Review Article

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Hemoglobin levels in pregnant women and its outcomes

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Abstract

The pregnancy is a sensitive period in women life; pregnant women should avoid any risk factor that can affect their health as well as the growth and development of their baby. One of the critical problems that pregnant women may face is iron deficiency and its anemia which represents a risk factor for preterm delivery, prematurity and small for gestational age, birth, and weight. The world health organization (WHO) estimates that an average of 56% of pregnant women in developing countries is anemic. This percentage ranges from 35-75% in specific areas, and is much higher than the 18% of pregnant women diagnosed with anemia in developed countries. Iron deficiency during pregnancy is thought to be caused by combination of factors such as previously decreased iron supply, the iron requirements of the growing fetus, and expansion of maternal plasma volume.[1]

Iron deficiency development is widely common among women especially pregnant ones since iron should be supported to the mother and her fetus which makes the intake crucial and important. And regarding that iron (heme and non-heme) has a low bioavailability, food enhancers and supplements are necessary for pregnant women especially in the begging and end of their pregnant period for support and growth. Enhancers of iron include meat, fish, and vitamin C as the most common ones while polyphenols, phytates in tea and coffee, and calcium represent the most important inhibitors of iron absorption. Good sources of iron should be taken with enhancers so that the absorption of iron increases. Pregnant women should be educated enough and well informed from their doctors to avoid or lessen the occurrence of such problem. This study was conducted in Lebanon to determine the prevalence and risk factors of low hemoglobin levels in pregnant women and the importance of iron intake in aiming changing these levels to decrease its risks.

Literature review

Women of fertile age and pregnant-lactating as well as their infants and young children are particularly affected with iron deficiency and its anemia resulting in serious health and functional consequences. It is estimated that about 2,150million people are iron deficient, and that this deficiency is severe enough to cause anemia in 1,200million people globally. About 90% of all anemias have an iron deficiency component. Roughly 47% of non-pregnant women and 60% of pregnant women have anemia worldwide, and including iron deficiency without anemia the figures may approach 60 and 90% respectively. In the industrial world as a whole, anemia prevalence during pregnancy averages 18%, and over 30% of these populations suffer from iron deficiency.[2]

The woman's diet is the main source of nourishment for the baby. In fact, the link between what the mothers consumes and the health of the baby is much stronger than once. Eating a healthy, varied diet in pregnancy will help get most of the vitamins and minerals that are essential during the period of pregnancy including iron and folic acid. It is best to get vitamins and minerals from the food, but pregnant women are in need of many supplements that are essential to their body as well to their babies including iron and folic acid. Iron is an essential mineral in the pregnancy period to the mother and to the baby as well. Supplementation of pregnant women with iron and folic acid reduces the incidence of hemoglobin <110 g/l to under 5%.

The hemoglobin concentration, hematocrit and red cell count fall during pregnancy because the expansion of the plasma volume is greater than that of the red cell mass. However, there is a rise in total circulating hemoglobin directly related to the increase in red cell mass. This in turn depends partly on the iron status of the individual. That's why pregnant women are recommended to have a hemoglobin level of 12-16g/DL and any value below 12 is considered as iron deficiency and below 10.5 as anemia.

Iron deficient anemic women have shorter pregnancies than non-anemic or even anemic but not iron deficient pregnant women. All anemic pregnant women had a higher risk of pre-term delivery in relation to non-anemic women. The iron-deficient, anemic group has twice the risk of those with anemia in general.[3] There a five to sevenfold increase in preterm delivery and low birth weight if the lowest hemoglobin concentration during pregnancy (https://www.bmj.com/content/310/6978/489.full.print). Moreover results of randomized clinical trials in the United States and in Nepal that involved early supplementation with iron showed some reduction in risk of low birth weight or preterm low birth weight.[4] Maternal hemoglobin levels are also associated with the weight of the baby at birth; a study done by The American Journal of Clinical Nutrition in 2000 conclude that the minimum incidence of low birth weight (<2.5kg) and of preterm labor (<37 completed weeks) occurred in association with a hemoglobin concentration of 95–105g/L. Such values are commonly considered to represent anemia.[5] However the weight of the baby varies in the last trimester of pregnancy; According to the American Pregnancy Association, a fetus weigh around 2pounds at 27weeks (7thmonth of pregnancy), 4 to 4.5 pounds by 32weeks (8th month of pregnancy) and grows up to 6.5 to 10 pounds in full term delivery (till the 9th month).[6]

Several dietary factors can influence the absorption of iron. Absorption enhancing factor to meat, fish and poultry is ascorbic acid (vitamin C); inhibiting factors are plant components in vegetables, tea and coffee (e.g., polyphenols, phytates), and calcium. Specific attention should be paid to the effects of tea on iron absorption.[7]

Ascorbic acid is the only main absorption enhancer in vegetarian diets found in Broccoli, and Citrus fruits (oranges, and lemon) while phytate and phenols are the two main inhibitors of iron absorption that can reduce the bioavailability of iron by binding to it; these compounds are found in tea, coffee and chocolate. An excess of calcium rich dairy can limit iron absorption. Milk can prevent your body from absorbing an adequate amount of iron. Even though milk has a high content of iron it contains calcium, an essential mineral and the only known substance to inhibit absorption of both non-heme and heme iron.[8]

Regarding the relation between hemoglobin levels of pregnant women and their disease status (diabetes type 1 and 2, gestational diabetes, hypertension and heart disease), studies differ in their results: some of them demonstrate that there is positive relation between hemoglobin/iron levels and disease status of individuals while others show a negative one. In a study done in 2003 by anemia and diabetes because the risk of becoming iron-deficient increases when diabetes is present; according to this study diabetic patients are more prone to have lower hemoglobin/iron levels than disease-free patients.[9] Another study done by Dr. Trevor J Orchard reveal that Hemoglobin levels may be higher as high as 18.8 g/dl in type 1 diabetes than in the general population.[10] In 2008, the department of Cardiac Services and General Practice in School of Medicine in Canada conducted a study resulting in that the prevalence of anemia in hypertension, a condition characterized by endothelial dysfunction, is unclear yet.[11] However in 2012, it was revealed that hemoglobin level was positively associated with both systolic and diastolic blood pressures.[12]

Age and exercise are two factors that are still being tested nowadays to determine if there is a relation with the level of hemoglobin/ iron in pregnant women. In a study carried out in Queen Elizabeth Central Hospital and Namitambo Health Centre Malawi, analysis showed an increased risk of anemia for women under 20years of age, but when corrected for gravidity and trimester at booking the increased risk with young age no longer.[13] Studies conducted to measure the effect of exercise on hemoglobin level in pregnant women are so minimal knowing that exercise is safe during pregnancy and proper exercise during pregnancy will likely help with weight loss after delivery of your baby. Exercise does not put the woman at risk for miscarriage in a normal pregnancy.[14] but there is no data concerning the relation between hemoglobin or iron and workout.

Data collection

The data was collected over one month from three different gynecologists: Dr. Modi Farhat, Dr. Iman Mallak and Dr. Jouhaina Bou Chakra in Chouf area targeting pregnant women in their last trimester. The participants of the study were aged between 20 and 38years old. The main objective of these observations and research is to determine the prevalence and the effect of low hemoglobin levels on the pregnancy and the baby's weight. A total of 50 pregnant women, 20 from each clinic, participated in the study and were asked to complete an 11 questions survey including yes/no questions and multiple-choice questions. The variables were set according to the risk factors of hemoglobin levels during pregnancy and the expected outcomes on the woman and her baby as proposed in the introduction and the literature review of the report.

The questionnaire consists on the following variables:

i. Age (in years)

ii. Parity(Number of pregnancy:1➔ First, 2 Second or third, 3➔ Four and more)

iii. Stage of the last trimester (1➔ 7th, 2➔ 8th, 3➔ 9th month)

iv. Number of meals per day beside snacks (1➔1-2 meals,2 3-5 meals, ➔More than 5meals)

v. Supplementation taken during this stage (1➔ Calcium, 2 Iron, ➔ Folic acid 4➔ Multivitamins and minerals)

vi. Disease status (1 Heart disease, 2➔ Diabetes type 1, 3➔ Diabetes type 2,

vii. 4➔ Gestational diabetes, 5➔ Hypertension)

viii. Meat/ poultry/ fish consumption per week (1➔ Once, 2➔ Twice, 3➔ More than three times)

ix. Consumption of meats with which vegetable (1➔ Tomato, 2➔ Broccoli, 3➔ Lemon, 4➔ Spinach 5➔ Combination of vegetables)

x. Tea or coffee consumption after meal (1➔ Yes, 2 No)

xi. Consumption of milk and fortified cornflakes (1➔ Yes, 2➔ No)

xii. Exercising (sport) (1➔ Yes, 2➔ No)

The main variables of the research were chosen with respect to the iron (as form of hemoglobin) enhancers and inhibitors and the number of parity, since many findings consist on these variables on affecting hemoglobin levels in pregnant women resulting in undesired effects on the pregnant and the baby's health. The hemoglobin levels of each pregnant woman were measured through blood tests done on a regular basis. (Supported form the doctors). However the weight of the unborn baby was measured by the doctors (via Ultra Sound); the weight of the baby is compared to a standard weight range (normal) according to the American Pregnancy Association in order to specify if the weight of the baby is healthy for the month of pregnancy. IBM SPSS Software is used for the analysis of results. The data was entered and organized in order to be tabled and tested for analysis.

Results

Descriptive statistics

Before testing all the variables that may affect the hemoglobin levels in pregnant women, detecting their daily food intake frequency is so important for the direction of the study (Figure 1), (Table 1).

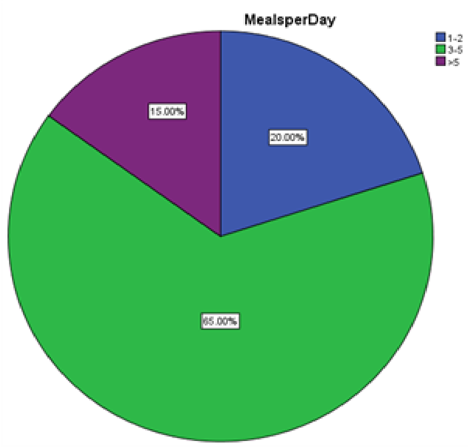

Figure 1 Meals per day.

Citation: Kadry S, Sleem C, Samad RA. Hemoglobin levels in pregnant women and its outcomes. *Biom Biostat Int J.* 2018;7(4):326–336. DOI: 10.15406/bbij.2018.07.00226

Table 1 Meals per day

		Frequency	Percent	Valid percent	Cumulative percent
Valid	1-2	12	20.0	20.0	20.0
	3-5	39	65.0	65.0	85.0
	>5	9	15.0	15.0	100.0
	Total	60	100.0	100.0	

Disease status

88.33% of the women in this study are disease free while 11.67% are diabetes type 1, diabetes type 2 and gestational diabetes patients (Figure 2), (Table 2).

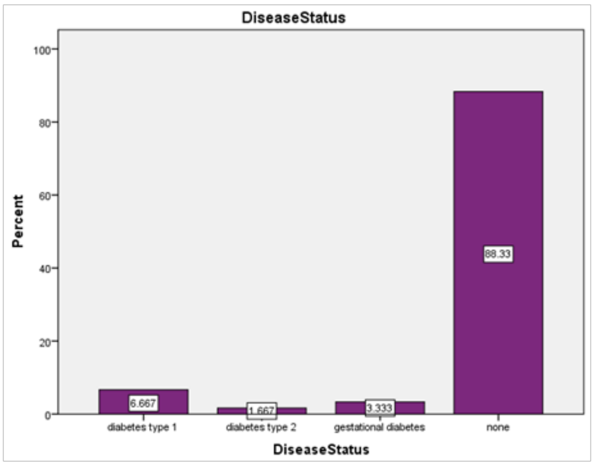

Figure 2 Disease status.

Table 2 Disease status

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Diabetes type 1	4	6.7	6.7	6.7
	Diabetes type 2	1	1.7	1.7	8.3
	Gestational diabetes	2	3.3	3.3	11.7
	None	53	88.3	88.3	100
	Total	60	100	100	

Supplementation intake

Calcium supplementation recorded the lowest intake: 56.67% do not take calcium as supplement. More than 90% (93.33, 95 and 98.33%) take iron or folic acid or multivitamins and minerals supplementation during their pregnancy (Figure 3).

Number of pregnancy

71.67% of the participants have at least 1 child or more (45% have 1 or 2 children and 26.67% have 3 children or more) (Figure 4).

Hemoglobin levels status

This pie chart shows the distribution of hemoglobin level among the pregnant women where 58.33% are normal (12-16g/dl) and 41.67% are abnormal (<12g/dl) (Figure 5).

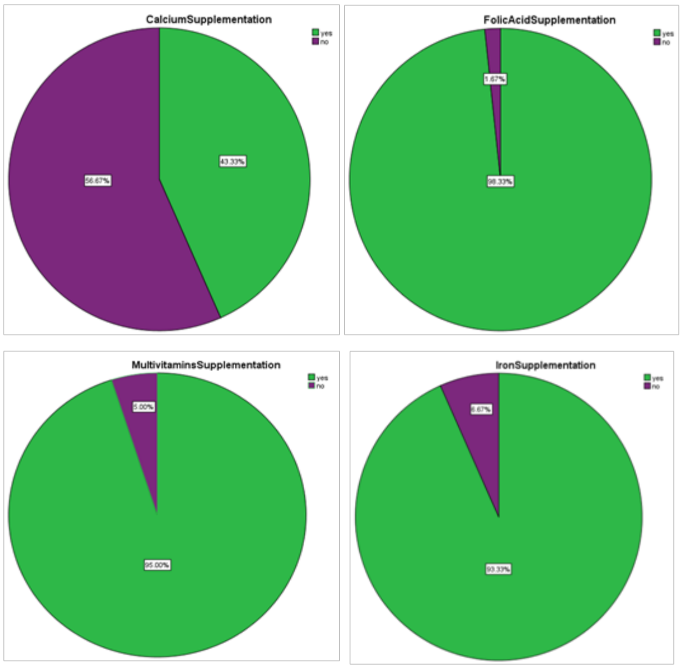

Figure 3 Supplementation intakes.

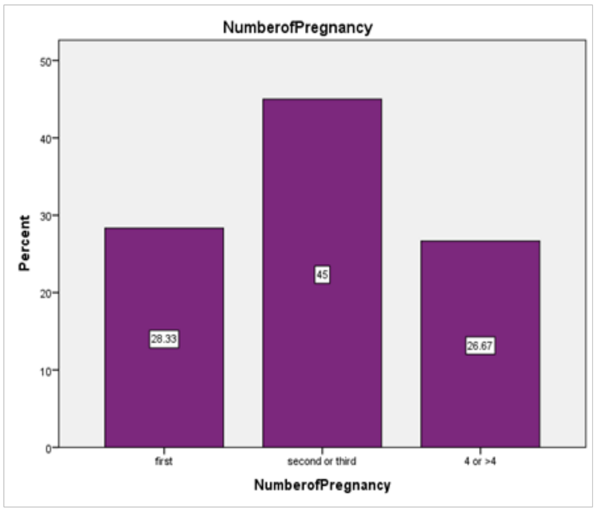

Figure 4 Number of pregnancy.

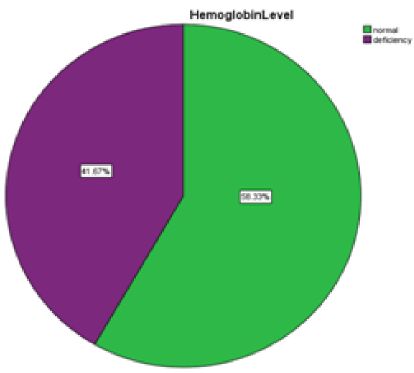

Figure 5 Hemoglobin levels.

Citation: Kadry S, Sleem C, Samad RA. Hemoglobin levels in pregnant women and its outcomes. *Biom Biostat Int J.* 2018;7(4):326‒336.
DOI: 10.15406/bbij.2018.07.00226

Weight of the baby status

Using the ultra sound technique the weight of the unborn baby can be measured; 65% of the unborn babies are normal are of normal weight while 35% are of abnormal weight according to the month of pregnancy of the mother (Figure 6).

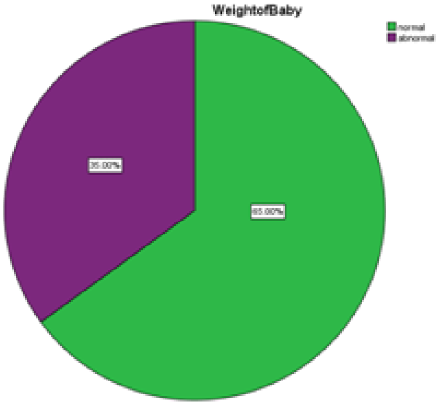

Figure 6 Weight of the baby.

Age

The participants' age varies between 20(minimum) and 38(maximum) with a mean age of 27years old (Table 3).

Table 3 Age

Statistics		
Age		
N	Valid	60
	Missing	0
Mean		27.00
Median		26.00
Mode		25
Minimum		20
Maximum		38

Meat Consumption per week

Meat consumption among the sample chosen is quite high since 85% of the pregnant consumes more than once per week meat products (Figure 7), (Table 4).

Hemoglobin level vs weight of the baby

Using Crosstabs:

79.5% (31 out of 39) of the babies are of normal weight with a normal mothers' hemoglobin level while 20.5% (8 out of 39) of the babies are of normal weight with a deficient mothers' hemoglobin level.

19% (4 out of 21) of the babies are of abnormal weight with a normal mother's hemoglobin level while 81% (17 out of 21) of the babies are of abnormal weight with a deficient mothers' hemoglobin level.

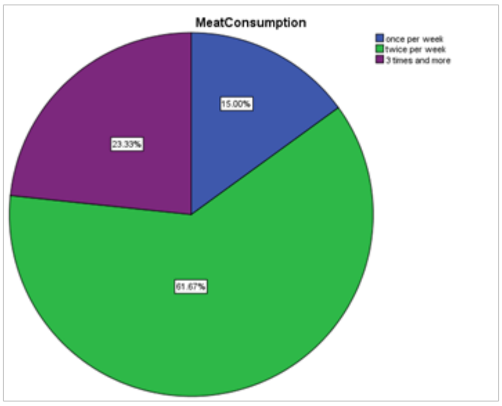

Figure 7 Meat consumption.

Inferential statistics:

1) Research question

Is there a correlation between age and hemoglobin level?

The applied test statistics: Non parametric correlation.

The null hypothesis: There is a correlation between age and hemoglobin level.

The alternative hypothesis: There is no correlation between age and hemoglobin level (Table 5).

As it is showed in the table above the correlation coefficient is 0.203 indicating that there is a weak positive correlation between hemoglobin levels and age of the pregnant women. These findings contradict the results of previous studies mentioned in the literature section of the report. Since there is a correlation between these two variables even if it is a weak one so we accept H0 and reject HA.

2) Research question

Is there a correlation between meat consumption and hemoglobin level?

The applied test statistics: Non parametric correlation.

The null hypothesis: There is a positive correlation between meat consumption and hemoglobin level.

The alternative hypothesis: There is no positive correlation between meat consumption and hemoglobin level (Table 6).

r=-0.435 indicates a negative moderate correlation between meat consumption of pregnant women and their hemoglobin levels.

These surprising results does not apply to the knowing fact that meat consumption increase hemoglobin level since heme present in meat is the base of the hemoglobin compound. In other hand, the absorption of iron (hemoglobin) especially during pregnancy period is affected by some enhancers which are not consumed properly by our study participants justifying these results. So we accept HA and reject H0

3) Research question

Is there a correlation between number of pregnancy and hemoglobin level?

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The applied test statistics: Non parametric correlation.

The null hypothesis: There is a correlation between number of pregnancy and hemoglobin level.

The alternative hypothesis: There is no correlation between number of pregnancy and hemoglobin level (Table 7).

We accept H0 and reject HA since r=0.381 indicating a moderate positive correlation between number of pregnancy (parity) and hemoglobin levels in pregnant women. This confirms previous findings and increases the interest of pregnant women in their hemoglobin levels that decreases with higher parity.

4) Research question

Is the association between sport and hemoglobin level significant?

The applied test statistics: Chi-square test.

The null hypothesis: There is no significant association between sport and hemoglobin level.

The alternative hypothesis: There is significant association between sport and hemoglobin level (Table 8).

Table 4 Hemoglobin Level* weight of baby cross tabulation

			Weight of baby		Total
			Normal	Abnormal	
Hemoglobin Level	Normal	Count	31	4	35
		% within Weight of Baby	79.50%	19.00%	58.30%
	Deficiency	Count	8	17	25
		% within Weight of Baby	20.50%	81.00%	41.70%
Total		Count	39	21	60
		% within Weight of Baby	100.00%	100.00%	100.00%

Table 5 Correlations

			Hemoglobin level	Age
Spearman's rho	Hemoglobin Level	Correlation Coefficient	1.000	0.203
		Sig. (2-tailed)	.	0.12
		N	60	60
	Age	Correlation Coefficient	0.203	1.000
		Sig. (2-tailed)	0.12	.
		N	60	60

Table 6 Correlations

			Hemoglobin level	Meat consumption
Spearman's rho	Hemoglobin level	Correlation Coefficient	1.000	-.435**
		Sig. (2-tailed)	.	0.001
		N	60	60
	Meat consumption	Correlation Coefficient	-.435**	1.000
		Sig. (2-tailed)	0.001	.
		N	60	60

**Correlation is significant at the 0.01 level (2-tailed)

Table 7 Correlations

			Number of pregnancy	Hemoglobin level
Spearman's rho	Number of Pregnancy	Correlation Coefficient	1.000	.381**
		Sig. (2-tailed)	.	0.003
		N	60	60
	Hemoglobin Level	Correlation Coefficient	.381**	1.000
		Sig. (2-tailed)	0.003	.
		N	60	60

**. Correlation is significant at the 0.01 level (2-tailed)

Citation: Kadry S, Sleem C, Samad RA. Hemoglobin levels in pregnant women and its outcomes. *Biom Biostat Int J.* 2018;7(4):326–336. DOI: 10.15406/bbij.2018.07.00226

Table 8 Hemoglobin Level* sport cross tabulation

			Sport		Total
			Yes	No	
Hemoglobin level	Normal	Count	15	20	35
		Expected Count	12.8	22.2	35.0
	Deficiency	Count	7	18	25
		Expected Count	9.2	15.8	25.0
Total		Count	22	38	60
		Expected Count	22.0	38.0	60.0

As we see in the table above, the expected count is the value that we expect to observe if there was no significant association between hemoglobin and sport. We expect to observe around 13 normal hemoglobin women who do sports and 22 normal hemoglobin women who do not do sports and so on.

These values are different among observed and expected counts. Chi- square is the test used in this case. This test helps to determine if those observed count are different enough for the test to be significant (association to be significant). The results of this test are shown in the table below: (Table 9).

Table 9 Chi-square tests

	Value	df	Asymp. sig. (2-sided)	Exact sig. (2-sided)	Exact sig. (1-sided)
Pearson Chi-Square	1.386[a]	1	0.239		
Continuity Correction[b]	0.82	1	0.365		
Likelihood Ratio	1.408	1	0.235		
Fisher's exact test				0.286	0.183
Linear-by-Linear Association	1.363	1	0.243		
N of Valid Cases	60				

[a]. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.17

[b]. Computed only for a 2x2 table

In this case, the assumption of the chi-square test is not violated (<20%). The p-value 0.239 (2.93%) is less than the 5% level of significance (alpha) so the results are statistically significant so we accept the alternative hypothesis that there is a significant association between hemoglobin levels and sport.

Hemoglobin level is dependent on sport.

To test how strong this significance is, the phi test is done since the sample size is small: (Table 10).

Table 10 Symmetric Measures

Symmetric Measures			
		Value	Approx. sig.
Nominal by Nominal	Phi	0.152	0.239
	Cramer's V	0.152	0.239
N of Valid Cases		60	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

0.152 is the correlation coefficient (size of the effect) showing a weak association between hemoglobin level and sport, justifying what is mentioned in the literature of the report.

5) Research question:

Is there a correlation between disease status and hemoglobin level?

The applied test statistics: Non parametric correlation.

The null hypothesis: There is a positive correlation between disease status and hemoglobin level.

The alternative hypothesis: There is no positive correlation between disease status and hemoglobin level (Table11).

We accept H0 and reject HA since there is a very weak positive correlation (0.086) between disease status of the pregnant women and their hemoglobin levels.

6) Research question:

Is there a correlation between coffee or tea consumption and hemoglobin level?

The applied test statistics: Non parametric correlation.

The null hypothesis: There is a negative correlation between coffee or tea consumption and hemoglobin level.

The alternative hypothesis: There is no negative correlation between coffee or tea consumption and hemoglobin level (Table 12).

Citation: Kadry S, Sleem C, Samad RA. Hemoglobin levels in pregnant women and its outcomes. *Biom Biostat Int J.* 2018;7(4):326‒336.
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Table 11 Correlations

			Hemoglobin level	Disease status
Spearman's rho	Hemoglobin Level	Correlation Coefficient	1.000	.086
		Sig. (2-tailed)	.	.514
		N	60	60
	Disease Status	Correlation Coefficient	086	1.000
		Sig. (2-tailed)	.514	.
		N	60	60

Table 12 Correlations

			Hemoglobin Level	Coffee or Tea consumption
Spearman's rho	Hemoglobin Level	Correlation Coefficient	1.000	.585**
		Sig. (2-tailed)	.	.000
		N	60	60
	Coffee or Tea Consumption	Correlation Coefficient	-.585**	1.000
		Sig. (2-tailed)	.000	.
		N	60	60

**Correlation is significant at the 0.01 level (2-tailed).

According to the correlation table above, the hemoglobin levels decrease with the increase of coffee and tea consumption. As we know caffeine contained in coffee and tea is the main cause of iron / hemoglobin non-absorption.

Spearman's rho is -0.585 so a moderate negative correlation exists between coffee or tea consumption (caffeine) and hemoglobin levels so H0 is accepted.

7) Research question:

Is there a correlation between calcium supplementation and hemoglobin level?

The applied test statistics: Non parametric correlation.

The null hypothesis: There is a negative correlation between calcium supplementation and hemoglobin level.

The alternative hypothesis: There is no negative correlation between calcium supplementation and hemoglobin level (Table 13).

In the pie chart in the descriptive statistics section, calcium supplementation intake among the participants recorded the lowest percentage (43.33%). This low value is justified by the correlation coefficient (-0.352) of the table above: since a negative correlation between hemoglobin levels and calcium supplementation exists we can say that physicians avoid the prescription of calcium as supplements because hemoglobin levels fall when calcium is consumed due to its inhibition effect on hemoglobin absorption.

We accept H0 and reject HA.

8) Research question

Is there a correlation between weight of the baby and hemoglobin level?

The applied test statistics: Non parametric correlation.

The null hypothesis: There is a positive correlation between weight of the baby and hemoglobin level.

The alternative hypothesis: There is no positive correlation between weight of the baby and hemoglobin level (Table 14).

A moderate positive correlation exists between hemoglobin levels and weight of the unborn baby. This result justifies the rapprochement in percentages of normal hemoglobin levels (58.33%) and normal weight baby (65%) considering that almost every normal hemoglobin pregnant will have a normal weight baby. So we accept H0 that there is a correlation between hemoglobin level and weight of the baby.

9) Research question

Is the association between number of meals per day and hemoglobin level significant?

The applied test statistics: Chi-square test.

The null hypothesis: There is no significant association between number of meals per day and hemoglobin level.

The alternative hypothesis: There is significant association between number of meals per day and hemoglobin level (Table 15).

As we see in the table above, the expected count is the value that we expect to observe if there was no significant association between hemoglobin and sport.

The chi square test helps to determine if those observed count are different enough for the test to be significant (association to be significant). The results of this test are shown in the table below: (Table 16).

Table 13 Correlations

			Hemoglobin level	Calcium supplementation
Spearman's rho	Hemoglobin Level	Correlation Coefficient	10000	-.352**
		Sig. (2-tailed)	.	0.006
		N	60	60
	Calcium Supplementation	Correlation Coefficient	-.352**	1
		Sig. (2-tailed)	0.006	.
		N	60	60

**Correlation is significant at the 0.01 level (2-tailed)

Table 14 Correlations

			Hemoglobin level	Weight of baby
Spearman's rho	Hemoglobin Level	Correlation Coefficient	1.000	.585**
		Sig. (2-tailed)	.	0
		N	60	60
	Weight of Baby	Correlation Coefficient	.585**	1.000
		Sig. (2-tailed)	0	.
		N	60	60

**Correlation is significant at the 0.01 level (2-tailed)

Table 15 Hemoglobin Level* Meals per Day Cross tabulation

			Meals per day			Total
			2-Jan	5-Mar	>5	
Hemoglobin Level	normal	Count	4	24	7	35
		Expected Count	7.0	22.8	5.3	35
	deficiency	Count	8	15	2	25
		Expected Count	5/0	16.3	3.8	25.0
		Count	12	39	9	60
Total		Expected Count	12.0	39.0	9.0	60.0

Table 16 Chi-square tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.651[a]	2	0.098
Likelihood Ratio	4.722	2	0.094
Linear-by-Linear Association	4.378	1	0.036
N of Valid Cases	60		

[a]. 1cells (16.7%) have expected count less than 5.The minimum expected count is 3.75.

Citation: Kadry S, Sleem C, Samad RA. Hemoglobin levels in pregnant women and its outcomes. *Biom Biostat Int J.* 2018;7(4):326‒336. DOI: 10.15406/bbij.2018.07.00226

In this case, the assumption of the chi-square test is not violated (<20%). The p-value 0.098 (0.98%) is less than the 5% level of significance (alpha) so the results are statistically significant so we accept the alternative hypothesis that there is a significant association between hemoglobin levels and number of meals per day.

Hemoglobin level is dependent on the number of meals consumed per day. To test how strong this significance is, the phi test is done since the sample size is small: (Table 17).

Table 17 Symmetric measures

		Value	Approx. sig.
Nominal by Nominal	Phi	0.278	0.098
	Cramer's V	0.278	0.098
N of Valid Cases		60	

[a]. Not assuming the null hypothesis.

[b]. Using the asymptotic standard error assuming the null hypothesis.

0.278 is the correlation coefficient (size of the effect) showing a weak association between hemoglobin level and number of meals consumed per day. Number of meals consumed per day by the pregnant woman and the quality of food is what make the association with the hemoglobin level.

10) Research question

Which variable affects positively or negatively hemoglobin levels in pregnant women?

The applied test statistics: Regression (Table 18).

As we see in the tables above, R is 0.683 which means that there is a correlation between hemoglobin and the others 4 variables (number of pregnancy, disease status, meat consumption and consumption of coffee or tea). According to the last table, number of pregnancy affects positively (0.153) the most hemoglobin levels among the pregnant women, while consumption of coffee or tea affects it negatively (-0.482).

Table 18 Variables entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Coffee or Tea, Disease Status, Number of Pregnancy, Meat Consumption[b]	.	Enter

[a]. Dependent Variable: Hemoglobin Level

[b]. Dependent Variable: Hemoglobin Level

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.683[a]	0.467	0.428	0.376

[a]. Predictors, (Constant), Coffee or Tea, Disease Status, Number of Pregnancy, Meat Consumption

Coefficients[a]

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.124	0.38		5.582	0
	Number of Pregnancy	0.153	0.068	0.23	2.242	0.029
	Disease Status	0.03	0.044	0.068	0.684	0.497
	Meat Consumption	-0.186	0.086	-0.231	-2.165	0.035
	Coffee or Tea	-0.482	0.109	-0.466	-4.419	0

[a]. Dependent Variable, Hemoglobin Level

11) Research question

Which variable affects positively or negatively hemoglobin levels in pregnant women?

The applied test statistics: Regression (Table 19).

This test helps us how the type of food consumed with meat affect the hemoglobin levels. Knowing that some of these foods are inhibitors (tomato and broccoli) and enhancers (vegetables, lemon, spinach) of iron absorption, according to the table tomato and broccoli affect negatively hemoglobin levels justifying the finding in many previous studies. While vegetables, lemon and spinach affect it positively with a higher positive association with lemon consumption.

Table 19 Model summary

Model	R	R square	Adjusted R square	Std. Error of the estimate
1	.726[a]	0.528	0.484	0.357

[a]. Predictors, (Constant), Spinach With Meat, Vegetables With Meat, Tomato With Meat, Broccoli With Meat, Lemon With Meat

ANOVA[a]

Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	7.695	5	1.539	12.064	.000[b]
	Residual	6.889	54	0.128		
	Total	14.583	59			

[a]. Dependent Variable, Hemoglobin Level

[b]. Predictors, (Constant), Spinach with Meat, Vegetables with Meat, Tomato with Meat, Broccoli with Meat, Lemon with Meat

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Coefficients[a]

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.596	0.464		1.284	0.205
	Tomato With Meat	-0.146	0.112	-0.142	-1.313	0.195
	Broccoli With Meat	-0.037	0.116	-0.032	-0.32	0.75
	Vegetables With Meat	0.07	0.106	0.07	0.66	0.512
	Lemon With Meat	0.653	0.123	0.662	5.297	0
	Spinach With Meat	0.029	0.104	0.027	0.277	0.783

[a]. Dependent Variable: Hemoglobin Level

Discussion

The results of this study were consistent with the recent findings of other studies concerning the effect of dietary habits on hemoglobin levels and its effects on the fetus. Some results contradict previous findings like the relation between age vs hemoglobin, sports vs hemoglobin and meat consumption vs hemoglobin. Furthermore, 85% of the participants consume meat products more than once per week resulting in a good quantity of iron (hemoglobin) but seems that the way of consuming meats is being incomplete because of the wrong consumption of enhancers to ensure the arrival of hemoglobin to the mother's blood and in fact to the baby's blood.

88.33% of the sample is disease free participants contributing in accurate results since diseases may cause changes in the metabolism of the individual or in the distribution of the foods' ingested nutrients, minerals and other compounds including iron/hemoglobin. The highest correlation coefficient between hemoglobin and the variables is the 0.585 recorded from hemoglobin and the weight of the baby confirming several previous studies that the baby is so affected by the mother's hemoglobin.

Conclusion

The hemoglobin levels in the pregnant woman are affected by not the quantity of heme and non-heme iron only but the enhancers of absorption. Good enhancers must be consumed by every woman, non-pregnant, preparing for pregnancy and pregnant one. In the pregnancy period the need for the mother is higher than ever since she's eating for two. During this period, not only the weight of the baby is affected by low hemoglobin levels of the mother; many outcomes are scientifically proved that are caused by such deficiency affecting the whole life of the baby mentally and physically. Pregnancy requires additional maternal absorption of iron. Maternal iron status cannot be assessed simply from hemoglobin concentration because pregnancy produces increases in plasma volume and the hemoglobin concentration decreases accordingly. So many other factors must be considered in future research.

In previous studies, sport shows no relation with hemoglobin levels but since a correlation coefficient of 0.152 exists, a start for new research must be present.

Some of the limitations of our study are:

i. The sample size is a bit small to come up with standardization.

ii. The participants were from different background, few of them were Syrian refugees that receive a low income resulting in low quality food and nonuse of supplementation.

iii. Few of the Syrian refugees that have participated in this study had given birth with no rest to the body to replenish the losses during the first pregnancy; this fact may be a reason why some of the pregnant woman follow a rich and balanced diet with the proper supplementation but still have low hemoglobin level.

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Conflict of interest

Author declares that there is no conflict of interest.

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