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Factors Determining Hemoglobin Levels in Vaginally Delivered Term Newborns at Public Hospitals in Lusaka, Zambia

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ABSTRACT

Background

In developing countries, prevalence of newborn anemia is high due to various maternal, newborn and placental factors . Early recognition and intervention are crucial to prevent complications and reduce infant morbidity and mortality.

Subject and methods

Data on 489 mother-singleton, term newborn pairs from six public hospitals in Lusaka was analyzed to determine the prevalence of newborn anemia and its associated risk factors. Anemia was defined as hemoglobin levels below 15g/dl for newborns and 11g/dl for mothers. The relationship between the variables was assessed using Chi-square tests and a binary logistic regression model, with the findings reported in terms of p-values, odds ratios, and 95% confidence intervals.

Results

The prevalence of anemia in newborns was 72.4%, with severe anemia at 2.5%. Maternal anemia rates were 30.5%, with severe anemia at 14.7%. Delayed cord clamping was done in 71.4% of deliveries, and 86.5% of newborns were tested for hemoglobin levels within 4-6 hours after birth. Maternal hemoglobin data were available for 49.7% of the 489 mothers, with infrequent assessment significantly associated with newborn anemia. Maternal age, parity, gestational age, and birth weight were also found to be associated with newborn anemia.

Conclusion

Enhanced antenatal care for pregnant mothers in resource-limited settings is crucial, focusing on maternal hemoglobin, nutrition, and medical conditions, as well as teenage pregnancy, primiparous and multiparous mothers, and preterm and low birthweight babies to prevent newborn anemia and reduce infant morbidity and mortality.

Key Words: newborn anemia, anemia in pregnancy, teenage pregnancy, primiparous, multiparous, vaginal delivery, maternal age, cord clamping.

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BACKGROUND

Anemia is defined as a hematocrit (HCT) level of less than two standard deviations measured for a child's age and gender.1,2 Anemia is defined in the newborn period using both gestational and postnatal age.[3] The leading causes of anemia in newborns include blood loss, decreased red blood cell synthesis, accelerated red blood cell breakdown, low birth weight, and prematurity.[4,5,6]

Anemia's clinical signs include poor feeding, rapid breathing, paleness, and a change in mental status due to poor systemic tissue perfusion.[7,8] Tissue hypoxia, delayed brain development, stunted growth, chronic heart failure, infectious diseases such as HIV and hepatitis as a result of repeated blood product infusions, and eventually multiple organ failure are all complications of unrecognized and untreated anemia in infants.[9,10,11,12,13] Infants under six months of age are at significant risk of anemia due to their rapid growth and insufficient iron intake, as breast milk is poor in iron.[14] As a result, they rely mostly on iron from intrauterine life.[15] It is much more damaging when the pregnant mother, who is the primary source of fetal iron, is anemic.

Globally, the prevalence of anemia during pregnancy is 42%, while newborn anemia in Sub-Saharan Africa is between 25 and 30%. In a prospective cohort study of 352 pregnant mothers in South western Uganda, Ngozi et al. found a 17% prevalence of newborn anemia based on umbilical cord blood and hemoglobin levels <13g/dl.[16] The Uganda study identified maternal anemia, cesarean delivery, high maternal parity, and young maternal age as risk factors for neonatal anemia. In Ethiopia, 22% of pregnant women are anemic.[17,18] In a cross-sectional study in Zambia (2016), the prevalence of anemia in pregnancy was 36.2%, using the mean haemoglobin of 11.2g/dl in 216 pregnant women over a period of 4 months. In the study, 45.6% of these women were found to have mild anemia, 51.9% had moderate anemia, and 2.5% had severe anemia in Zambia.[19] The search for published data on newborn anemia in Zambia was unfruitful.

Although newborn anemia can have serious consequences for neonates' health and well-being throughout their lives, it receives little attention from healthcare practitioners and researchers in low-income nations.[20] There are no specific policies or guidelines for screening of newborn anemia in Africa. To the best of our knowledge, no other study has addressed this problem locally, and the 6 Public Hospitals involved in this study serve a large number of populations within and around the Central province of the country. Therefore, this study aimed to determine the prevalence of newborn anemia and associated factors in public hospitals located in Lusaka district of Zambia.

MATERIALS AND METHODS

Study Design: This was a secondary analysis of a cross-sectional study.

Study setting

The study was conducted at six public hospitals in the Lusaka district, including the Women and Newborn Hospital, a part of the University Teaching Hospitals and the largest tertiary hospital in the country. The first-level hospitals included Chawama, Chilenje, Chipata, Kanyama, and Matero hospitals. Matero General Level Hospital is the largest general hospital in Lusaka, with Chawama, Chilenje, and Kanyama hospitals serving high-density areas. Kanyama Level One Hospital has a high patient volume and is considered a high-volume site with low socioeconomic status.[21]

Sampling Method

Six Research Assistants were recruited in each of the Public Hospitals. Sampling technique was consecutive, on first-come-first-serve basis until the desired sample size of 572 was obtained. Recruitment of participants in all the 6 Public Hospitals took place concurrently. The mother- newborn pair were recruited from the admission wards of the 6 public hospitals located in Lusaka District. The study was conducted over a 5-month period between 15th January to 3rd June 2024 at the 6 public hospitals as outlined in Table 1.

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Table 1. Sample Distribution

Setting	**Sample size**	**Percentage**
Women and Newborn Hospital	229	40
First level hospitals	343	60
--Chawama	69	12.1
--Chilenje	68	12
--Chipata	69	12.1
--Kanyama	69	12.1
--Matero	68	12
Total	572	100%

83 (14.5%) out of the 572 participants recruited, had incomplete hospital records, hence only data from 489 mother-newborn pairs were analysed.

DATA SOURCE AND SAMPLE

The mother-newborn‟s socio-demographic and clinical data were collected using structured questionnaire based-interviews that were created in English and translated to the local languages. Maternal body mass index (BMI) was calculated from measured weight (kg) and height (cm) using the standard method during the interview. Latest maternal Hb and date were obtained from the hospital file. The weight of the newborn baby was determined by midwives at birth. Timing of umbilical cord clamping after birth was recorded.22 Newborn Hemoglobin was determined with a portable hemoglobinometer, the Hemo Cue Hgb analyzer (Hemo Cue Hb201+, Sweden) according to standard guidelines within the first 24 hrs after birth. In this study, newborn anemia was defined as Hgb <15g/dL and maternal anemia as Hgb <11g/dL.23,24

Statistical analysis

The data was manually cleaned, processed, checked for completeness and entered into Microsoft Excel. It was then exported into SPSS version 26 for analysis. After categorizing and defining the variables, a descriptive analysis was carried out for each of the independent variables and presented with numbers, frequencies and percentages. Chi test and Binary logistic regression analysis were used to assess the relationship between the newborn anemia and each independent variable. Multicollinearity and fitness of the model were checked. Factors with p-values <0.1 were included in the regression model. Odds ratio (OR), with a 95% confidence interval (CI) were computed. For all, statistical significance was declared at p-value <0.05. The reporting in this study were guided by the STROBE guidelines for observational studies.[25]

Ethics

The Institutional Review Board of the University of Zambia (UNZABREC) approved original study titled „ASSESSING THE IMPACT OF DELAYED CORD CLAMPING ON NEONATAL HAEMOGLOBIN LEVELS IN VAGINAL DELIVERIES AT THE WOMEN AND NEWBORN HOSPITAL AND PUBLIC FIRST LEVEL HOSPITALS IN LUSAKA DISTRICT, ZAMBIA“

with reference number 4998-2024 was the source of the data for this article. Additional approvals from NHRA, WNH, and Lusaka Provincial Health Office were obtained before data could be collected. Further permission was obtained from Senior Medical Superintendent at each of the first level hospitals. The mother‟s written informed consent and assent were obtained. Participants were assured of confidentiality as well as anonymity.

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The participants were informed that they were free to withdraw from the study without any negative consequences. All study documents were secured under a locked cabinet. This study posed no harm to the participants as it was an observational study. For newborns diagnosed with anemia, communication was established with the attending Doctor for further assessment and treatment. In order to protect the privacy and confidentiality of the participants, no personal identification such as name was collected. This study was carried out in accordance with the Helsinki Declaration. Results of the study will be made available to stakeholders to obtain information, which could be used for strategies to improve perinatal care.

RESULTS

Participants

The study targeted pregnant women giving birth at WNH-UTH and all 5 first level Hospitals in Lusaka district.

Clinical characteristics of the newborns in the study

Of note, only 135 (27.6%) newborns out of the 489 recruited had normal hemoglobin levels of 15g/dl and above and 12 (2.5%) were severely anaemic with Hb <10g/dl, Table 2.

Table 2: Clinical characteristics of newborns in the study, n=489

	Frequency	**Percent**
Birthweight		
Low Birth weight (< 2.5 kg)	47	9.6
Normal weight (2.5-4 kg)	407	83.2
Macrosomia (> 4kg)	35	7.2
Gestational age		
Term (37-40 weeks)	418	85.5
Postdate (>40 weeks)	71	14.5
Apgar score		
Moderate Asphyxia (4-6)	49	10
Normal (7-10)	440	90
Newborn postnatal Hemoglobin		
Severe anaemia (<10g/dl)	12	2.5
Moderate anaemia (10-12.9g/dl)	172	35.2
Mild anaemia (13-14.9g/dl)	170	34.8
Normal (≥15g/dl)	135	27.6
Time of estimating Hb after birth		

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6-8hrs	25	5.1
4-6hrs	423	86.5
<4hrs	41	8.4
Cord clamping practice		
Early (<60 seconds)	140	28.6
Late (≥60 seconds)	349	71.4
Total	489	100

A higher percentage of the mothers were young (>25-35years of age, 43.1%), overweight (47.9%), of secondary school education (50.3%), primiparous (40.7%) with no underlying medical condition (89.0%) and have never had a miscarriage (81.0%). Of note, the teenagers had a higher percentage (9.4%) of those with low BMI, compared to other age groups, p<0.001 (OR 3.84; 95%CI 1.03,14.36), Table 3.

Table 3: Maternal characteristics in the study, n=489

Maternal Characteristics	**Frequency**	**Percent**
Age		
Teenage (< 18 years)	32	6.5
Very young (18-25 years)	209	42.7
Young (>25-35 years)	211	43.1
Elderly (>35 years)	37	7.6
BMI (kg/m^2)		
Wasted (<18.5)	15	3.1
Normal (18.5-24.9)	174	35.6
Overweight (25-29.9)	234	47.9
Obese (>30)	66	13.5
Education		
None	31	6.3
Primary	144	29.4
Secondary	246	50.3
Tertiary	68	13.9
Maternal Medical (present or absent)		

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Presence of underlying medical condition	54	11.0
Absence of underlying medical condition	435	89.0
Parity (delivery)		
1	199	40.7
2	108	22.1
3	100	20.4
4	64	13.1
>4	18	3.7
Miscarraige (Yes/No)		
Yes	93	19.0
No	396	81.0
Total	489	100.0

Proportion of women with HIV infection was the highest amongst the maternal medical conditions in the study (19/54=35.2%), followed by hypertension (14/54=25.9%) and Hepatitis B virus infection (13.0%), Table 4.

Table 4: Maternal medical diagnosis in the study, n=54

Maternal Medical Diagnosis	Frequency	Percent
Diabetes Mellitus	3	5.6
Hepatitis B Virus infection	7	13
Heart Disease	3	5.6
HIV infection	19	35.2
Hypertension	14	25.9
Pregnancy Induced Hypertension	4	7.4
Sickle Cell Disease	4	7.4
Total	54	100.0

Only 246 out of the 489 mothers in the study had a record of hemoglobin in their hospital files. 75 (30.5%) of these 246 mothers were anemic. 11 (14.7%) of the 75 anemic mothers had severe anemia. Majority, (156, 63.4%) of these 246 mothers had their last hemoglobin estimate performed more than 4 weeks before delivery. Of the 75 mothers, who were anemic, 59 (78.7%) of them had anemic newborns; compared to 125 (73.1%) of the 171 mothers that were not anemic, p=0.355; OR =1.36 (95% CI 0.71, 2.59). Majority of the 156 mothers, who had their pre-delivery hemoglobin performed more than 4 weeks prior (127, 81.4%) had anemic newborns, compared to only 28 (54.9%) out of the 51 mothers who had their pre-delivery hemoglobin performed <1 week before delivery (p<0.001; OR 3.60; 95%CI 1.81, 7.14), Table 5.

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Table 5: Maternal Hemoglobin levels in the study, n=246

Anaemia	**Frequency**	**Percent**
Anaemic	75	30.5
Not Anaemic	171	69.5
Time when last pre-delivery Hb was done		
1 (>4 weeks)	156	63.4
2 (2-4 weeks)	19	7.7
3 (1-2 weeks)	13	5.3
4 (<1 week)	51	20.7
Total	246	
Grades of Anaemia		
Severe Anaemia (<7g/dl)	11	14.7
Moderate Anaemia (7-8.9g/dl)	9	12.0
Mild Anaemia (9-10.9g/dl)	55	73.3
Total	75	100.0

Univariate analysis was done to investigate the relationships between the independent variables and newborn anemia. Birthweight had no significant relationship with newborn hemoglobin. The early term newborns were 3.31 (95% CI:1.98, 5.56) times more likely to be anemic compared with the postdate newborns (p<0.001). Early cord clamping was more likely to result in newborn anemia, compared to delayed cord clamping (OR=1.34; 95% CI 0.85, 2.11), however, this was not significant, p=0.206. Maternal medical illness was signifcantly associated with neonatal anemia, p=0.011; OR=2.80 (95% CI 1.23, 6.36). Though, babies sampled more than 6hrs after birth, were more likely to be anemic (20 out of 25 [80%]) compared to those sampled within 4 hrs after birth (25 out of 41 [61%]); OR 2.56 (95% CI 0.80, 8.20), this relationship was not significant at p=0.175. Maternal age was significantly associated with newborn anemia (p<0.001). Teenage mothers (30 out of 32, 93.8%) were 5.68 times (95% CI 1.94, 16.60) more likely to have anemic babies, followed by the elderly mothers (33 out of 37, 89.2%). The young mothers were the least likely to have anemic newborns (125 out of 211, 59.2%). Parity was also significantly associated with newborn anemia, p<0.001. The Para 4 mothers (53 out of 64, 82.8%) were 6.02 times (95%CI 1.94, 18.87) more likely to have anemic newborns, followed by the primips (162 out of 199, 81.4%; OR 5.46 [95% CI 2.02, 14.93]), Table 6.

Table 6: Crosstabulation of factors contributing to neonatal postnatal hemoglobin in the study

Postnatal Neonatal Hb			**Total**
Anaemic (%)		**Not anaemic (%)**	
Birthweight	p-value=0.660		
Low Birth weight	32 (68.1)	15 (31.9)	47
Normal Birth weight	298 (73.2)	109 (26.8)	407

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High Birth weight		24 (68.6)	11 (31.4)	35
Gestational age	p. value<0.001; OR=3.31			
Term		319 (76.3)	99 (23.7)	418
Postdate		35 (49.3)	36 (50.7%)	71
Apgar score	p. value=0.607; OR =1.20			
Moderate Asphyxia		37 (75.5)	12 (24.5)	49
Normal Apgar score		317 (72.0)	123 (28)	440
Time of estimating newborn's Hb	p. value= 0.175			
6-8hrs		20 (80.0)	5 (20.0)	25
4-6hrs		309 (73.0)	114 (27.0)	423
<4hrs		25 (61.0)	16 (39.0)	41
Cord clamping	p=0.206; OR=1.34			
Early		107 (76.4)	33 (23.6)	140
Late		247 (70.8)	102 (29.2)	349
Maternal age (years)	p<001			
Teenage (<18)		30 (93.8)	2 (6.3)	32
Very young (18-25)		166 (79.4)	43 (20.6)	209
Young (>25-35)		125 (59.2)	86 (40.8)	211
Elderly (>35)		33 (89.2)	4 (10.8)	37
Maternal BMI	p=0.452			
Wasted (<18.5)		12 (80.0)	3 (20.0)	15
Normal (18.5-24.9)		120 (69.0)	54 (31.0)	174
Overweight (25-29.9)		176 (75.2)	58 (24.8)	234
Obese (>30)		46 (69.7)	20 (30.3)	66
Maternal Education	p=0.072			
None		28 (90.3)	3 (9.7)	31
Primary		108 (75.0)	36 (25.0)	144
Secondary		172 (69.9)	74 (30.1)	246

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Tertiary		46 (67.6)	22 (32.4)	68
Maternal Medical illness	p=0.011; OR= 2.80			
Yes		47 (87.0)	7 (13.0)	54
No		307 (70.6)	128 (29.4)	435
Parity (# of deliveries)	p<0.001			
1		162 (81.4)	37 (18.6)	199
2		65 (60.2)	43 (39.8)	108
3		66 (66.0)	34 (34.0)	100
4		53 (82.8%)	11 (17.2%)	64
>4		8 (44.4)	10 (55.6)	18
Miscarraige	p=0.733; OR=0.92			
Yes		66 (71.0)	27 (29.0)	93
No		288 (72.7)	108 (27.3)	396
Total	Count	354(72.4)	135(27.6)	489

In the multivariate analysis using binary logistic regression model, the low birthweight, the term baby, teenage pregnancy, presence of maternal medical condition, Parity 1, 2 and the multiparous mothers remained significantly associated with newborn anemia.

Table 7: Binary Logistic regression analysis of variables determining newborn anemia, n=489

B			**S.E.**	**Wald**	**df**	**p-value**	**OR**	**95% C.I.for OR**	
								Lower	**Upper**
Step 1[a]	Low birthweight			8.80	2	0.012			
	Normal birthweight	-1.180	0.40	8.55	1	0.003	0.307	0.14	0.68
	High birthweight	-.712	0.55	1.70	1	0.192	0.491	0.17	1.43
	Term gestation	1.135	0.29	15.07	1	<0.001	3.110	1.75	5.52
	Normal Apgar score	0.543	0.41	1.74	1	0.187	1.720	0.77	3.85
	Delayed clamping	0.357	0.26	1.95	1	0.162	1.429	0.87	2.36
	Teenager			19.26	3	<0.001			
	Very young	1.17	0.78	2.26	1	0.133	3.21	0.70	14.66
	Young	2.07	0.79	6.97	1	0.008	7.94	1.71	36.96

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	Elderly	0.68	1.00	0.47	1	0.493	1.98	0.28	13.92
	Presence of Maternal medical condition	1.09	0.46	5.55	1	0.019	2.96	1.20	7.32
	Parity 1			16.09	4	0.003			
	Parity 2	0.75	0.31	5.98	1	0.014	2.11	1.16	3.83
	Parity 3	0.19	0.32	0.36	1	0.547	1.21	0.65	2.27
	Parity 4	-0.39	0.43	0.81	1	0.367	0.68	0.29	1.58
	Parity>4	1.56	0.60	6.87	1	0.009	4.77	1.48	15.35
	Constant	-3.68	0.98	14.19	1	0.000	0.03		

a. Variable(s) entered on step 1: Birthweight, Gest.2.age, Apgar2score, cclamp, Mat.age.cd, Med.Mat, Parity.

DISCUSSION

The study examined the prevalence of anemia and its associated risk factors in 489 term, vaginally born newborns within the first 24 hours of life. It revealed a considerably higher rate of newborn anemia at 72.4% than the 29.1% prevalence reported in a facility-based study of 278 term babies in Ethiopia[26]. The variation in the prevalence of anemia in newborns can be attributed to the utilization of different definitions of newborn anemia in the two studies. Specifically, the Ethiopian study employed a hemoglobin cut-off point of 13.5g/dl, whereas the Zambian study used a higher cut-off point of <15g/dl. Furthermore, the rate of low birth weight (LBW) in the Ethiopian study was notably lower at 2.2% compared to the 9.6% reported in the Zambian study, low birthweight being a known cause of newborn anemia. Small-for-gestational age percentage of 21.4% in a cross-sectional data analysis of a cohort study in East Africa, was higher than the 9.6% documented in this Zambia study.[27] In the Ethiopian study, delayed cord clamping (1-3 minutes) was uniformly implemented for all deliveries, with birth umbilical cord blood being sampled for hemoglobin assessment. On the other hand, the Zambian study indicated that early cord clamping was executed in 28.6% of deliveries (cord clamping had no significant impact on newborn hemoglobin levels in this study), and newborn hemoglobin levels were evaluated from foot heel capillary samples within 8 hours post-delivery. Furthermore, only 8.4% of blood sampling took place within 4 hours of life in the Zambian study. Notably, maternal anemia was less prevalent at 24.1% in the Ethiopian study compared to the 30.5% reported in the Zambian study. Additionally, the mothers' mean age (26.21 years, sd=5.73) and nutritional status in the Zambian study were comparable to those in the Ethiopian study (mean 26 years, sd=4.4).

The prevalence of newborn anemia in the present study surpassed that of Rio de Janeiro, Brazil (32.6%), Lagos, Nigeria (35%), and Gondar, Ethiopia (25%). [28,29,30] However, the observed high rate of newborn anemia aligns with figures reported in Ghana (57.3%), Benin (61.1%), and southern Nigeria (65.6%).[31,32,33]

Although the prevalence of maternal anemia in the current Zambian study (30.5%) surpassed the 24.1% documented in the Ethiopian study, there was no significant association between maternal anemia and newborn anemia, in contrast to the findings in the Ethiopian and Ugandan studies. The current level of maternal anemia was lower than the 36.2% documented in the 2016 Zambia study.[19] This disparities may be attributed to the fact that hemoglobin records were accessible for only 49.7% of the 489 sampled mothers in the Zambian study. However, the timing of pre-delivery maternal hemoglobin determination was significantly linked to newborn anemia in this Zambian study, with mothers whose hemoglobin levels were infrequently assessed during pregnancy showing an increased propensity to give birth to anemic newborns.

As the fetus receives nutrients, including iron and folate, from the mother, depleted maternal iron stores can prevent the fetus from accumulating sufficient iron, resulting in decreased fetal iron stores and reduced fetal

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hemoglobin levels.[34,35,36,37,38] The physiological changes and metabolic demands of pregnancy result in an increased need for iron during pregnancy,[39,40,41,42] predisposing women to maternal anemia. Maternal anemia induces adaptations in placental and fetal physiology, potentially leading to pregnancy and childbirth complications such as low birth weight, neurodevelopmental disorders, and premature delivery.[43, 44,45,46,47]

Maternal age was not found to be a significant determinant of newborn hemoglobin levels in either the Uganda or Ethiopia studies. However, in the Zambian study, teenage pregnancy showed a particular association with newborn anemia. Teenagers in the current study also displayed a higher likelihood of being malnourished compared to other age groups. While the Uganda study did not find a statistically significant association, it noted that younger mothers were more likely to have anemic newborns. Regarding parity, it was deemed significant in both the Zambian and Uganda studies. In the Zambian study, both primiparous and grandmultiparous mothers were significantly associated with newborn anemia. Likewise, in the Uganda study, higher maternal parity correlated with an increased likelihood of newborn anemia. Maternal medical conditions, particularly HIV, were identified as significant contributors to newborn anemia in this study. This study underscores the significance of quality antenatal care in ensuring the birth of full-term and normal birth weight babies, thus reducing the likelihood of postnatal anemia.

Limitations

The available data lacked specific details concerning antenatal care and the sex of the newborn, factors that could potentially influence newborn hemoglobin levels. Additionally, the authors acknowledged the absence of a global consensus on standard cut-off points for newborn hemoglobin, as evidenced by the various definitions of newborn anemia used in different studies.

Strength

This study, conducted across multiple centers, yielded valuable insights into antenatal care practices and newborn anemia in resource-limited settings, addressing a gap in the current literature. Additionally, while previous studies relied on umbilical cord-blood samples, the present study utilized peripheral blood collected from the heel site to estimate postnatal newborn hemoglobin levels, offering a more accurate depiction of the newborn hemoglobin profile.

CONCLUSION AND RECOMMENDATIONS

Enhanced antenatal care for pregnant mothers in resource-limited settings should place greater emphasis on maternal hemoglobin levels, nutrition, and medical conditions. Additionally, specific attention should be directed towards teenage pregnancy, primiparous and multiparous mothers, as well as preterm and low birthweight babies, with the aim of preventing newborn anemia and subsequently reducing infant morbidity and mortality.

Author Contributions: The corresponding author (Dr Adenike Oluwakemi Ogah) co-supervised the study and the original dissertation write-up, conducted the secondary data analysis, interpreted the results and drafted this manuscript. Dr Chrispin Mwando, conceived the study title, collected the data and drafted the original dissertation. Dr Kenneth Chanda supervised the study and original dissertation write-up. Dr Selia Nganjo co-supervised the study and original dissertation write-up. All the authors contributed to the intellectual content of this manuscript and final editing of the article.

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REFERENCES

1. Kligman SG, Shah B. Nelson Textbook for Pediatrics. 21 ed. philadelphia; 2019.
2. Von Lindern JS, Lopriore E. Management and prevention of neonatal anemia: current evidence and guidelines. Expert Rev Hematol. 2014;7(2):195–202. doi: 10.1586/17474086.2014.878225
3. Lokeshwar MR, Dalal R, Manglani M, Shah N. Anemia in newborn. Indian J Pediatr. 1998;65(5):651–661. doi: 10.1007/BF02731037
4. Javert CT. Hemorrhagic disease of the newborn. Am J Obstet Gynecol. 1938;35(2):200–214. doi: 10.1016/S0002-9378(38)90112-7
5. Suzuki S, Iwata G, Sutor AH. Vitamin K deficiency during the perinatal and infantile period. InSemin Thromb Hemost. 2001;27(2):93–98. doi: 10.1055/s-2001-14066
6. Kenet G, Chan A, Soucie J, Kulkarni R. Bleeding disorders in neonates. Haemophilia. 2010; 16: 168–175. doi: 10.1111/j.1365-2516.2010. 02316.x
7. John A, Widness M. Pathophysiology of anemia during the neonatal period, including anemia of prematurity. Neoreviews. 2008;9: e520–e525. doi: 10.1542/neo.9-11-e520
8. Arakhita Swain SM, Trilochan M, Satpathy SK, Saiprasanna B. Aetiopathological and clinical study of anemia in newborns admitted to a tertiary care centre. Shock. 2017; 4:3–77.
9. Christensen RD, Ohls RK. Anemia in the neonatal period. Neonatology. 2018;1489–1514. doi: 10.1007/978-88-470-1405-3103
10. Abay A, Yalew HW, Tariku A, Gebeye E. Determinants of prenatal anemia in Ethiopia. Archiv Public Health. 2017;75(1):51. doi:10.1186/s13690-017-0215-7
11. Mosiño A, Villagómez-Estrada KP, Prieto-Patrón A. Association between school performance and anemia in adolescents in Mexico. Int J Environ Res Public Health. 2020;17(5):1466. doi:10.3390/ ijerph17051466
12. Levy A, Fraser D, Rosen SD, et al. Anemia as a risk factor for infectious diseases in infants and toddlers: results from a prospective study. Eur J Epidemiol. 2005;20(3):277–284. doi:10.1007/s10654-004-6515-6
13. Allali S, Brousse V, Sacri A-S, Chalumeau M, de Montalembert M. Anemia in children: prevalence, causes, diagnostic work-up, and long-term consequences. Expert Rev Hematol. 2017;10 (11):1023–1028. doi:10.1080/17474086.2017.1354696
14. Lozoff B, Beard J, Connor J, Felt B, Georgieff M, Schallert T. Longlasting neural and behavioral effects of iron deficiency in infancy. Nutr Rev. 2006;64(5): S34–S43. doi:10.1301/nr.2006.may.S34-S43
15. Chaparro CM. Setting the stage for child health and development: prevention of iron deficiency in early infancy. J Nutr. 2008;138 (12):2529–2533. doi:10.1093/jn/138.12.2529
16. Ngonzi, J., Tibaijuka, L., Kintu, T.M. et al. Prevalence and risk factors for newborn anemia in southwestern Uganda: a prospective cohort study, 26 June 2023, PREPRINT (Version 1) available at Research Square [https://doi.org/10.21203/rs.3.rs-3054549/v1]
17. Bekele A, Tilahun M, Mekuria A. Prevalence of anemia and its associated factors among pregnant women attending antenatal care in health institutions of Arba Minch Town, Gamo Gofa Zone, Ethiopia: a cross-sectional study. Anemia. 2016;2016:1–9. doi:10.1155/2016/1073192
18. WHO. Worldwide Prevalence of Anaemia 1993–2005: WHO Global Database on Anaemia. WHO; 2008.
19. Lubeya, M.K, Vwalika, B., Anaemia in Pregnancy among Pregnant Women in Lusaka District, Zambia. Medical Journal of Zambia, Vol. 44, No. 4: 238-243 (2017)
20. WHO. The Global Prevalence of Anaemia in 2011. Geneva: WHO; 2015.
21. University Teaching Hospital, Lusaka. https://www.lstmed.ac.uk/research/departments/clinical-sciences/neonatal-nutrition-network/network-of-neonatal-units-1
22. World Health Organization. Guideline: Delayed Umbilical Cord Clamping for Improved Maternal and Infant Health and Nutrition Outcomes. World Health Organization; 2014.
23. WHO. Iron deficiency anemia. assessment, prevention, and control. A Guide for Programme Managers. WHO; 2001:47–62.
24. 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):1–7. doi:10.1186/s13052-019-0764-1
25. Ev E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. Strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational

studies. BMJ. 2007;335(7624):806–8.
26. 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. Journal of Multidisciplinary Healthcare. 2021:14 2607–2615
27. Ogah, A. and Kapasa, M. (2023). Magnitude and determinants of delayed breastfeeding initiation among mothers who deliver by cesarean section in a rural general hospital in east africa.. https://doi.org/10.1101/2023.06.06.23290985
28. Adediran A, Gbadegesin A, Adeyemo TA, et al. Cord blood haemoglobin and ferritin concentrations in newborns of anaemic and non-anaemic mothers in Lagos, Nigeria. Niger Med J. 2013;54 (1):22. doi:10.4103/0300-1652.108889
29. de Sá SA, Willner E, Pereira TAD, de Souza VR, Boaventura GT, de Azeredo VB. Anemia in pregnancy: impact on weight and in the development of anemia in newborn. Nutr Hosp. 2015;32 (5):2071–2079.
30. Tiruneh T, Kiros T, Getu S. Hematological reference intervals among full-term newborns in Ethiopia: a cross-sectional study. BMC Pediatr. 2020;20(1):1–6. doi:10.1186/s12887-020-02320-5
31. Laar AK, Grant FE, Addo Y, et al. Predictors of fetal anemia and cord blood malaria parasitemia among newborns of HIV-positive mothers. BMC Res Notes. 2013;6(1):350. doi:10.1186/1756-0500-6-350
32. Uneke C, Iyare F, Sunday-Adeoye I, Asiegu O, Nwosu K, Ajayi J. Effects of maternal plasmodium falciparum malaria, anemia and HIV infection on fetal hemoglobin levels in Nigeria. Internet J Gynecol Obstet. 2009;12. Available from: http://ispub.com/IJGO/12/1/12598.
33. Koura GK, Ouedraogo S, Le Port A, et al. Anaemia during pregnancy: impact on birth outcome and infant haemoglobin level during the first 18 months of life. Trop Med Int Health. 2012;17(3):283–291.
34. Bergmann RL et al. 2010 „Prevalence and risk factors for early postpartum anemia", European Journal of Obstetrics & Gynecology and Reproductive Biology, 150(2), pp. 126–131. Available at: https://doi.org/10.1016/j.ejogrb.2010.02.030.
35. Kosto A et al. (2015) „The effect of maternal anemia on maternal and neonatal outcomes in twin pregnancies", The Journal of Maternal-Fetal & Neonatal Medicine, pp. 1–4. Available at: https://doi.org/10.3109/14767058.2015.1084616.
36. Shukla AK, Srivastava S, Verma G. (2019) „Effect of maternal anemia on the status of iron stores in infants: A cohort study", Journal of Family & Community Medicine, 26(2), pp. 118–122. Available at:https://doi.org/10.4103/jfcm.JFCM_115_18.
37. Alegbeleye JO, Abam DS, Orazulike NC. (2020) „Outcome of Maternal Anaemia on Cord Haemoglobin of the Newborn in Port Harcourt, Nigeria", Journal of Biosciences and Medicines, 08(05), pp. 142–152. Available at: https://doi.org/10.4236/jbm.2020.85014.
38. Rathoria R, Rathoria E. (2021) „Effect of maternal anemia on cord blood haemoglobin of newborn",International Journal of Reproduction, Contraception, Obstetrics and Gynecology, 11(1), p. 64. Available at: https://doi.org/10.18203/2320-1770.ijrcog20215076.
39. Kohli UA, Rajput M, Venkatesan S. (2021) „Association of maternal hemoglobin and iron stores with neonatal hemoglobin and iron stores", Medical Journal Armed Forces India, 77(2), pp. 158–164. Available at: https://doi.org/10.1016/j.mjafi .2019.11.002.
40. Ogah, A.O. INFREQUENT FEEDING MASKING THE BENEFITS OF EXCLUSIVE BREASTFEEDING AT 14WEEKS POST-DELIVERY IN A RURAL SETTING: IMPACT ON INFANT GROWTH AND MATERNAL MENTAL HEALTH. medRxiv 2024.06.07.24308596; doi:https://doi.org/10.1101/2024.06.07.24308596
41. Ogah, A.O., Infant Weight Faltering and Feeding Patterns at 6 Weeks Post-Delivery in a Rural East African Community:Comparing Incremental Versus Static Weight Assessments. medRxiv 2023.12.13.23299669; doi: https://doi.org/10.1101/2023.12.13.23299669
42. Adenike Oluwakemi Ogah, James-Aaron Ogah, Elizabeth Edigwu Ogah. LEVELS OF EXCLUSIVE BREASTFEEDING AND CORRELATES AT 10WEEKS POST-DELIVERY IN A RURAL SETTING. medRxiv 2024.04.15.24305842; doi: https://doi.org/10.1101/2024.04.15.24305842
43. Dane B et al. (2013) „Does maternal anemia affect the newborn? ", Türk Pediatri Arşivi, 48(3), pp. 195–199. Available at: https://doi.org/10.4274/tpa.1068.
44. Wiegersma AM et al. (2019) „Association of Prenatal Maternal Anemia With Neurodevelopmental Disorders", JAMA Psychiatry, 76(12), p. 1294. Available at:

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue IX September 2024

https://doi.org/10.1001/jamapsychiatry.2019.2309.

45. Rahmati S et al. (2020) „The relationship between maternal anemia during pregnancy with preterm birth: a systematic review and meta-analysis", The Journal of Maternal-Fetal & Neonatal Medicine, 33 15 , pp. 2679–2689. Available at: https://doi.org/10.1080/14767058.2018.1555811.
46. Sanjay Aher KM, Kadam S. Neonatal Anemia. KEM Hospital, Pune, Maharashtra, India: KEM Hospital; 2008.
47. Rao R, Georgieff MK. Iron therapy for preterm infants. Clin Perinatol. 2009;36(1):27–42. doi: 10.1016/j.clp.2008.09.013