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Original Article

Effect of Maternal Anemia on Neonatal Hemoglobin Levels. (A Single Pilot Center Study)

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Abstract

Background: Maternal anemia is a significant risk factor for premature labor, low neonatal birth weight and low hemoglobin levels in the newborn. **Objectives**: We aimed to assess the impact of maternal anemia on their newborn hemoglobin levels just after the delivery. **Methods**: The study included 200 mothers and their newborns. We took a detailed history from the mothers which included age, maternal education level, residence, parity and nutritional status. We measured newborn birth weights and assessed their gestational ages. In addition, we measured hemoglobin level for the mothers just before delivery and their newborns. **Results**: Maternal anemia was present in 59% of the studied mothers, being predominant in non-educated mothers with poor nutritional status and in those living in rural areas without regular antenatal care. There was a significant positive correlation between maternal hemoglobin at delivery and hemoglobin in their newborn (r=0.546, p=0.000). The mean birth weight of anemic newborns (2.7 ± 0.6kg) was significantly lower than that of their non-anemic counterparts (3.2 ± 0.6kg) (p=0.000). Mean birth weight of newborns whose mothers were anemic was 2.7 kg ± 0.6 compared to 3.4 kg ± 0.6 in newborns whose mothers were not anemic (p=0.000). Newborn complications were associated with a cut off level of maternal hemoglobin ≤ 10.7g/dL with a sensitivity of 83% and a specificity of76.6%. **Conclusion**: Maternal anemia is a common problem and was present in more than half of the studied mothers. Maternal anemia at delivery increased the chances for low birth weight and neonatal anemia.

Key words: Neonatal anemia; anemia during pregnancy; pregnancy outcome, low birth weight

Introduction

Anemia during pregnancy is serious common problem, Prevalence of anemia among pregnant women in Egypt was reported at 22.6% in 2016, according to the World Bank collection of development indicators, compiled from officially recognized sources [1]. Anemia during pregnancy is more common in Southern Asian countries (52%) and Central and West African countries (56%).[2]

Anemia during pregnancy is defined by the Centers for Disease Control and Prevention as a hemoglobin (Hb) concentration of 11 g/dL in the first and third trimesters or 10.5 g/dL in the second trimester. [3]

In developing countries, anemia during pregnancy is a prevalent concern, primarily due to poor nutritional condition and high incidence of parasitic infection. [2]

Maternal anemia has been reported to have adverse effects on both the mother and newborn. Fatigue, limited work capacity, impaired immunological function, higher risk of heart illnesses, and mortality are all severe health impacts for the mother. [4]

In neonates delivered to anemic women, adverse perinatal outcomes such as preterm delivery and small for gestational age (SGA) neonates and increased perinatal mortality rates have been noted. The perinatal outcome, birth weight, and Hb level all improve with iron supplementation. [5]

Maternal anemia must be adequately prevented and managed, especially iron-deficiency anemia, which accounts for most instances of anemia during pregnancy.[6]

We conducted this study to assess the impact of maternal anemia on their newborn hemoglobin level just after the delivery.

Aim of the study

A descriptive study to determine how maternal anemia affects neonatal outcomes

Patients and Methods

Study setting: The study was carried out at the obstetrics and gynecology department, Kasr Al-Ainy hospital, Cairo University; between February 2019 and August 2019. (n = 200).

Study participants: Apparently healthy pregnant women aged from 20 to 42 years at time of their delivery (at childbirth) at obstetrics causality were included, Cairo university hospitals. They were randomly chosen on different days of the week between February 2019 and August 2019. Pregnant women with comorbidities, such as kidney disease, heart disease, chronic hemolytic anemia, antepartum hemorrhage, and previous blood transfusion, were excluded.

Study design: Prospective cohort study

Data collection tools: The participants completed a questionnaire that included questions relating to their age, residency, education level, previous pregnancy, chronic disease history, prenatal follow-up, prenatal iron supplementation, intake frequency of major food groups, either on a daily or weekly basis (meat and other proteins, dairy products, vegetables, fruits, grains, and other starches), and mode of delivery. Information on neonates was also collected, including sex, gestational age, birth weight and percentile, and Hb level. We measured birth weight without diapers or outer clothing using a calibrated scale. We used the Ballard score to estimate the gestational age, and neonates ≥37 weeks were considered term. SGA was described as a birth weight below the 10th percentile, a birth weight between the 10th and 90th percentile (appropriate to gestational age), and birth weight more than the 90th percentile (large to gestational age 'LGA'). The Hb levels of the mothers and newborns were measured using a Mission® Plus Hemoglobin Meter (San Diego, USA) as follows:

Specimens were collected using single-use lancets to prick the fingertip for blood collection. The Mission® Plus Hemoglobin Meter requires a tiny sample, which may be obtained from fresh capillary whole blood.

Mothers and newborns were categorized into two groups according to Hb concentration: anemic and non-anemic. Pregnant women were determined to have severe, moderate, mild, or no anemia by Hb concentrations < 8 g/dL, 8–9 g/dL, 10–10.9 g/dL, and ≥11 g/dL, respectively. Anemia in full-term and preterm babies was defined as Hb concentration < 17 and < 16.4 g/dl, respectively.

Ethics Approval

An informed consent was obtained from the mothers on admission to Kasr Al-Ainy teaching hospital to perform descriptive studies when needed. All needed official permissions were obtained. The study was approved by ethical committee for research in Kasr Al-Ainy faculty of medicine Cairo university Egypt.

Statistical analysis

All data have been reviewed to be complete and logical. In Microsoft Office Excel 2016, we have inserted pre-coded data. The Statistical Package of Social Science Software program, version 25, was used to analyze the pre-coded data. We used mean and standard deviation to describe the quantitative variables and compared them with an independent t-test. At the same time, we used frequency and percentage to express the qualitative variables and compared them with the chi-square test. We considered P-values less than 0.05 significant.

Results

Maternal evaluation: In the current study, we included 200 pregnant women, 97 (48.5%) women gave birth vaginally, and 103 (51.5%) women received cesarean section. The mothers were between 20–42 years at delivery (mean, 28 ± 5.2 years). Approximately 22% were urban residents. About 32% were illiterate. Of the illiterate women, 92% lived in rural areas.

Moreover, 148 (74%) were multigravida, and 57 (28.5%) did not receive regular antenatal care (ANC). Furthermore, 45% of the mothers had completed primary education, 22% had completed secondary school, and only 1% were highly educated and the rest 32% was illiterate.

We assessed the hematological status of the mothers by measuring their hemoglobin levels and categorize into 118 cases were anemic mothers (59%) and 82 cases were non anemic mothers (41%). Among anemic mothers, anemia was mild in 112, moderate in 6. Prenatal iron supplementation was taken by 64.5% of the participants. Among the anemic mothers, 52 mothers (44.1%) received prenatal iron supplementation. Among the mothers who supplemented with iron, none suffered from severe anemia. The main risk factors for anemia during pregnancy were rural residency, numerous pregnancies, and a lack of antenatal care (ANC) "Table 1."

Maternal anemia was associated with lower intake of all nutritive food items (meat, other proteins, vegetables, fruits, grains, dairy products), although Rice, starch and bread consumption remained high which were deficient in iron and fail to keep iron in values.

Neonatal evaluation: Just over half of the newborns (50.5%) were males with a mean birth weight of 3 kg ± 0.7 with range 1- 4.7. Eighty two percent were full term and only 18% were preterm. Regarding weight percentile, 39% had weights between 75-90th, 26% between 25-50th, 17% between 50-75th, 8% between 10-25th and only 5% were < 10th. In this study, we found that 93 of the newborns (46.5%) had neonatal anemia. The mean value of hemoglobin level at birth was 16.6 ± 2g/dL (range 9.5 - 21.2).

Relations between neonatal parameters and maternal parameters: Hemoglobin levels at birth were significantly lower in newborns of mothers with anemia compared to those without anemia (15.8 ± 2 versus 17.8 ± 1.4 p=0.000).

We found 77(65.3%) of newborns born to anemic mothers had low Hb concentrations at birth compared to 16 (19.5%) of infants born to non-anemic mothers (p < 0.0001).

Preterm deliveries occurred in 29.7% of mothers with anemia compared to only

1.2 % of mothers without anemia (p=0.000). There was a significant difference between birth weight of newborns of anemic mothers compared to those without anemia (2.7 ± 0.6 kg versus 3.4 ± 0.4 kg, p=0.000). Babies of anemic mothers had lower weight percentiles than babies of non-anemic mothers, p=0.000.

Neonatal anemia was more common among babies of non-educated mothers (38.7 % versus 25.2 %, p=0.041). Neonates of mothers from rural areas had a higher incidence of anemia than those from urban areas (87.1% versus 12.9%, p=0.001). Neonatal anemia was detected more in those born by caesarean sections than by normal vaginal delivery (63.4% versus 36.6%, p=0.002). The mothers who underwent ANC follow up were less likely to have newborns with neonatal anemia than those who did not (62.4 % versus 79.4%, p=0.008). On the other hand, there was a significantly higher incidence of prematurity in anemic cases compared to non anemic newborns (25.8% versus 11.2 %, p=0.006).

Identification of risk factors of neonatal anemia: We documented a significant positive correlation between Hb concentration in pregnant women and birth weight of their neonates (r = 0.69, p < 0.001). We used the logistic regression curve to calculate the risk of anemia in newborns. We found that the maternal Hb level has good discrimination ability, with an area under the curve (AUC) > 0.7 (0.815) and 95% confidence interval (CI) between 0.734 and 0.897. At a cut-off ≤10.15, the sensitivity was 91.1%, and specificity was 65.3%. The risk of low birth weight was calculated using simple logistic regression. The results showed that maternal Hb level had good discrimination ability as the AUC was > 0.7 (0.9), and the 95% CI was between 0.813 and 1. At a cut-off ≤ 8.85, maternal Hb had a sensitivity (90%) and specificity (93%) to determine neonatal birth weight. Maternal anemia was attributed to adverse neonatal outcomes such as preterm delivery, SGA, and newborn hemoglobin levels "Table 1."

Table1: Neonatal parameters in anemic and non-anemic mothers

Item	Mother anemia		
	Yes (n=118)	No (n=82)	P value
Age(yrs)			
Range	21 - 42	20 - 37	
Mean ± SD	29 ± 6	28 ± 4.5	0.151
Maternal education level (n,%)			
No education	44 (37.3)	19 (23.2)	0.035
Education	74 (62.7)	63 (76.8)	
Residence (n,%)			
Urban	21 (17.8)	27 (32.9)	0.014
Rural	97 (82.2)	55 (67.1)	
Parity (n,%)			
Primiparous	26 (22)	26 (31.7)	0.125
Multiparous	92 (78)	56 (68.3)	
Delivery (n,%)			
Vaginal	56 (47.5)	41 (50)	0.723
Caesarean section	62 (52.5)	41 (50)	
ANC follow up(n,%)			
Yes	67 (56.8)	76 (92.7)	0.000
No	51 (43.2)	6 (7.3)	
Gestational age(wks) (n,%)			
Preterm	35 (29.7)	1 (1.2)	0.000
Full term	83 (70.3)	81 (98.8)	
Birth weight (kg)			
Range	1 - 3.9	1.9 - 4.7	
Mean ± SD	2.7 ± 0.6	3.4 ± 0.4	0.000
Hemoglobin level at birth(g/dL)			
Range	9.5 - 21.2	14 - 21	
Mean ± SD	15.8 ± 2	17.8 ± 1.4	0.000
Neonatal anemia			
Yes	77 (65.3)	16 (19.5)	0.000
No	41 (34.7)	66 (80.5)	

SD: Standard deviation**; ANC**: antenatal care

Table (2): Relations of maternal anemia to food frequency questioners

Item	Mother anemia (n,%)		
Item	Yes (n=118)	No (n=82)	P value
Iron intake during pregnancy			
Yes	52 (44.1)	77 (93.9)	0.000
No	66 (55.9)	5 (6.1)	
Meat & meat substitutes & other proteins			
Daily	8 (6.8)	55 (67.1)	0.000
Non-Daily	110 (93.2)	27 (32.9)	
Milk products			
Daily	54 (45.8)	59 (72)	0.000
Non-Daily	64 (54.2)	23 (28)	
Vegetables			
Daily	66 (55.9)	62 (75.6)	0.004
Non-Daily	52 (44.1)	20 (24.4)	
Fruits			
Daily	53 (44.9)	48 (58.5)	0.058
Non-Daily	65 (55.1)	34 (41.5)	
Bread			
Daily	110 (93.2)	81 (98.8)	0.085
Non-Daily	8 (6.8)	1 (1.2)	
Grains and other starches			
Daily	19 (16.1)	26 (31.7)	0.009
Non-Daily	99 (83.9)	56 (68.3)	

Discussion

Anemia during pregnancy is considered a common concern, and its incidence in Africa is 56%. In this study. At childbirth, 59% of pregnant women were anemic. This high percentage of anemia among our subjects was due to our hospital being a tertiary government hospital and usually serving people in the low-socioeconomic category.

Our results correspond with Rahman et al., which reported that 42.7% of pregnant women were anemic in low and middle-income nations. They noted that anemia's prevalence varied by the economic profile of the country (45.4% in low-income, 39.8% in lower-middle-income, and 37.1% in upper-middle-income countries) [2].

Anemia in pregnancy is a complex condition, and the most prevalent cause is iron deficiency, followed by other micronutrient deficiencies (folic acid, vitamin B12, and vitamin A) [7]. In the current study, 64.5% of anemic mothers received prenatal iron supplementation. However, our subjects had a high incidence of anemia despite this supplementation. This could be explained by the low compliance rate of taking iron supplements, even with optimal motivation and instructions, due to the unwanted side effects, an improper dose or duration of iron supplementation, other micronutrient deficiencies, or irregular feeding patterns. However, none of the iron-supplemented subjects had severe anemia.

Iron deficiency anemia of mothers affects babies throughout pregnancy. It increases the incidence of SGA, premature delivery, and long-term cognitive abnormalities, alteration in thermoregulation, lipid metabolism abnormalities, stroke and seizures, motor dysfunction and coordination, and in several cases, hearing abnormalities [8].

In this study, low Birth weight and prematurity was more common significantly in anemic mothers. Similarly, Bodeau-Livinec et al. reported that maternal anemia increases the risk of premature delivery and low birth weight [9]. Heydarpour et al., in agreement with our study, found a high chance of preterm labor among anemic mothers than non-anemic mothers [10]. The prematurity due to maternal anemia might be attributed to increased oxidative of fetoplacental unit and release of mediators that trigger uterine contraction hence the delivery.

Srour et al. divided pregnant mothers into three groups according to Hb concentration and compared each group with gestational age. The results showed that increased gestational age with increased maternal Hb levels [11]. Furthermore, Al-hajjiah et al. found that maternal Hb correlated positively to birth anthropometry (birth weight, length, and head circumference) [12]. A previous study by Haider et al. found that for each 1 g/L increase in maternal Hb, the neonatal birth weight increased by 14.0 (6.8 –21.8) gram [13]. It was explained by the maternal anemia affects placental angiogenesis, limiting fetal oxygen supply and subsequent restriction of intrauterine growth and low birth weight. This comes in agreement of our study that reported around two thirds of newborns born to anemic mothers had low Hb concentrations at birth compared to 16 (19.5%) of infants born to non-anemic mothers ($p < 0.0001$).

In addition, we analyzed maternal and neonatal hemoglobin levels and discovered a good association between maternal hemoglobin levels at delivery and infant hemoglobin levels ($r = 0.546$, $p = 0.000$). Gestational iron deficiency can alter iron homeostasis in neonates, leading to an increased risk of iron deficiency anemia later despite adequate iron supplementation [8]. Indeed, Koura et al. study showed that maternal anemia was strongly linked to neonatal anemia ($p = 0.002$) [14]. Furthermore, Dane et al. found lower mean Hb levels (17.49 ± 2.4 g/dL vs. 18.1 ± 2.4 g/dL; $p = 0.026$) in the newborns of mothers who were anemic compared to non-anemic mothers. Also, the mean cord blood Hb level was lower in newborns with anemic mothers (17.3 ± 3 g/dL versus 18.1 ± 2.4 g/dL; $p < 0.05$) [15].

The primary risk factors for neonatal anemia were living in rural areas, low education level and lack of prenatal follow-up ($p = 0.001$, 0.041, 0.02 respectively). The percentage of illiteracy among the pregnant mothers in the current study was high (32%); this may have been because we enrolled them from a government hospital that serves patients from low-socioeconomic and low-income areas. In this study, we figured out a significant relationship between maternal illiteracy and maternal anemia incidence, in that maternal anemia was more prevalent among uneducated women (37.3% versus 23.2%, $p = 0.035$). Possible explanations for this finding include the majority of the women living in rural areas, did not receive regular ANC, and were multigravida.

Okwu and Ukoha conducted a similar study in Nigeria and discovered that uneducated pregnant women had a considerably higher incidence of maternal anemia than educated women [16]. In contrast, in other studies, a high educational level seemed significantly associated with anemia [17].

There was a strong correlation between maternal residence and incidence of maternal and neonatal anemia in the current study. Asrie used logistic regression analysis to examine the potential relationship between anemia and sociodemographic features and clinical conditions and found a significant association with living in the countryside ($p < 0.001$). Furthermore, the study found that most participants (89.7 percent) lived in metropolitan regions, which are thought to have a lower incidence of anemia due to improved awareness, hygiene, and sanitation [18]. This, together with other studies, showed that women of lower socioeconomic classes have a higher risk of gestational anemia [19].

We discovered a significant link between non-regular ANC follow-ups and the incidence of maternal anemia in the current research, with anemia being more common in mothers who had non-regular ANC follow-ups ($p < 0.0001$). Regular follow-ups enable the discovery of anemic instances that could otherwise go undetected in mothers who do not attend ANC regularly.

Improving ANC coverage, prenatal iron, and folic acid supplements and reducing maternal undernutrition could lead to better pregnancy outcomes and mother health [20]. Indeed, Worku et al. reported that micronutrient supplements, folic acid, iron supplementations, nutrition education, and other associated services during ANC visits might lower the risk of developing anemia [21].

We found that a rare intake of meat, other proteins, vegetables, fruits, grains, and micronutrients were a significant risk factor for anemia. Often rice, bread and other starches were also associated with anemia during pregnancy. According to Lebso et al., the food security level, food frequency, and once-a-week food from animal origin were protective. In contrast, lack of iron supplementation and low dietary diversity score showed a statistically significant association with anemia [22,23]

According to forementioned findings, we recommend to close follow up assessment of both anemic mothers and their newborns. It was implemented by improving nutrition by continuous maternal nutritional education and guidance by flyers in primary health care centers.

Conclusions

Anemia is a common medical disorder in pregnancy in Egyptian women and severe anemia is associated with poor maternal and neonatal hemoglobulin. Severe maternal anemia increases the risk for low birth weight and neonatal anemia.

List of Abbreviation

WHO: World Health Organization

Hb: hemoglobin

ANC: antenatal care

AUC: area under the curve

CI: confidence interval

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Author's contributions

N El.koofy , ZA , AM have designed this study together. HE contributed to the data collection, ST and YR contributed to data analysis. ST contributed to data processing. YR shared in writing the manuscript. ALL authors read and approved the final manuscript.

Conflict of 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

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On behalf of authors, I declare that they have no competing interests.

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