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Original Article

Nutritional Status of Anemic and Non-anemic Mothers, and Outcomes of Neonates Born at Zawia Medical Center – Libya.

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ABSTRACT

Purpose: Anemia is a common medical disorder during pregnancy, especially in third world countries like Libya. Iron deficiency during pregnancy may be attributed to health problems and malnutrition during pregnancy. The aim of this study is to determine hemoglobin levels in umbilical cord blood and to evaluate the relationship between maternal hemoglobin concentration and perinatal outcomes in Zawia Medical Center.

Methods: This is a cross-sectional study of 81 pregnant women who were admitted to the maternity ward of the Department of Gynecology and Obstetrics of Zawia Medical Center from 2 July 2023 to 20 September 2023. Blood samples were collected from women in labor in ethylenediaminetetraacetic acid (EDTA) tubes. Immediately, after blood samples were collected, a complete blood count (CBC) test was performed, and in the same context, cord blood samples were examined.

Results: The hemoglobin values of anemic and non-anemic mothers and their neonates were 9.33 ± 1.01 g/dL and 14.44 ± 1.26 g/dL, and 12.12 ± 1.51 g/dL and 14.37 ± 2.10 g/dL, respectively. Moderate anemia was the most commonly observed in the population of this study (24.69%), followed by mild anemia (27.16%) and severe anemia (1.24%). There was a significant correlation between maternal hemoglobin concentration and cord blood hemoglobin concentration (p-value ≤ 0.05). In addition, the study showed that Libyan pregnant mothers concentrate more on consuming traditional local food, some of which is poor in micronutrients.

Conclusions: The results of this study showed that the average hemoglobin in newborns was lower than the values reported by many other studies. It also showed that there is a linear relationship between maternal and umbilical cord hemoglobin.

Keywords: Pregnancy, hemoglobin, anemia, maternal, newborns.

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INTRODUCTION

During pregnancy, a female's body goes through many changes, such as hormonal and physiological changes, circulatory changes, respiratory and metabolic changes, and breast and cervical changes.[1] The placental membrane allows the exchange of nutrients and gases between the fetus and the mother's body. The fetus goes through a process known as organogenesis, where most major systems develop within eight weeks after implantation, or ten weeks of gestational age.[1,2] showed that the average duration of pregnancy from implantation of the fertilized egg until birth is 280 days.

During this period, many health issues may affect the mother's and/or her child’s health. Such issues include hypertension, diabetes, anemia, urinary tract infection, and psychological problems (National Center for Chronic Disease Prevention and Health Promotion-Department of Reproductive Health, NCCDPHP).[3] Anemia is a public health problem, and the most common blood disorder occurs during pregnancy, especially in developing countries. It contributes significantly to increasing maternal morbidity and mortality during the perinatal period.[4] The World Health Organization (WHO) has classified anemia during pregnancy into three categories: first trimester hemoglobin <11 g/dl, second trimester hemoglobin <10.5 g/dl, and third trimester hemoglobin level <10.5 to 11 g/dl.[5] According to the severity, the WHO has classified anemia into: nonanemic Hb > 11 g/dl, mild anemia Hb = 10-10.9 g/dl, moderate anemia Hb = 7-9.9 g/dl, and severe anemia Hb < 7 g/dl.

Iron deficiency (ID) results from depletion of stored iron if not adequately taken. The WHO reported that serum ferritin levels were less than 15 µg/L throughout all trimesters of pregnancy, resulting in iron deficiency anemia (IDA).[5,6,7] Because of the importance of determining body iron status during pregnancy, ferritin is the most widely used indicator and the most practical and sensitive screening test for iron accumulation during pregnancy and has been recommended as a screening test in all pregnant women.[8] The relationship between pregnancy outcomes and hemoglobin levels has been reported in many studies, where it has been observed that hemoglobin concentration reaches its lowest levels in the second trimester of pregnancy due to an increase in plasma volume that is not matched by a proportional increase in red cell volume. The consistency of this relationship varies based on the trimester of HGB assessment.[9] Women usually develop anemia during pregnancy due to the continuous need for iron and vitamins because of the physiological burden of pregnancy, and the inability to meet the demand for these nutrients leads to anemia.[10]

Healthy and good nutritional habits during pregnancy play an important role in determining the nutritional status of the mother and her fetus. Poor nutritional habits during pregnancy, such as low intake of essential nutrients such as vitamin A, vitamin C, iron, and protein, may lead to many disorders.[11] Thereafter, the absence of these nutrients in a pregnant woman's diet may lead to anemia, which may contribute to increased risk for pregnancy outcomes. These risks include increased rates of stillbirth, low birth weight, premature birth, and perinatal maternal mortality.[11,12] Poor dietary habits and patterns such as consuming large amounts of tea, coffee, or cocoa during meal times, reducing the number of meals per day (less than 3 meals), and lack of dietary diversity also may contribute to increasing the consequences of anemia disorders.[11] The aim of this study is to evaluate the impact of gestational anemia on perinatal outcomes at Zawia Medical Center/Libya.

MATERIALS AND METHODS

Study Population

For this study, we included women who were admitted to the Gynecology and Obstetrics Department at Zawia Medical Center between July 2, 2023, and September 20, 2023, for delivery. The woman is considered to be eligible to be included if she is free of the following diseases: hepatitis B, HIV, syphilis, and COVID-19 and chronic diseases (such as diabetes mellitus).

Study Site

The current study was conducted at Zawia Medical Center. It is a teaching hospital with a large capacity.

It includes several departments such as internal medicine, surgery, orthopedics, gynecology, and obstetrics. It is located in the city of Zawia, west of the capital, Tripoli, at a distance of about 45 km to the west. At this center, there are about 5000 births per year. The maternity unit contains enough beds to meet the needs of the pre- and postpartum stages. The department includes obstetrician consultants and specialized doctors, with many experienced midwives.

Interview Data Form

The head of the research team designed the survey form for this study, and the researchers subsequently conducted a face-to-face interview with patients to fill out the survey form. This survey form includes the demographic, biological, and clinical data obtained. Sociodemographic characteristics were obtained, including maternal age, parity, educational level, conservative status, maternal nutritional status, hemoglobin genotype, mode of delivery, and perinatal outcomes.

Blood Sample Collection

Four to five milliliters of blood were collected from the umbilical cord of babies at the end of the second stage of labor (immediately after birth) by clamping and cutting the end of the umbilical cord. A venous blood sample was taken from the pregnant woman inside the labor room immediately after the birth. The blood samples were collected in ethylene diamine tetra acetic acid (EDTA) tubes.

Hematological Analysis

The blood samples were tested for complete blood count (CBC) parameters, which include red blood cells (RBCs), the concentration of hemoglobin (HGB), and the hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), red cell distribution width (RDW), counts of white blood cells (WBCs), white blood cell differential count; lymphocyte count (LYM) and its percentage (LYM%), neutrophil count (NEU) and its percentages (NEU%), mixed cells count (MXD) and its percentages (MXD%), and platelets (PLT), mean platelet volume (MPV) and platelet distribution width (PDW). The samples were analyzed using Sysmex KX-21 N.[13]

Then the blood samples were centrifuged, and the serum was separated and stored at -20°C in a hospital laboratory freezer for a maximum of two to four days. Then serum ferritin (SF) was determined by chemical immunoassay (IMMULITE, diagnostic products). Maternal anemia in the third trimester was defined as HGB <110 g/L.[5] In the newborn, low hemoglobin was defined as cord blood HGB 130 g/L.[14,15] The newborn is considered to have severe iron deficiency if iron stores in cord blood are SF < 75 mg/L and cord SF < 35 mg/L.[16,17]

Statistical Analysis

The collected data and laboratory results were coded, checked for completeness, and analyzed using IBM SPSS version 22 (SPSS Inc., Chicago, Illinois, U.S.A.) statistical software for Windows. Descriptive statistics (mean, standard deviation, and percentages) were determined and presented. T-test tested comparisons between the means. Pearson's correlation and one-way ANOVA were used to investigate an association between variables; also, a homogeneity of variance test was used. Statistical significance was considered at $p \leq 0.05$.

RESULTS

Eighty-one pregnant women, who were admitted in the maternity unit at Zawia Medical Center from 2 July 2023 to 20 September 2023, were included in the current study. These women were classified into two groups (group A (N = 30) anemic pregnant women and group B (N = 51)) non-anemic pregnant women). Demographic features of the study population are presented in Table 1.

The mother's blood volume increases during pregnancy, as does the amount of iron. The mother's body uses iron to produce more blood to supply oxygen to the fetus. In the current study, 19% of pregnant women were anemic, 30.5% were iron deficient, and 50.5% did not suffer from iron deficiency. 33.3% of mothers with anemia did not consume iron supplements during pregnancy, while 66.7% of the studied population consume these supplements during the first trimester of pregnancy. Also, 14.3% of pregnant women who did not suffer from iron deficiency did not consume iron supplements, while 85.7% of them consume these supplements during the first trimester of pregnancy. Based on the results of hemoglobin levels, the study population was classified into five groups: the hemoglobin range for the first group was from 6 to 9.5 g/dl, and the range for the last group ranged from over 14 g/dl, as shown in (Table 2).

In the present study, we categorized 30 anemic pregnant women as mild, moderate, and severe according to the WHO classification system (mild anemia HGB = 10-10.9 g/dl, moderate anemia HGB = 7-9.9 g/dl, and severe anemia HGB < 7 g/dl). Out of 81 cases, anemia was mild in 27.2% women, moderate in 24.7% women, and severe in 1.2% women (Table 3).

Table 1. Demographic features of the study population.

Characters	Category	Frequency (%)
Maternal age (years)	<19 20-24 25-29 >30	5 (6.17) 18 (22.22) 34 (41.98) 24 (29.63)
Parity	primiparous multiparous	22 (25.93) 78 (74.07)
Maternal education level	primary school secondary school high institute university	35 (42.2) 3 (3.6) 23 (27.7) 22 (26.5)
Mode of delivery	normal vaginal cesarean section (C/S)	22 (27.16) 59 (72.84)
Gender of newborn	male female	32 (39.51) 49 (60.49)

Table 2. Hemoglobin ranges of the study population.

HGB Ranges	Repetition	Percentages
6 – 9.5	18	21.6
9.6 – 10.5	18	21.6
10.6 - 12	27	32.5
12.1 - 14	13	15.6
Up to 14	7	8.4

Table 3. Mean hemoglobin concentration of mothers according to WHO classification of anemia.

Maternal Hemoglobin g/dL (WHO) Classification	Mean maternal Hemoglobin g/dL	No of patients	Percentages
Non anemic HGB > 11 g/dL	12.53 ± 1.48	38	46.91
Mild anemia HGB = 10–10.9 g/dL	10.50 ± 0.300	22	27.16
Moderate Anemia HGB = 7–9.9 g/dL	8.92 ± 0.740	20	24.69
Severe anemia HGB < 7 g/dL	Nill	1	1.24

Regarding the hematological and biochemical results of mothers and newborns, it showed that hemoglobin levels for anemic mothers and their newborns were 9.33 g/dl ± 1.01 and 14.44 g/dl ± 1.26, respectively, and that hematocrit values were 29.80% ± 3.26 and 44.17% ± 4.52, respectively. In contrast, these values were much higher in non-anemic mothers and their newborn babies as follows: 12.12 g/dl ± 1.51, 14.37 g/dl ± 2.10, 37.08% ± 4.28, and 40.93% ± 45.66, respectively (Table 4).

In the same context, the values of iron and serum ferritin in anemic and non-anemic mothers were 61.83 ug/l ± 51.57, 75.62 ug/l ± 87.61, and 92.92 ug/l ± 80.86, 144.50 ug/l ± 87.13, and 69.56 ug/dl ± 49.17, 131.95 ug/dl ± 45.54, and 92.92 ug/dl ± 80.86, 154.53 ug/dl ± 26.51, respectively. Homogeneity of differences test regarding variables (hemoglobin, red blood cells, iron, and ferritin for both natural and cesarean deliveries) between the two groups of anemic and non-anemic pregnant women (Tables 5, 6). The statistical results are presented in the following tables and discussed clearly.

Table 4. Hematological and biochemical results of the study population.

Parameters		Anemic group (Mean + S.D)	Non-anemic group (Mean + S.D)
HGB (g/dl)	mothers	9.33 ± 1.01	12.12 ± 1.51
	newborn	14.44 ± 1.26	14.37 ± 2.10
Hct (%)	mothers	29.80 ± 3.26	37.08 ± 4.28
	newborns	44.17 ± 4.52	40.93 ± 45.66
MCV (fl)	mothers	79.87 ± 9.84	89.97 ± 8.16
	newborns	106.22 ± 4.29	103.90 ± 15.07
Ferritin (ug/l)	mothers	61.83 ±51.57	92.92 ± 80.86
	newborns	75.62 ± 87.61	144.50 ± 87.13
Iron (ug/dl)	mothers	69.56 ± 49.17	92.92 ± 80.86
	newborns	131.95 ± 45.54	154.53 ± 26.51

Table 5. Test of homogeneity of variances regarding variables between maternal and fetal.

Groups	Parameters	Levene Statistic	df1	df2	P value
Mothers	Hb	1.44	1	79	0.233
	Hct	0.645	1	79	0.424
	MCV	0.013	1	79	0.909
	RDW	1.286	1	79	0.260
	Ferritin	0.637	1	58	0.428
	Iron	0.295	1	58	0.589
Newborn	HGB	7.660	1	82	0.007
	Hct	3.640	1	82	0.060
	MCV	3.554	1	82	0.063
	RDW	0.999	1	82	0.320
	Ferritin	0.014	1	58	0.840
	Iron	1.869	1	58	0.177

Table 6. Homogeneity of variances test for hemoglobin, erythrocytes, iron and ferritin for normal and cesarean deliveries.

Statistic Scales		HGB	RBC	Iron	Ferritin
Levene Statistic	F test	0.181	0.543	3.605	5.859
	P value	0.671	0.463	0.063	0.019
95% Confidence Interval of the Difference	Lower	0.00384	0.02449	-	1.14547
	Upper	1.80198	0.49565	67.35955	19.00834

DISCUSSION

Non-anemic pregnant women have an adequate stored iron as they get enough iron during pregnancy. If they do not have symptoms of anemia, the risk of complications associated with anemia will be much lower[18,19]

In the current study, the percentage of natural births is 27.30% for pregnant women who gave birth at Zawia Medical Center. While the percentage of cesarean deliveries reached 72.60%. Obstetricians and gynecologists confirm that the high rate of cesarean sections is not for medical reasons, such as the conditions of the fetus and its location inside the mother's womb, but rather the mother's desire to give birth by cesarean section has the most influential role.[20] Levine's test showed homogeneity in hemoglobin variation between mothers and their newborn infants. Its value was 1.44, corresponding to a P value of 0.233 for mothers, and 7.660, corresponding to a P value of 0.007 for newborns, respectively. Levene's tests for ferritin and iron were 0.637 and 0.295, corresponding to a P value of 0.428 and 0.589 for mothers and 0.014 and 1.869, corresponding to a P value of 0.840 and 0.177 for newborns, respectively. It appears that there is varying homogeneity between the various variables for both the mother and the newborn. Also, homogeneity of the variance of hemoglobin, red blood cells, iron, and ferritin was found for both normal and cesarean deliveries, where the P values were 0.671, 0.463, 0.063, and 0.019, respectively, as shown in (Tables 5, 6).

Similarly, some studies have shown that maternal blood iron concentration is only linked to neonatal iron levels.[21]

On assessment of statistical significance, one-way analysis of variance (ANOVA) showed statistical significance for the levels of ferritin and iron in newborns born to mothers with and without anemia; the P value for ferritin was 0.008 and 0.008, while for iron it was 0.079 and 0.079, respectively. The results of an ANOVA of newborns born to anemic and non-anemic mothers, shown in (Tables 8), showed that there was a significant difference between the means of ferritin and iron in newborns with anemia and pregnant women without anemia ($P \leq 0.05$). In the same context, these results did not indicate a significant difference between the means of HGB, Hct, MCV, and RDW.

The Pearson correlation coefficient showed that there were no statistically significant differences between the means of red blood cells, ferritin, and iron for the blood of mothers with and without anemia and their newborns. In the same context, there was statistical significance between the average hemoglobin values of non-anemic mothers and their newborns, which were 12.12 ± 1.51 and 14.37 ± 2.10, respectively ($p = 0.027$). Pearson's results also indicated that there was equality between the number of white blood cells in the mother's blood and the umbilical cord blood in both groups ($P = 0.36$). The results of this study are similar to those observed in several other studies,[12,14,22-26] which failed to find a relationship between hemoglobin in maternal and cord blood, although many physiological changes occur in the mother during fetal development. These changes require increased metabolic rates. In the same context, malnutrition of the pregnant

Table 7. One-way ANOVA to determine differences variables of newborns born to anemic and non-anemic mothers.

Parameters	Groups	Sum of Squares	df	Mean Squares	F test	P. value
HB	Between Groups	.0990	1	0.099	0.030	0.864
	Within Groups	274.961	82	3.353		
	Total	275.060	83		0.780	0.780
Hct	Between Groups	2.600	1	2.600		
	Within Groups	2715.890	82	33.121	0.078	0.780
	Total	2718.490	83			
MCV	Between Groups	106.685	1	106.685	0.720	0.399
	Within Groups	12145.439	82	148.115		
	Total	12252.123	83			
RDW	Between Groups	.000	1	0.000	0.000	0.991
	Within Groups	19.248	82	0.235		
	Total	19.248	83			
Ferritin*	Between Groups	55193.354	1	55193.354	7.675	.008*
	Within Groups	417120.355	58	7191.730		
	Total	472313.709	59			
Iron	Between Groups	4788.707	1	4788.707	3.270	0.079*
	Within Groups	52721.188	36	1464.477		
	Total	57509.895	37			

Table 8. Pearson's correlation between anemic & non- anemic maternal and their newborns.

Groups	Parameters	Mother	Fetal	p-value
Anemic mothers	HGB g/dl	9.33 ± 1.01	14.44 ± 1.26	0.415
	RBC %	3.70 ± 0.50	4.16 ± 0.43	0.118
	WBC*10^3	11.87 ± 5.50	10.86 ± 3.65	0.364*
	Ferritin ug/l	12.96 ± 10.11	57.39 ± 45.64	0.285
	Iron ug/dl	66.19 ± 46.93	131.95 ± 45.54	0.942
Non-anemic mothers	HGB* g/dl	12.12 ± 1.51	14.37 ± 2.10	0.027*
	RBC %	3.70 ± 0.450	4.16 ± .42	0.519
	WBC*10^3	3.70 ± 0.50	4.16 ± 0.43	0.364*
	Ferritin ug/l	59.02 ± 241.50	145.09 ± 84.98	0.889
	Iron ug/dl	92.92 ± 80.86	148.46 ± 32.47	0.890

mother leads to negative outcomes during pregnancy, such as increased infant mortality rates, and poor mental development later in life.[27,28,29,30]

The current study also showed that the dietary pattern of the study population focused on consuming local popular meals as shown in (Tables 9-11), where the most common meals for breakfast were dairy products, canned tuna, and eggs with a weekly frequency of 51.8%, 43.3%, and 32.5%, respectively, while for lunch they were couscous, rice, pasta, and beans, with a weekly frequency of 46.9%, 54.2%, 50.6%, and 20.5%, respectively, while the most common meals for dinner were minced meat, salad, dairy products, and fruits, with a weekly frequency of 35.70%, 21.60%, 15.60%, and 33.70%, respectively. In the same context, some studies have stated that traditional local Libyan meals do not meet the micronutrient needs, especially for pregnant mothers.[31] Obaid (2016) pointed out, as shown in (Table 12), that the average percentage of iron in these meals may reach 3.07 ± 2.69 milligrams per 100 ml.

The average values of the iron component in the most frequent popular meals during the days of the week of this study, such as tub, couscous, and baked pasta, were 1.75 and 1.50. And 1.30 mg per 100 ml, respectively. Also, the results of this study demonstrated that there is a decrease in the consumption of foods rich in mineral salts and vitamins, such as vegetables and fruits, and that the largest percentage of members of the study population did not follow any supplementary nutrition program.

CONCLUSION

Although the current study showed that there is a significant correlation between maternal HGB and their newborn, it was carried out on a few pregnant mothers who presented to the hospital for delivery. Therefore, the results cannot be generalized to all pregnant women, rather than applying similar studies in other hospitals. To reduce the increase in anemia in pregnant Libyan women, supplementary nutrition programs must be followed in accordance with the recommendations of the World Health Organization.

Table 9. Types of food consumed for breakfast.

Meal type	Frequency	Percentages %
Honey	8	9.6
Coffee	6	7.2
Hen eggs	27	32.5
Milk	24	28.9
Dairy products	43	51.8
Tuna	36	43.3
Other meals	11	13.4

Table 10. Types of food consumed for lunch.

Meal type	Frequency	Percentages %
Cuscus	39	46.9
Rice	45	54.2
Macaroni	42	50.6
Bazin	17	20.5
Meat	21	25.4

Table 11. Types of food consumed for dinner.

Meal type	Frequency	Percentages %
Minced meat	30	35.7
Legumes	7	8.4
Salad	18	21.6
Milk	6	7.2
Milk product	13	15.6
Fruits	28	33.7

Table 12. Mineral contents of the most common Libyan meals.

NO.	Meals	Ca	Fe	P	K	Na
1	Albazeen	24.25	1.75	18.30	211	96
2	Couscous bal-khdra	6.25	1.50	23.00	206	162
3	Macaroni ambcabach	25.00	1.30	21.50	215	74
4	Reshda ambcabach	16	1.81	22.11	173	67
5	Tomato sauced macaroni	7.20	11.80	31.10	205	235
6	Uruz bal-bsalh	26.15	1.25	21.10	211	87
7	Tbejh bazela	10	1.87	24.70	371	365
8	Shakshouka	20	2.17	33.60	200	130
9	Al-zimaith	11	1.75	47	199	160
10	Al-besisa	43	1.20	39	211	51
11	Mhachi (velvl , Qureih)	19	3.20	44	303	112

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