CI:5.01 –

39.11, p =0.004. Children who were referred were 13 times likely to have hypocalcaemia after phototherapy compared to those who were born in KNH, AOR =13.11, 95%CI:4.01 – 23.11, p =0.002 as shown in Table 5.

Table 5:Multivariable analysis of risk factors associated with hypocalcaemia after phototherapy

Factors	**AOR(95%CI)**	**P-value**
Parity		
Nulliparous	7.02(0.85 - 21.55)	0.071
Multiparous	Ref	
ANC visit		
Less than four visits	8.91(2.01 - 23.11)	0.006
≥4 visits	Ref	
Gender of child		
Female	15.01(5.01 - 39.11)	0.004
Male	Ref	
Place of birth		
Referral	13.11(4.01 - 23.11)	0.002
KNH	Ref	

CHAPTER FIVE: DISCUSSION

5.1.Prevalence of phototherapy-induced hypocalcaemia among term neonates with jaundice

The findings from present study revealed that the prevalence of hypocalcaemia after 48 hours of phototherapy was 19.8%. These findings are comparable to a study in Nepal by Basnet et al. which revealed that among term neonates the prevalence of hypocalcaemia was 14% with majority of them experiencing hypocalcaemia after 48 hours of phototherapy (4). However, the present findings were lower compared to a study conducted in Saudi Arabia by Khan et al. which established that hypocalcaemia after phototherapy was 22.8% after 24 hours (1). Similarly, another study in India also found higher prevalence of hypocalcaemia after phototherapy at 35% (20). The findings from the present study also contrast those from another study in Egypt which established that between the two groups who were on phototherapy, those with hat and those without, the proportion of hypocalcaemia was 24.2% in the group without hat and 9.7% in the group with hat. These findings illustrate that phototherapy-induced hypocalcaemia can be prevented by covering the head during phototherapy (24). This seems to be a safe, effective, and cheap method to prevent hypocalcaemia and its complications, with no need for prophylactic administration of calcium. Another study conducted in India established that after 48 hours of phototherapy, the prevalence of hypocalcaemia was 30% in term neonates and 70% among preterm neonates (27). In another study in Kolhapur, India, found that the prevalence of hypocalcaemia after phototherapy was 26% (9). There are also studies which found significantly high hypocalcaemia after phototherapy among term neonates. There is a study in Saudi Arabia that established high prevalence of hypocalcaemia after phototherapy where 40% of term neonates developed hypocalcaemia after 48 hours of phototherapy. The high number of hypocalcaemia after phototherapy could be explained by the assertion that term neonates have a greater need for calcium because they undergo significant

skeletal growth during the first few months of life. Additionally, they have a higher demand for calcium to support muscle function, cardiac function, and nerve conduction. Therefore, term neonates require a higher intake of calcium compared to preterm neonates. Thus, healthcare providers should closely monitor calcium levels in term neonates receiving phototherapy and supplement their calcium intake as needed to prevent hypocalcaemia. The findings from the present study were also higher compared to findings from a study in Iran, a study reflects 7% of term neonates with hypocalcaemia after phototherapy (26). As a result of phototherapy, the pineal gland is suppressed by transcranial light, which leads to a decrease in melatonin levels and an increase in calcium absorption by the bones, which ultimately results in hypocalcaemia.

5.2.Comparison of serum calcium levels before and after 48 hours among term neonates

The present study found that the average serum levels were higher before phototherapy (M = 2.27, SD±0.2) mg/dl compared to after phototherapy (M = 2.14, SD±0.22)mg/dl. The difference was found to be statistically significant. These findings are consistent with those from a study conducted in India which revealed that there was a significant difference in mean serum calcium level before (M =2.33 mmol/l) and after (M = 2.20 mmol/l) (19). Another comparable case control study in Egypt by Elshenawi et al. comparing serum calcium level before and after phototherapy found that the mean calcium was 2.16 ± 0.39 mmol/l pre-phototherapy and 2.06 ± 0.41 mmol/l post-phototherapy. The difference was statistically significant ($p < 0.001$) (21). Further, the present findings were also consistent with those from a study conducted in Bangladesh by Yeasmin et al. revealed that total serum bilirubin and calcium levels fall significantly among all groups after phototherapy.The findings revealed that the mean serum level decreased significantly after phototherapy from (M =2.36 mmol/l) to (M =2.31 mmol/l) (5).

5.3.Factors associated with hypocalcaemia after phototherapy.

The factors from the present study established that mothers who had less than four visits were nine times likely to have hypocalcaemia as compared to those who had four or more visits. These findings however are inconsistent with those from a study in Tehran by Sajjadian et al. (2013) which did not find any association between ANC visit and hypocalcaemia after phototherapy (26). While ANC visits may not directly prevent phototherapy-induced hypocalcaemia, they can help identify and manage risk factors for neonatal jaundice, which is a known risk factor for hypocalcaemia. ANC visits also provide an opportunity for healthcare providers to monitor neonates who have undergone phototherapy and identify any potential complications, including hypocalcaemia.

The present findings also established that Female children were 15 times more likely to have hypocalcaemia after phototherapy compared to male patients. These findings are also incomparable with those from Tehran by Alizadeh-Taheri et al. who found that hypocalcaemia among neonates on phototherapy was higher among male neonates (10.4%) compared to female neonates (4.2%) (26). Similarly, Khan et al. also found contrasting findings in a study in Pakistan which established that there was no significant difference in hypocalcaemia after phototherapy between male and female patients. Overall, the available evidence suggests that male neonates may be at a higher risk of developing phototherapy-induced hypocalcaemia compared to female neonates, but more research is needed to fully understand the relationship between gender and hypocalcaemia in neonates undergoing phototherapy. It is important to note that other factors, such as gestational age, birth weight, and underlying medical conditions, can also affect the risk of developing hypocalcaemia in neonates.

The current study further established that children who were referred were 13 times likely to have hypocalcaemia after phototherapy compared to those who were born in the facility. These findings are comparable with those from Mukesh et al. in a study conducted in Nepal which

revealed that there was higher hypocalcaemia after phototherapy in patients who were referred compared to those born in the hospital (28). This may be due to factors such as delayed initiation of phototherapy, inadequate monitoring, or differences in management practices between healthcare facilities. Generally, the available evidence suggests that neonates who are referred for phototherapy may be at a higher risk of developing hypocalcaemia compared to neonates who receive phototherapy at the facility where they were born (24). However, more research is needed to fully understand the relationship between referral status and hypocalcaemia in neonates undergoing phototherapy.

5.4.Study strengths and limitations

5.4.1. Strengths of the study

The study provides a detailed investigation on serum calcium levels in neonates with jaundice undergoing phototherapy as well as documentation of the prevalence and factors associated with hypocalcaemia after phototherapy.

5.4.2. Limitations of the study

The sample size utilized was small to make policy changes regarding monitoring of calcium levels during phototherapy.

The study focussed on only 48 hours of phototherapy.

5.5 Conclusion And Recommendations

5.5.1.Conclusion

The prevalence of hypocalcaemia after 48 hours of phototherapy was found to be higher at 19.8%.

Phototherapy was found to have significant effect on serum calcium levels (Before =2.27 mmol/l, After =2.14 mmol/l)

Factors associated with hypocalcaemia after 48 hours of phototherapy included number of ANC visits, female gender of neonate and neonate referral status.

5.5.2. Recommendations

Monitoring of calcium levels and complications of hypocalcaemia should be considered in neonates receiving phototherapy.

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APPENDICES

Appendix I: Informed Consent

PART I: Information Sheet

Introduction/Purpose of the study

My name is Dr. Mohamednoor Ismail Omar, a registrar at the University of Nairobi, Department of Paediatrics and Child Health. I am conducting a study to compare serum calcium levels before and after 48 hours among term neonates with jaundice at Kenyatta National Hospital. This study is essential in investigating the effect of phototherapy among neonates which is essential in management of jaundice. It will also help determine whether there is need to consider other approaches based on complications arising from phototherapy management.

Study Approval

This study is being conducted with the approval of the UoN Department of Paediatrics and Child Health and KNH-UoN Ethics and Review Committee. Approval No……..

Participant selection

I wish to recruit your child with your permission to be part of this study considering that your child meets the inclusion criteria that I am looking at enrolling him/her as a participant. This study does not alter the intervention given to your child and thus participation is a simple process.

Voluntary Participation/Participants rights and roles

Your participation in the study is voluntary and you are free to withdraw from the study even after recruitment without any consequences

Procedure

Once you agree to participate in my study, I will ask you some questions using a pre-developed questionnaire. The information sought include demographic, clinical and phototherapy related information based on the objectives of this study. Baseline 2ml of venous blood sample will be obtained before the start of phototherapy and then follow up blood sample will be taken after 48 hours of phototherapy. Incase there are any calcium derangement found, the principal investigator will notify you and share your results with ward in-charge for appropriate care. The serum calcium will be measured at KNH pediatric laboratory using the KNH standardized

procedures to ensure continuous and seamless patient care. The primary outcome measure will be the level of calcium which will be documented before and after 48 hours.

Confidentiality

Neither your child's name or your name or contact details will appear on the questionnaire. Instead the questionnaires will have serial numbers. The form containing your information will be kept in a locked cabinet and I will be the only person with access to the cabinet. The information that will be obtained from the research will be used strictly for research purposes.

All the information obtained during the research will be kept confidential to everyone who will participate in it.

Benefits and Reimbursements

Participation in this study will help in understanding of presence of any complications after phototherapy based on measurement of the serum calcium levels. Incase your child is found to have hypoglycemia; the findings will be communicated by the Principal investigator and he or will be referred for appropriate care in the hospital.

There will however be no monetary compensation and we will not be responsible for your mobile phone charges.

Risks

Since the study involves drawing of blood. This means that there are minor risks that are likely to occur such as bleeding from fetal blood sampling, changes in baby's heart rate and possible infection. However, the principal investigator will draw blood himself and thus prior to taking of blood, he will conduct physical examination to the child to assess viability to withstand the process before drawing blood.

Communication

In case of any clarifications or queries during and after the study, you are free to contact me: Mahad Abdirahman on my Phone at **0722179457** or my Supervisor: Dr. Ahmed Laving on: +254 (0)724 644122 or email ahmed.rafik@uonbi.ac.ke .You may also contact the Chair, KNH-UoN ERC email: uonknherc@uonbi.ac.ke or +254 721 257746, (020) 318262 Ext.28250.

Thank you

PART II: Certificate of Consent

I have read the information, or it has been read to me. I have had the opportunity to ask questions about it and any questions that I have asked have been answered to my satisfaction. I consent voluntarily to have my child and I participate in this research.

Name of Parent/Legal Guardian:_____

Signature/thumbprint of Parent/ Legal Guardian: _____Date:__Day/month/year

Statement by person taking consent:

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands the purpose of the study.

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced in to giving consent, and the consent has been given freely and voluntarily.

Name of person taking the consent:_____

Signature of person taking the consent:_____

Date:__

Dr. Ismail

Signature____Date__

SEHEMU YA I: Karatasi ya Taarifa

Utangulizi/Madhumuni ya utafiti

Jina langu ni Dkt. Mohamednoor Ismail Omar, mwanafunzi wa shahada ya uzamili katika chuo kikuu cha Nairobi , Idara ya Madaktari wa Watoto na Afya ya Mtoto. Ninafanya utafiti kulinganisha viwango vya kalsiamu katika seramu ya damu kabla na baada ya saa 48 miongoni mwa watoto wachanga walio na homa ya manjano katika Hospitali ya Kitaifa ya Kenyatta.

Uchaguzi wa mshiriki

Ninanuia kumshirikisha mtoto wako kuwa sehemu ya utafiti huu ikizingatiwa kuwa mtoto wako anakidhi vigezo ninavyovyangalia kumsajili kama mshiriki. Utafiti huu haubadilishi uingiliaji kati wa huduma unaotolewa kwa mtoto wako na hivyo ushiriki ni mchakato rahisi.

Haki na majukumu ya Kushiriki/Washiriki kwa Hiari

Kushiriki kwako katika utafiti ni kwa hiari na uko huru kujiondoa kwenye utafiti hata baada ya kuajiriwa bila matokeo yoyote.

Utaratibu

Ukikubali kushiriki katika utafiti wangu, nitakuuliza baadhi ya maswali kwa kutumia dodoso lililotayarishwa awali. Taarifa zinazotafutwa ni pamoja na maelezo ya demografia, kiafya na matibabu ya picha kulingana na malengo ya utafiti huu. Sampuli ya msingi ya damu itapatikana kabla ya kuanza kwa phototherapy na kisha sampuli ya damu ya ufuatiliaji itachukuliwa baada ya masaa 48 ya phototherapy.

Usiri

Wala jina la mtoto wako au jina lako au maelezo ya mawasiliano hayataonekana kwenye dodoso. Badala yake dodoso zitakuwa na nambari za mfululizo. Fomu iliyo na taarifa zako itawekwa kwenye kabati lililofungwa na nitakuwa mtu pekee mwenye uwezo wa kuingia

kwenye baraza la mawaziri. Taarifa zitakazopatikana kutokana na utafiti zitatumika madhubuti kwa madhumuni ya utafiti.

Taarifa zote zilizopatikana wakati wa utafiti zitawekwa siri kwa kila mtu atakayeshiriki.

Faida na Malipo

Kushiriki katika utafiti huu kutasaidia katika uelewa wa uwepo wa matatizo yoyote baada ya phototherapy kulingana na kipimo cha viwango vya kalsiamu ya serum. Iwapo mtoto wako anapatikana kuwa na hypoglycemia; matokeo ya utafiti huo yatawasilishwa na mpelelezi Mkuu na yeye au atapewa rufaa ya kupata huduma stahiki hospitalini. Hata hivyo hakutakuwa na fidia ya fedha na hatutawajibika kwa tozo zako za simu za mkononi.

Hatari

Kwa kuwa utafiti unahusisha utoaji damu. Hii inamaanisha kuwa kuna hatari ndogo ambazo zinaweza kutokea kama vile kutokwa na damu kutokana na sampuli ya damu ya fetasi, mabadiliko ya mapigo ya moyo ya mtoto na uwezekano wa maambukizi. Hata hivyo, mpelelezi mkuu atatoa damu ya mtoto mwenyewe na hivyo kabla ya kuchukua damu, atafanya uchunguzi wa kimwili kwa mtoto ili kutathmini uwezekano wa kuhimili mchakato huo kabla ya utoaji damu.

Katika kesi ya maswali yoyote:

Ikiwa una maswali yoyote kuhusiana na utafiti, jisikie huru kuwasiliana nami Dk. Mohammednoor Ismail kwa Simu yangu ya rununu nambari: 0722179457.

SEHEMU YA II: Cheti cha Idhini

Nimesoma habari, au imesomwa kwangu. Nimepata fursa ya kuuliza maswali juu yake na maswali yoyote ambayo nimeuliza yamejibiwa kwa kuridhika kwangu. Ninakubali kwa hiari mimi na mtoto wangu kushiriki katika utafiti huu.

Jina la Mzazi/Mlezi wa Kisheria:_____

Sahihi/alama ya kidole gumba ya Mzazi/ Mlezi wa Kisheria:_____

Tarehe:_____ Siku/mwezi/mwaka_____-

Taarifa ya mtu anayekubali:

Nimesoma karatasi ya habari kwa usahihi kwa mshiriki anayetarajiwa, na kwa kadiri ya uwezo wangu nilihakikisha kuwa mshiriki anaelewa madhumuni ya utafiti.

Ninathibitisha kuwa mshiriki alipewa nafasi ya kuuliza maswali kuhusu utafiti, na maswali yote yaliyoulizwa na mshiriki yamejibiwa kwa usahihi na kwa kadri ya uwezo wangu.

Ninathibitisha kuwa mtu huyo hajalazimishwa kutoa idhini, na idhini imetolewa kwa hiari na kwa hiari.

Jina la mtu anayepokea idhini:_____

Sahihi ya mtu anayekubali idhini:_____

Tarehe:_____

Dkt Ismail

Sahihi_____Tarehe

Appendix III: Study Questionnaire
Please fill all the questions as required

Study Serial No……

Section A: Demographic characteristics

Maternal characteristics

1. Maternal age (years)……..
2. Level of education
   Primary [ ] Secondary [ ] Tertiary [ ]
3. Marital status
   Single [ ] Married [ ]
4. Residence
   Urban [ ] Rural [ ]
5. Parity ……
6. ANC Visits …….
7. Multiple pregnancy
   Yes [ ] No [ ]
8. Mother Blood Group ……

Child characteristics

9. Gender of the child
   Male [ ] Male [ ]
10. Gestational age (weeks)……
11. Place of birth
    KNH[ ] Refferal [ ]
12. Weight at birth (g)……..
13. Age of neonate (days)…….
14. Mode of delivery
    SVD[ ] Caesaria section [ ]
15. Birth history

Ruptured membranes [ ] Birth trauma [ ]

Induction of labor [ ] Normal labor [ ]

16. Apgar score at 1st minute ……
17. Apgar score at 5th minute ……
18. Apgar score at 10th minute ……

Section B: Phototherapy management

19. Time of clinical diagnosis of jaundice
    <24 hours [ ] 24 – 48 hours [ ]

    Above 48 hours (Specifiy……)

20. Total Bilirubin (µmol/L)……..
21. Direct Hyperbilirubinemia? Yes [ ] No [ ]
22. Hemoglobin level (g/dl)……
23. Fetal blood group …….
24. Associated diagnosis
Sepsis [ ] Prematurity [ ] HIE [ ]

25. Congenital abnormality Yes [ ] No [ ]
26. If yes which one……

Rhesus incompatibility [ ]

ABO incompatibility [ ]

Unknown Polycythemia Yes [ ] No [ ]

Others (specify)……

27. Please provide the following information before and after phototherapy

Parameter	Before	After
Serum calcium (mg/dl)		
Sodium (mEq/l)		
Potassium (mEq/l)		
Chloride		

28. Presence of hypocalcemia
Yes [ ] No [ ]

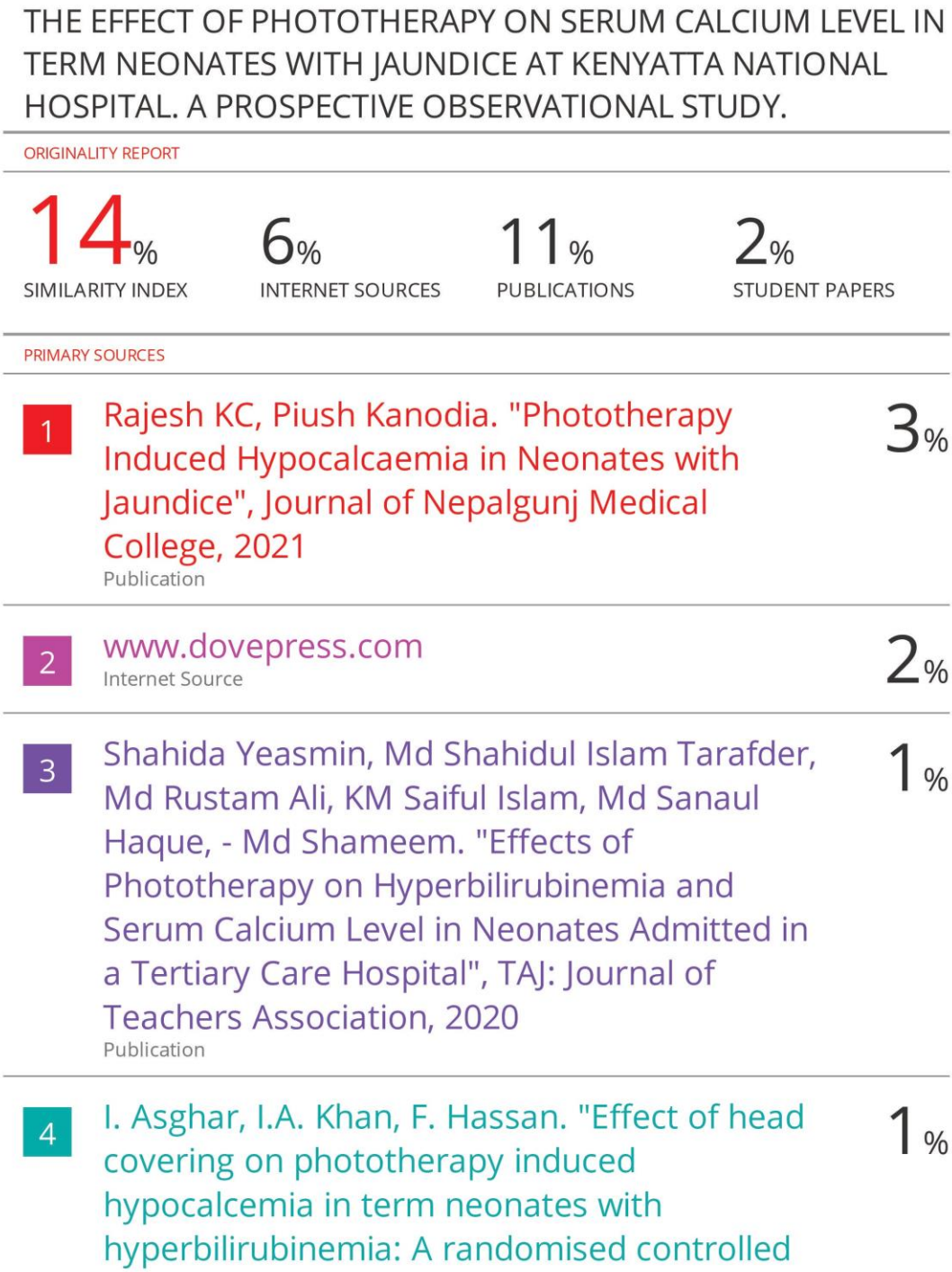
29. Hospital stay in days ……

Appendix III: Safety protocol

The following infection prevention control measures will be taken per the Kenyan ministry of health / WHO guidelines and protocols by the principal investigator and research assistants

- Alcohol-based sanitizers and hand washing will be used before and after contact with the participants.
- Disposable gloves will be used as an additional measure to the above, before contact with the participants and hands cleaned. It shall be disposed of per health care waste disposal guidelines.
- Scrubs or dust -coats will be worn when in contact with participants.
- Surgical masks will be worn at all times.
- Goggles will be worn for eye protection when collecting blood samples.
- Disinfection of commonly shared clinical equipment (tape-measure, stethoscopes, thermometers) before and after use on each of the participants and sharps shall be disposed off appropriately.

Appendix IV: Similarity Index



THE EFFECT OF PHOTOTHERAPY ON SERUM CALCIUM LEVEL IN TERM NEONATES WITH JAUNDICE AT KENYATTA NATIONAL HOSPITAL. A PROSPECTIVE OBSERVATIONAL STUDY.

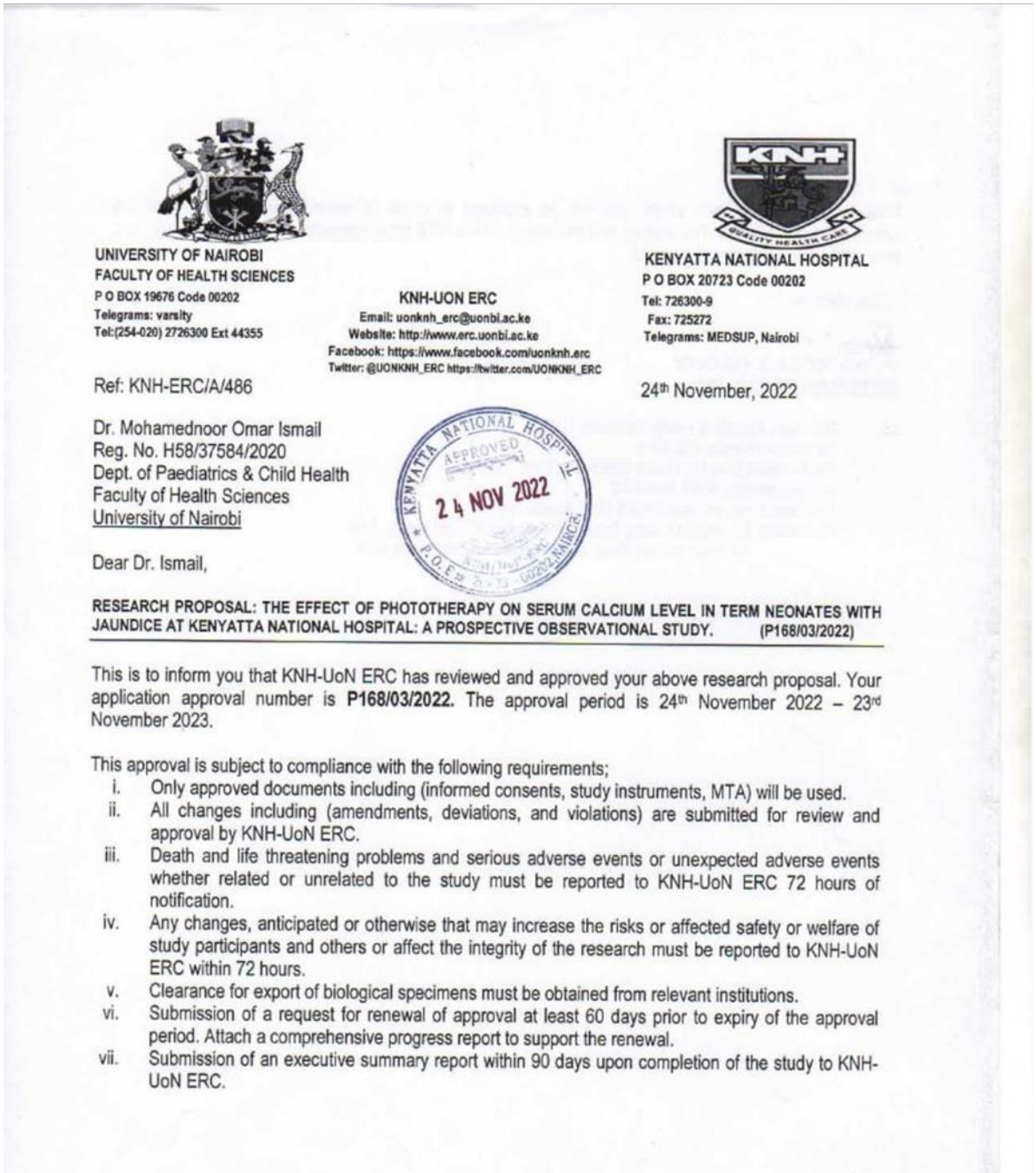
ORIGINALITY REPORT

14%	6%	11%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Rajesh KC, Piush Kanodia. "Phototherapy Induced Hypocalcaemia in Neonates with Jaundice", Journal of Nepalgunj Medical College, 2021 Publication	3%
2	www.dovepress.com Internet Source	2%
3	Shahida Yeasmin, Md Shahidul Islam Tarafder, Md Rustam Ali, KM Saiful Islam, Md Sanaul Haque, - Md Shameem. "Effects of Phototherapy on Hyperbilirubinemia and Serum Calcium Level in Neonates Admitted in a Tertiary Care Hospital", TAJ: Journal of Teachers Association, 2020 Publication	1%
4	I. Asghar, I.A. Khan, F. Hassan. "Effect of head covering on phototherapy induced hypocalcemia in term neonates with hyperbilirubinemia: A randomised controlled	1%

Appendix V: ERC Approval.



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Ref: KNH-ERC/A/486

24th November, 2022

Dr. Mohamednoor Omar Ismail
Reg. No. H58/37584/2020
Dept. of Paediatrics & Child Health
Faculty of Health Sciences
University of Nairobi

KENYATTA NATIONAL HOSPITAL APPROVED 24 NOV 2022

Dear Dr. Ismail,

RESEARCH PROPOSAL: THE EFFECT OF PHOTOTHERAPY ON SERUM CALCIUM LEVEL IN TERM NEONATES WITH JAUNDICE AT KENYATTA NATIONAL HOSPITAL: A PROSPECTIVE OBSERVATIONAL STUDY. (P168/03/2022)

This is to inform you that KNH-UoN ERC has reviewed and approved your above research proposal. Your application approval number is **P168/03/2022.** The approval period is 24th November 2022 – 23rd November 2023.

This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, MTA) will be used.
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by KNH-UoN ERC.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to KNH-UoN ERC 72 hours of notification.
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH-UoN ERC within 72 hours.
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to KNH-UoN ERC.