Global Pediatrics 8 (2024) 100164

Contents lists available at ScienceDirect

Global Pediatrics

journal homepage: www.elsevier.com/locate/gpeds

Evaluation of the factors associated with anemia in neonates admitted to the Neonatal Unit of Maiwand Teaching Hospital: A cross-sectional study

Mansoor Aslamzai [a,*], Yazdan Danish [b], Turyalai Hakimi [c], Bashir Jawadi [b]

[a] Department of Neonatology, Kabul University of Medical Sciences "Abu Ali Ibn Sina", Kabul, Afghanistan
[b] Faculty of Medicine, Kabul University of Medical Sciences "Abu Ali Ibn Sina", Kabul, Afghanistan
[c] Department of Pediatric Surgery, Kabul University of Medical Sciences "Abu Ali Ibn Sina", Kabul, Afghanistan

ARTICLE INFO

Keywords:
Anemia
Epidemiology
Newborn
Prematurity

ABSTRACT

Background: While anemia has been associated with severe outcomes in neonates, there is a lack of scientific data regarding the associated factors of this problem in newborn babies of Afghanistan; hence, this study was undertaken to fill that gap. The objective of this study was to evaluate the factors associated with anemia in neonates who were admitted to the Neonatal Unit.

Methods: This analytic cross-sectional study with retrospective document review was conducted at the Neonatal Unit of the Maiwand Teaching Hospital in Kabul City, Afghanistan, in 2023. SPSS 26 and certain statistical methods were used to carry out the statistical analysis.

Results: Of the 220 newborns enrolled in this study, anemia occurred in 26.8% of them. Based on gestational age, the occurrence rates of neonatal anemia within groups of term and preterm neonates were 23% and 41.3%, respectively. The occurrence of neonatal anemia was found to be 60% in extremely low birth weight, 41.2% in very low birth weight, 27.2% in low-birth-weight neonates, and 23.9% in normal birth weight neonates. The neonates in the anemic group versus the non-anemic group had a mean birth weight of (2516.18 ± 898.79 vs 2749.62 ± 766.02 g, $P = 0.03$, 95%CI= -691_-9.9), a mean gestational age of (35.47 ± 3.7 vs 37.4 ± 2.5 w, $P = 0.04$, 95% CI= -1.6_ -0.9), a mean age of (11.41 ± 6.39 vs 9.9 ± 6.88 days, $P = 0.35$, 95%CI= -1.6_4.6), a mean CRP level of (13.6 ± 7.6 vs 9.8 ± 5.6 mg, $P = 0.01$, 95%CI= 0.8_7.8) and a mean hemoglobin level of (11.1 ± 1.7 vs 17.3 ± 2.5 g, $P = 0.04$, 95%CI=-7.4_-5.1). There was a significant association between neonatal anemia and preterm birth (OR=2.4, $P = 0.04$, 95%CI=0.08_0.5), male sex (OR=2.4, $P = 0.04$, 95%CI= 0.1_0.3), neonatal sepsis (OR=2.5, $P = 0.01$, 95%CI= 0.1_ 0.6), cesarean delivery (OR=3.4, $P = 0.00$, 95%CI=1.7_6.5), maternal age greater than 35 years (OR=2.9, $P = 0.03$, 95%CI=0.04_0.6), no iron intake by the mother during pregnancy (OR=1.9, $P = 0.002$, 95%CI=1.1_3.4), antepartum hemorrhage (OR=4.7, $P = 0.00$, 95%CI=1.3_10.3), and poor household income (OR=2.6, $P = 0.03$, 95%CI=0.03_0.2).

Conclusions: Newborns admitted to the Neonatal Unit had a significant prevalence of neonatal anemia. The highest occurrence rates were seen within groups of preterm and extremely low-birth-weight newborn babies. Neonatal anemia was found to be associated with lower mean neonatal birth weight and gestational age, as well as with preterm birth, male sex, a higher CRP level, neonatal sepsis, older maternal age, cesarean delivery, no maternal iron consumption, antepartum hemorrhage, and a poor household income.

Background

Approximately 2.4–2.8 million neonatal deaths were reported globally, and 99% of these deaths were observed in low- and middle-income countries.[1,2] According to the report by UNICEF, the neonatal mortality rate in Afghanistan was one of the highest in the world.[3,4] Anemia, defined as a reduction in hemoglobin level, is a health problem around the world. Anemia is observed in 2 billion people, of whom children

Abbreviations: AKI, Acute Kidney Injury; CHD, Congenital Heart Disease; CBC, Complete Blood Count; CRP, C-reactive protein; ELBW, Extremely Low Birth Weight; KUMS, Kabul University of Medical Sciences; LBW, Low Birth Weight; G, Gram; MCV, Mean Corpuscular Volume; NEC, Necrotizing Enterocolitis; NICU, Neonatal Intensive Care Unit; NNS, Neonatal Sepsis; NNJ, Neonatal Jaundice; OR, Odd Ratio; VLBW, Very Low Birth Weight; W, Weight.

* Corresponding author.
E-mail address: mansooraslamzai@gmail.com (M. Aslamzai).

https://doi.org/10.1016/j.gpeds.2024.100164
Received 1 February 2024; Received in revised form 21 February 2024; Accepted 22 February 2024
Available online 23 February 2024

under 5 years of age are the age group at highest risk.[5] Neonatal anemia is a serious public health issue because it increases baby mortality and morbidity due to reduced oxygen-carrying capacity in the first few weeks of life.[6]

Anemia, or low hemoglobin levels, remains a frequent health problem in neonatal intensive care units. Compared with full-term infants, anemia is more common in preterm infants.[7] After birth, all infants experience a gradual decrease in hemoglobin, which results in varying degrees of anemia. During the first weeks of life, the hemoglobin concentration decreases significantly as a consequence of the reduced production of erythrocytes due to decreased production of erythropoietin (EPO) and also by the decreased erythrocyte lifespan during this period.[8]

The prevalence of neonatal anemia in Ethiopia, Uganda, and Thailand is reported at 23.2%, 17%, and 7.2%, respectively. [6,9,10] Lower gestational age, antepartum hemorrhage, multiple births, and hyperbilirubinemia were associated with neonatal anemia.[6,9] Maternal anemia, delivery by cesarean section, vaginal bleeding during pregnancy, and maternal failure to take iron-folate supplements during pregnancy were factors associated with newborn anemia.[5] Cesarean delivery was associated with a lower umbilical cord hemoglobin level compared to vaginal delivery.[10] Anemia was associated with respiratory distress syndrome in preterm newborn babies admitted to the intensive neonatal care unit.[11]

Afghanistan is a low-income and landlocked country in South Asia with a land area of about 652 864 km2 and an estimated total population of 39.8 million in 2021.[12] Up to date, no research has been done to find the associated factors of anemia in Afghan newborn babies and data about this problem is limited. Therefore, this study was carried out to reveal the factors associated with anemia in newborn babies who were admitted to the Neonatal Unit of Maiwand Teaching Hospital (MTH). Such data is very important for better neonatal care, the generation of hypotheses, decreasing neonatal mortality, future research, and health policymaking.

Methods

Study design, setting, and population

This analytic cross-sectional study with retrospective document review was conducted at the Neonatal Units of Maiwand Teaching Hospital (MTH), Kabul City, during 2023. This is a governmental and tertiary hospital that provides different health care services, such as pediatrics and neonatology. This hospital offers free tertiary-specialized services, trains new healthcare providers, and supports a substantial research program. The pediatric ward of this hospital has 90 beds for units of neonatology, pediatric intensive care, malnutrition, infectious diseases, and pediatric internal diseases, including cardiology, gastroenterology, pulmonology, hematology, nephrology, and endocrinology. The pediatric ward recorded 2690 inpatient admissions, including 635 neonates, in 2023. The 12-bed neonatal unit of MTH provides medical facilities, including mechanical ventilation, continues positive airway pressure, resuscitation, blood gas analysis, total parenteral nutrition, and surfactant therapy, as well as portable machines for x-rays, echocardiography and ultrasonography. During the last decade, the health care for newborns at the hospital has been provided with structured services involving interns, residents, and senior physicians, along with the nursing staff. The MTH also has a pediatric surgery ward with 20 beds. In 2023, 1260 pediatric patients were admitted for surgical interventions in this ward. The common surgical problems of thorax, abdomen, urology and neurology were managed. The study population is composed of term and preterm neonates (infants up to 28 days old).

Inclusion and exclusion criteria

Term and preterm neonates were enrolled in this study and eight cases with incomplete data were excluded.

Sample size, sampling strategy and procedure

The sample size calculation was performed by Stata 14. A predicted difference of 0.15 in the proportion of anemia between term and preterm neonates was taken into consideration. With an alpha error of 0.05 and a power of 80%, the two-sample proportion test estimated a sample size of 200 neonates. With the consideration of 10% dropout, total sample size was calculated to be 220 neonates. Between February and October 2023, 228 neonates were admitted to the neonatal unit of MTH. Of the 228 cases, 220 newborn babies were enrolled to the study, and the other 8 neonates were excluded due to incomplete data. An expert laboratory technologist collected 2 mL of venous blood with EDTA anticoagulant for Complete Blood Count (CBC) tests. The CBC parameters were determined using a Hematology Analyzer (Medonic, Sweden). According to the outcome (anemia), neonates were separated into anemic (study) and non-anemic (control) groups and were evaluated for associated factors. During the study period, 59 neonates with anemia and the other 161 neonates without anemia were recruited by the census sampling method. Some data regarding the exposures was collected retrospectively from the clinical records.

Variables. *the main variables are:*

1. The gestational age of neonates in weeks was determined by the last menstrual period (LMP) or, the new Ballard scoring system, or antenatal maternal ultrasound. Prematurity was defined as birth occurring before 37 weeks of gestation and was classified as extremely (less than 28 weeks of gestation), early (28–31 weeks of gestation), moderate (32–33 weeks of gestation) and late (34–36 weeks of gestation).
2. The birth weight of neonates in grams was determined by accurate balance during the first 24 h of life. According to the birth weight, the neonates were classified as low-birth-weight (1500–2500 g), very low-birth-weight (1000–1500 g), and extremely low-birth-weight (less than 1000 g).
3. The Apgar score was recorded at the 1st minute of birth. The neonates with an Apgar score of less than 7 at the 5th minute were accepted as having perinatal asphyxia.
4. Neonatal anemia was defined as a hemoglobin level of less than 13 gr/dl or a hematocrit (Hct) fewer than 39%. The severity of anemia was graded as mild anemia (Hct of 35–38%), moderate anemia (Hct of 25–34%) and, severe anemia (Hct of less than 25%). Based on the morphology of red blood cell, the anemia was classified as normocytic (MCV of 90-130 fL), microcytic (MCV of less than 90 fL) and macrocytic (MCV of more than 130 fL). The hemoglobin level was measured at the admission day.
5. Neonatal sepsis was diagnosed by the presence of three of the five criteria: elevated C-reactive protein, leukocytosis or leucopenia, an elevated count of premature granulocytes, temperature instability and symptoms of infection.
6. The diagnosis of thrombocytopenia and neonatal jaundice were based on the platelet count of less than 150,000/mm3 and serum bilirubin level of more than 5 mg/dl, respectively.
7. Acute kidney injury was diagnosed by a serum creatinine level of more than 1.5 mg/dl.
8. Congenital heart disease (CHD) was diagnosed by echocardiography.
9. Premature rupture of membrane (PROM) was defined as amniotic membrane rupture more than 18 h before delivery.
10. The maternal age in years, type of delivery (vaginal or cesarean), and parity, was defined as the number of births with a gestational age of more than 20 weeks.
11. Maternal antenatal visits: A prenatal visit is any appointment a mother makes related to her pregnancy with a general practitioner or

maternity unit.

12. Paternal and maternal education: Parents who could read and write were classified as literate and those who couldn't read and write were categorized as illiterate.

13. Household monthly income: It is defined as the total monthly income of all members who are over the age of 15. Based on family monthly income, the household income was classified as good, moderate, and poor, with more than $1000, $200–1000, and less than $200, respectively.

Data collection tools and statistical analysis

Raw data was first collected on the data collection sheets and then entered into the SPSS 26 statistical analysis software. Continuous quantitative data was presented using the mean and standard deviation (SD), while qualitative data were expressed in number of cases and percentage (%). Independent *t*-test and Chai square test were used to evaluate the significance of the association between anemia and dichotomous exposures. The correlations of gestational age with birth weight and hemoglobin level with platelet count were assessed by bivariate correlation. A power of 80% and an alpha error of 0.05 were accepted, so the p-value less than 0.05 was considered significant.

Ethical approval and consent to participate

All elements of this study were approved by the Department of Neonatology (protocol number of 9 and date of 11/02/2023), Kabul University Medical Sciences. The consents were taken from patients' guardians for participating in this study. The Helsinki Declaration was taken into consideration and all the personal information remained anonymous.

Result

Two hundred twenty newborn babies were evaluated for the factors associated with neonatal anemia at the Neonatology unit of the Maiwand Teaching Hospital, Kabul City. The mentioned neonates had a mean age of 10.91 ± 7.49 days, a mean birth weight of 2701.81± 797.73 g, a mean gestational age of 36.21±2.8 weeks, a mean Apgar score of 7.8 ± 1.3 and a mean hemoglobin level of 16±3.4 g. The mean maternal age was 26.2 ± 5.9y and the mean paternal age was 31.8 ± 8.7y. Premature rupture of membrane was observed in 50 (22.7%) of cases. According to the sex distribution, 137 (62.3%) of neonates were boys and the other 83 (37.7%) were girls. The occurrence rate of neonatal anemia in newborn babies was 26.8 percent, as shown in Table 1, with the highest rates found within the groups of preterm and extremely low birth weight. According to the grade, 43 (72.9%), 12 (20.3%) and 4 (6.8%) had mild, moderate and severe anemia, respectively. Based on the morphology of red blood cell, 38 (64.4%) cases of anemia were normocytic and the other 21 (35.6%) cases were microcytic.

Preterm birth, neonatal higher CRP, male sex, neonatal sepsis, cesarean delivery, maternal antepartum hemorrhage, maternal age greater than 35 years and poor household income had a significant association with neonatal anemia, as shown in Table 2. There was no statistically significant association between neonatal anemia and Apgar score, type of birth weight, number of deliveries, maternal education, place of delivery, paternal age, paternal education, antenatal visits, residency, premature rapture of membrane, neonatal jaundice, acute kidney injury, disseminated intravascular coagulation, and congenital heart disease in such infants.

Table 1
Occurrence rate of anemia within different categories of neonates

Categories of Neonates	Neonates with Anemia, *n*	Neonates without Anemia, *n*	Occurrence Rate, %
All Neonates, n=220	59	161	26.8
Classes of Birth Weight, No			
NBW (2500g or more)	34	108	23.9
LBW (1500-2000 g)	15	41	27.2
VLBW (1000-1499)	7	10	41.2
ELBW (less than 1000g)	3	2	60
Classes of Gestational Age, No			
Term (37-42 W)	40	134	23
Preterm (less than 37 W)	19	27	41.3
Sex, No			
Boys	45	92	32.8
Girls	14	69	16.8

Discussion

The current analytic cross-sectional study revealed the frequency and associated factors of neonatal anemia in neonates who were hospitalized in the Neonatal Unit of Maiwand Teaching Hospital, Kabul City. Based on the results, the occurrence rate of anemia in neonates was 26.8%, and the highest rates were demonstrated within groups of preterm and extremely low birth weight neonates, at 41.2% and 60%, respectively. The majority cases (64.4%) of anemia were normocytic, and the remainder 35,6 cases were microcytic. The probable causes of normocytic anemia were multifactorial, including prematurity, low birth weight, sepsis, disseminated intravascular coagulation and maternal antepartum hemorrhage. While microcytic anemia was developed most likely due to iron deficiency, caused by maternal no iron intake during their pregnancy. The current study discovered that prematurity, lower birth weight, male sex, a higher level of CRP, neonatal sepsis, cesarean section, maternal age more than 35 years, antepartum hemorrhage, no antepartum iron intake by the mother, and poor household income were significantly associated with anemia in neonates (Table 2). This indicates that the risk of neonatal anemia was significantly increased by lower gestational age, lower birth weight, male sex, higher level of CRP, neonatal sepsis, higher maternal age, cesarean delivery, antepartum hemorrhage, no maternal iron intake and poor household income.

According to a cross-sectional study conducted by Alamneh et al., the prevalence of neonatal anemia was 23.2%, with the highest rate (32.6%) observed in preterm neonates who were admitted to the Tibebe Ghion Specialized Hospital, Northwest Ethiopia,[9] The frequency of neonatal anemia in term neonates were comparable with our study (Table 1). The rate of anemia in preterm neonates was higher in our study (41.2%). This difference may be attributed to the higher occurrence rate of factors associated with anemia in preterm neonates of our country.

An observational study was conducted by Dereje et al. at the Nekemte Specialized Hospital, Western Ethiopia. Based on the results, maternal anemia, cesarean section, vaginal bleeding during pregnancy, and maternal failure to take iron-folate supplements during pregnancy were associated factors of neonatal anemia.[5] Alamneh et al. carried out a study at the Tibebe Ghion Specialized Hospital, Northwest Ethiopia. This study found that lower gestational age was associated with anemia in newborns.[9] Tiruneh et al. conducted a study at the University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia. In this study, maternal antepartum hemorrhage and multiple births were found to be associated factors with neonatal anemia.[6] Ngonzi et al. conducted an observational study in southwestern Uganda. This study found that cesarean delivery was associated with a lower umbilical cord hemoglobin level compared to vaginal delivery.[10] According to studies

Table 2
Comparison of factors associated with anemia in neonates

Variables	Neonates with Anemia (n=59)	Neonates without Anemia (n=161)	P-value (95%CI)
Age in days, Mean (SD)	11.41 (6.39)	9.9 (6.88)	0.35 (-1.6_4.6)
Birth weight in grams, Mean (SD)	2516.18 (898.79)	2749.62 (766.02)	0.03 (-691_-9.9)
Gestational age in weeks, Mean (SD)	35.47 (3.7)	37.4 (2.5)	0.04 (-1.6_-0.9)
Hemoglobin level in grams, Mean (SD)	11.1 (1.7)	17.3 (2.5)	0.00 (-7.4_-5.1)
Apgar score of 1st minute, Mean (SD)	7.73 (1.5)	7.84 (1.36)	0.67 (-2_3.2)
Maternal age in years, Mean (SD)	27.08 (7.87)	25.97 (5.54)	0.03 (1.1_4.3)
Number of deliveries, Median (IQR)	4 (2)	3 (2)	0.43 (-0.6_1.7)
Classes of birth weight, No (%)			
ELBW (less than 1000g)	3 (5.1)	2(1.2)	
VLBW (1000-1499)	7 (11.9)	10 (6.2)	
LBW (1500-2000 g)	15 (25.4)	41 (25.5)	
NBW (2500gr or more)	34 (57.6)	108 (67.1)	
OR	4.2		0.08 (0.2_1.5)
Classes of GA, No (%)			
Preterm (less than 37 W)	19 (32.2)	27 (16.8)	
Term (37-42 W)	40 (67.8)	134 (83.2)	
OR	2.4		0.04 (0.08_0.5)
Sex, No (%)			
Boys	45 (76.2)	92 (57.2)	
Girls	14 (23.8)	69 (42.8)	
OR	2.4		0.04 (0.1_0.3)
Mode of delivery, No (%)			
Cesarean	24 (40.1)	27 (16.7)	
Vaginal	35 (59.9)	134 (83.3)	
OR	3.4		0.00 (1.7_6.5)
Place of delivery, No (%)			
Home	2 (2.9)	13 (8.3)	
Hospital	57 (97.1)	148 (91.7)	
OR	0.4		0.27 (0.2_15.5)
Premature rupture of membrane, No (%)			
Yes	12 (20.3)	35 (21.7)	
No	47 (79.7)	126 (78.3)	
OR	0.9		0.86 (0.5_3.7)
Antepartum hemorrhage, No (%)			
Yes	22 (37.3)	18 (11.2)	
No	37 (62.7)	143 (88.8)	0.00 (1.3_10.3)
OR	4.7		
Neonatal blood parameters, Mean (SD)			
Hb (g/dl)	11.1 (1.7)	17.3 (2.6)	0.00 (-7.4_-5.1)
MCV (fL)	95 (5.2)	98 (4.3)	0.62 (-5.6_11.4)
WBC (10^3/mm^3)	11.8 (5.3)	13.1 (7.6)	0.34 (-4.9_1.8)
Platelets (10^3/mm^3)	243.6 (158.6)	224.2 (127.6)	0.46 (-72_48.6)
CRP (mg/dl)	13.6 (7.6)	9.8 (5.6)	0.01 (0.8_7.8)
Reticulocytes (%)	1.9 (0.2)	1.7 (0.3)	0.7 (-0.5_1.2)
Feeding, No (%)			
Breastfeeding	40 (67.7)	113 (70.2)	
Formula Feeding	19 (32.3)	48 (29.7)	
OR	0.9		0.7 (0.7_3.2)
Associate illnesses, No (%)			
Sepsis	28 (47)	62 (38.5)	0.01 (0.1_0.6)
Thrombocytopenia	22 (37)	48 (30)	0.37 (0.8_5.3)
NNJ	18 (30.5)	67 (41.6)	0.32 (0.4_2.4)
AKI	5 (8.5)	11 (6.8)	0.37 (0.9_1.8)
CHD	3 (5)	10 (6)	0.96 (0.3_7.8)
Residency			
Urban	50 (84.7)	130 (80.7)	
Rural	9 (15.3)	31 (19.3)	
OR	1.3		0.56 (0.4_5.4)
Type of maternal age			
More than 35 years old	7 (11.9)	7 (4.3)	
20-35 years old	50 (84.7)	140 (87)	
Less than 20 years old	2 (3.4)	14 (8.7)	
OR	2.9		0.03 (0.04_0.6)
Maternal education			
Literate	10 (17)	21 (13)	
Illiterate	49 (83)	140 (87)	
OR	1.4		0.47 (0.1_3.1)
Type of Paternal age			
More than 35 years old	16 (27)	38 (23.6)	
20-35 years old	43 (73)	123 (76.4)	
OR	1.2		0.71 (0.3_2.3)
Paternal education			
Illiterate	40 (67.8)	90 (55.9)	
Literate	19 (32.2)	71 (44.1)	
OR	1.7		0.22 (0.4_5.2)
Type of antenatal visits			
More than 3 visits	48 (81.4)	105 (65.2)	
1-3 visits	10 (16.9)	49 (30.4)	
No Visits	1 (1.7)	7 (4.4)	
OR	2.3		0.11 (0.8_4.6)
Household income			
Poor	21 (35.6)	28 (17.4)	
Moderate	29 (49.1)	99 (61.5)	
Good	9 (15.3)	34 (21.1)	
OR	2.6		0.03 (0.03_0.2)
Intake of iron during pregnancy			
No	24 (40.7)	43 (26.7)	
Yes	35 (59.3)	118 (73.3)	
OR	1.9		0.002 (1.1_3.4)

of Shimanda et al. and Li et al., boys and children in poorer households have an increased risk of anemia.[13,14] Our study demonstrated a significant association between neonatal anemia and prematurity, lower birth weight, male sex, cesarean section, antepartum hemorrhage no antepartum iron intake by mother and poor household income. These findings are similar to the studies of Dereje et al., Alamneh et al., Tiruneh et al., Ngonzi et al. Shimanda et al. and Li et al.[5,9,6,10,13,14]

The current study also revealed a significant association of higher mean level of CRP, neonatal sepsis and maternal age more than 35 years with anemia in newborn babies. The mentioned associated factors of neonatal anemia are novel findings. Numerous researchers have explored the rationales that would explain such an association, despite the fact that similar findings have not been found in scientific

investigations. CRP is an acute-phase protein of systemic inflammation that synthesized in the liver in response to cytokines or tumor necrosis factor produced during infections or inflammatory mechanisms. The Hb level was significantly lower in patients with elevated concentrations of CRP compared to individuals with normal CRP levels.[15] Furthermore, the magnitude of anemia, leucopenia, and thrombocytopenia was higher in neonatal sepsis.[16] Based on the study of Hochler et al., advanced maternal age was associated with preterm birth and neonatal complications.[17] Hence, older maternal age may be a risk factor for neonatal anemia as well.

In Afghanistan, health services and maternal health literacy are insufficient,[18] therefore, the data regarding the maternal hemoglobin level during pregnancy was incomplete and not reported.

Conclusions

Neonatal anemia was prevalent among neonates admitted to the Maiwand Teaching Hospital, with the highest rates detected in preterm and extremely low-birth-weight babies. The current study also identified that prematurity, male sex, a higher neonatal CRP level, neonatal sepsis, cesarean delivery, older maternal age, maternal antepartum hemorrhage and poor household income were significantly associated with neonatal anemia. These findings are particularly important for improving neonatal care, establishing hypotheses, conducting additional studies, decreasing neonatal mortality, and developing health policy.

What is new in our study

A significant association of higher mean level of CRP, neonatal sepsis and maternal age more than 35 years with anemia in newborn babies was found. The mentioned associated factors of neonatal anemia are novel findings. Thus, these conditions can be included in the list of associated factors for neonatal anemia. Further research is required to support our findings.

Consent for publication

Not applicable.

Authors' information

Mansoor Aslamzai is a professor at the Department of Neonatology, Kabul University of Medical Sciences (KUMS), Afghanistan. He became a member of the European Society for Pediatric Research in 2021. Yazdan Danish and Bashir Jawadi are general practitioners. Turyalai Hakimi is an associate professor at the Department of Pediatric Surgery, KUMS.

CRediT authorship contribution statement

Mansoor Aslamzai: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Yazdan Danish:** Resources, Project administration, Data curation. **Turyalai Hakimi:** Writing – review & editing, Project administration, Data curation. **Bashir Jawadi:** Data curation.

Declaration of competing interest

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

Funding

We performed this study without any fund.

Acknowledgement

We gratefully acknowledge the Neonatal Unit of MTH for the cooperation in this study.

References

1. Hug L, Alexander M, You D, Alkema L. National, regional, and global levels and trends in neonatal mortality between 1990 and 2017, with scenario-based projections to 2030: a systemic analysis. *Lancet Glob Health*. 2019;7(6):e710–e720. https://doi.org/10.1016/S2214-109X(19)30163-9.
2. Aslamzai M, Hamidi FH, Hassin Z. Comparing the effect of room air versus commercially available oxygen for the resuscitation of asphyxiated neonates in Kabul City: a Randomised Clinical Trial. *Indian J Neonatal Med Res*. 2019;7(3). https://doi.org/10.7860/IJNMR/2019/42701.225. PO14-PO19.
3. Health, UNICEF Afghanistan. 2019. https://www.unicef.org/afghanistan/health.
4. Aslamzai M, Hamidi MF, Halimi A. The effects of dual-strain probiotics on the weight gain in premature neonates of Kabul City: a randomized clinical trial. *Glob Pediatr*. 2023;3. https://doi.org/10.1016/j.gpeds.2023.100062.
5. Dereje I, Etefa T, Gebremariam T, Getaye A, Tunta A, Gerbi A. Prevalence of anemia and associated factors among term newborns in Nekemte Specialized Hospital, Western Ethiopia. *J Multidiscip Healthc*. 2021;14:2607–2615. https://doi.org/10.2147/JMDH.S326962.
6. Tiruneh T, Shiferaw E, Enawgaw B. Prevalence and associated factors of anemia among full-term newborn babies at University of Gondar comprehensive specialized hospital, Northwest Ethiopia: a cross-sectional study. *Ital J Pediatr*. 2020;46:1. https://doi.org/10.1186/s13052-019-0764-1.
7. Ming S, Zhang D, Chen L, Shi Y. Effects of anemia and red blood cell transfusion in preterm infants on the development of bronchopulmonary dysplasia: a propensity score analysis. *All Life*. 2021;14(1):830–839.
8. Kliegman RM, Geme JW, Blum NJ, Shah SS, Tasker RC, Wilson KM. *Nelson Textbook of Pediatrics*. 21th ed. US.A. Lange; 2020:3865–3907. ISBN:978-0-323-52950-1.
9. Alamneh TT, Tilahun SF, Beyne MB, Fekadu SA, Assem AS, Kassa SF. Prevalence and associated factors of anemia among newborns at Tibebe Ghion Specialized Hospital, Northwest Ethiopia. *Int J Gen Med*. 2022;15:6465–6474. https://doi.org/10.2147/IJGM.S365817.
10. Ngonzi J., Tibaijuka L., Kintu T.M., et al. Prevalence and risk factors for newborn anemia in southwestern Uganda: a prospective cohort study. 2023 https://doi.org/10.21203/rs.3.rs-3054549/v1.
11. Aslamzai M, Froogh BA, Mukhlis AH, Faizi OA, Sajid SA, Hakimi Z. Factors associated with respiratory distress syndrome in preterm neonates admitted to a tertiary hospital in Kabul city: a retrospective cross-sectional study. *Glob Pediatr*. 2023;3. https://doi.org/10.1016/j.gpeds.2023.100035.
12. UN Data, Afghanistan. 2021, http://data.un.org.
13. Shimanda PP, Amukugo HJ, Norström F. Socioeconomic factors associated with anemia among children aged 6-59 months in Namibia. *J Public Health Afr*. 2020;29(1):1131. https://doi.org/10.4081/jphia.2020.1131, 11.
14. Li H, Xiao J, Liao M, et al. Anemia prevalence, severity and associated factors among children aged 6–71 months in rural Hunan Province, China: a community-based cross-sectional study. *BMC Public Health*. 2020;20:989. https://doi.org/10.1186/s12889-020-09129-y.
15. MA Santos-Silva, Sousa N, Sousa JC. Correlation Analysis between hemoglobin and C-reactive protein in patients admitted to an emergency unit. *J Clin Med*. 2021;10(22):5411. https://doi.org/10.3390/jcm10225411.
16. Adane T, Worku M, Tigabu A, Aynalem M. Hematological abnormalities in culture positive neonatal sepsis. *Pediatric Health Med Ther*. 2022 Jun 7;13:217–225. https://doi.org/10.2147/PHMT.S361188.
17. Hochler H, Lipschuetz M, Suissa-Cohen Y, et al. The impact of advanced maternal age on pregnancy outcomes: a retrospective multicenter study. *J Clin Med*. 2023;12(17):5696. https://doi.org/10.3390/jcm12175696.
18. Rostamzadeh M, Ezadi Z, Hosseini M, Husseini AA. Maternal health literacy and pregnancy outcomes in Afghanistan. *J Educ Health Promot*. 2022;28(11):421. https://doi.org/10.4103/jehp.jehp_746_22.