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Erythrocyte Sedimentation Rate Levels Among A Sample of Pregnant Women Attending Health Centers in Erbil-Iraq

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Abstract
Background and objectives: There are so many significant hematological changes occurring in pregnancy, erythrocyte sedimentation rate (ESR) is one of them. The objectives of this study were to determine the range of erythrocyte sedimentation rate values obtained in healthy pregnant women and to examine the effect of gestational age and hemoglobin concentration on erythrocyte sedimentation rate.**Patients and methods:** This is a quantitative analytic cross- sectional study conducted in several primary health centers in different places in Erbil -Iraq from April 1st 2015 to April 1st 2016. A convenience sample of (300) healthy pregnant women in the reproductive age groups (15-45 years) and in their first, second and third trimester were included. Erythrocyte sedimentation rate, hemoglobin concentration, and gestational age were estimated in all participants. Chi square and ANOVA analysis were used to determine the influence of hemoglobin concentration and gestational age on erythrocyte sedimentation rate.**Results:** For 300 pregnant women examined, the mean ESR value was 47.69±25 mm/h and the range values obtained were 5-116 mm/h. Gestational age and hemoglobin concentration both significantly influenced erythrocyte sedimentation rate (P<0.001).There was a statistically significant difference between the mean ESR value in anemic and non-anemic pregnants (P=0.003).There was a statistically significant increase in ESR in the course of pregnancy from 1st to 3rd trimester (P <0.001). Occupation shows a statistically significant association with ESR (P=0.05), while no significant association was found between ESR and other socio-demographics.**Conclusions**: This study shows that erythrocyte sedimentation rate increases during pregnancy and that both gestational age and hemoglobin concentration significantly influence erythrocyte sedimentation rate. For the correct interpretation of ESR values obtained during pregnancy, gestational age and hemoglobin concentration must be taken into account.
Keywords: Erythrocyte sedimentation rate, pregnancy, anemia.

Introduction:

The erythrocyte sedimentation rate (ESR) is one of the measurements of the acute phase response. It is helpful in detecting the presence of inflammation and its response to treatment. It is influenced by anemia, which may be present in inflammatory diseases, and by the proteins of the acute phase response. [1]

Measurement of the erythrocyte sedimentation rate in disease was first introduced for clinical use in 1918 by Fahraenus and later modified by Westergren. [2,3] A reference method was subsequently developed by the International Committee for Standardization in Hematology(ICSH) and this is still commonly used. The ICSH has been associated with the International society for laboratory hematology (ISLH) since 2007. [4] Values of between 0-20mm/hour for women below the age of 50 years are generally taken to be normal. [1,5] Although it was unable to find a definitive range of ESR values that is considered normal during pregnancy, however some studies have indicated that values of 4-57 mm/h in first trimester, 7-47mm/h in second trimester and 13-70 mm/h in third trimester were considered normal. [6]

The density of single erythrocyte is the same as that of plasma, and sedimentation does not occur until aggregation or "rouleaux" formation takes place. [7] Both "acute phase proteins " especially fibrinogen and Immunoglobulins promote aggregation and result in an increased ESR.In addition, the concentration of erythrocytes in plasma is important; a decreased concentration increases the ESR as a result of increased rouleaux formation.

Anemia is estimated to affect nearly 2/3 of the pregnant women in developing countries.[8] Inadequate antenatal care along with poor knowledge of dietary needs of pregnant women, and overall poor socio-economic conditions are all responsible for this in our country. [9-11] It is very difficult to define a normal reference for hemoglobin concentration during pregnancy. According to the standard laid down by WHO, anemia in pregnancy is present when hemoglobin concentration is ≤11.0 g/dl. [12]

Because of the marked increase in circulating fibrinogen in pregnancy [13], the ESR is known to be elevated. However, the upper limit of normal has never been clearly established. Similarly, as a result of plasma expansion in normal pregnancy [14], or as a result of a decrease in hemoglobin concentration because of anemia [15], rouleaux formation is more likely to occur, further increasing the ESR.

The aim of this study is to determine levels of ESR in healthy pregnant women with uncomplicated

pregnancies. The effects of gestational age and hemoglobin concentration on ESR measurements will be examined.

Methods:

Design and sample collection: This is a quantitative analytic cross- sectional study conducted in several primary health centers (Brayati, Kurdistan, Nawroz, Malafandi and Tayrawa) in different places in Erbil city, Kurdistan region-Iraq from April 1st 2015 to April 1st 2016. A convenience sample of (300) healthy pregnant women in the reproductive age groups (15-45 years) and in their first, second and third trimester were included.

Exclusion criteria:

Exclusion criteria include any pregnant women with history of other gynecological disorders, bleeding disorders, diabetes or gestational diabetes, hypertension or pregnancy induced hypertension.

Materials and subjects:

Gestational age was determined at booking from the last menstrual period and confirmed by ultrasonography. Erythrocyte sedimentation rate and hemoglobin concentration were measured after collecting a 2.5 ml of venous blood from each pregnant woman under aseptic condition and put into EDTA vial. Diluted blood was sedimented in a glass tube mounted vertically on a stand. Hemoglobin concentration was determined using an automated cell counter. The data were collected by designing interview administered close ended questionnaire, prepared for this purpose by the researcher and the supervisor and were filled by the researcher by direct interview (structured interview ,face to face) with pregnant women and measure their ESR and Hemoglobin level.

The questionnaire including information about: Socio-demographic data (age, occupation, socioeconomic class, and educational status) , current obstetrical history (parity and gestational age at time of visit), social history of smoking and measured serum level of ESR and Hb.

The specific "eighteen score" scoring system to determine the socio-economic class of the study population was used in the study with some modification[16].

Ethical considerations:

The study proposal was submitted to the Ethics Committee of the College of Medicine at Hawler Medical University and facilitation letter from Erbil Directorate of Health (DOH) was obtained. This study was conducted by using an informed verbal consent that was obtained from the pregnant women prior to participate in the study. The purpose of the study was carefully explained to each pregnant woman.

Statistical analysis:

Statistical analysis was used by entering the data in to the computer using Microsoft Excel version. The statistical package for social sciences program (SPSS, version 17) was used for data analysis. The results were analyzed using frequency of distribution and Chi square. P-value ≤ 0.05 was considered statistically significant [17]. Appropriate tables were used for data representation .ANOVA analysis was also used to find P value.

Results:

According to this study, about 2/3 of the participants (264/300; 88%) were 18-35 years old and about half of the participants were multigravida (1-4) [156/300; 52%]. According to the participants' educational status, more than half of them (180/300; 60%) were primary and secondary education. About 3/4 of the participants (252/300; 84%) were house wives. The participants were divided into 3 groups according to their gestational weeks, 1st trimester (≤13 weeks), 2nd trimester (14-26 weeks) and 3rd trimester (> 26 weeks), nearly 1/3 of the participants in each group. 62.3% (187/300) of the participants were from medium socioeconomic class. Regarding birth space, nearly 1/2 of the participants (139/300; 46.3%) were ≥ 2 years from the last pregnancy, as shown in Table 1.

Overall mean erythrocyte sedimentation rate (ESR) for the study population was 47.69 ± 25 mm/hour (rang: 5-116), while the mean gestational age was 19.24 ± 9.74 weeks (range: 4-39).The mean hemoglobin concentration (Hb) was 10.09 ± 0.91 g/dl (range: 7.2-12.7) and the mean age of the pregnant women was 26.6 ± 5.8 years (range: 15-41 years old) as shown in Table 2.

Table 3 shows that there is statistically significant association between ESR and gestational age of the participants (P value of both ANOVA and chi square was <0.001). Nearly 1/2 of the participants (120/300;49.4%) , their ESR value was ≥ 20mm/h in their 2nd trimester (14-26 weeks), while only 5.3% (3/300) of them, their ESR value was < 20mm/h in their 3rd trimester.

Similarly, Table 4(A) shows that there is a statistical significant association between decrease in Hb level and an increase in erythrocyte sedimentation rate (P value was 0.047 and 0.002 in chi X^2 and ANOVA,

respectively). About 3/4 of the participants (70.6%, 212/300) which their Hb level between 7-10.9 gm/dl had highest ESR (≥ 20mm/h), while only 13/300 (4.3%) of them in which their Hb level ≥ 11gm/dl, had ESR < 20mm/h.

While Table 4(B) shows that there is a statistically significant difference between the mean ESR values of anemic and non-anemic pregnants (P=0.003).

The ESR revealed a significant increase in the course of pregnancy from 1st to 3rd trimester and it was statistically significant. The mean value of ESR in 1st trimester was 30.5±18.3mm/h (range 5-60), the mean value of ESR in 2nd trimester was 53.3±22.6 mm/h (range 9-67) and for the 3rd trimester was 61.6±24 mm/h (range 15-116), (P value < 0.001) as shown in Table 5(A and B).

There was a statistically significant association between occupation and ESR (P value =0.05). More than 2/3 of the participants (209/300; 86%) who had ESR ≥ 20mm/h were housewives, while there were no participants (0%) had ESR <20mm/h as shown in Table 6.

However, there was no statistically significant association between ESR and maternal age, educational status, socio-economic status, parity, birth space, previous mode of delivery, type of contraception, and smoking, as shown in the Tables 7-15.

Discussion

The aim of present study was to determine the levels of ESR in healthy pregnant women with uncomplicated pregnancies and to examine the effects of gestational age and hemoglobin concentration on ESR measurements. Pregnancy is known to have effects on the hematological properties of blood, such as packed red cell (PCV), plasma viscosity, red cell aggregation and relative whole viscosity.[18,19] The anemia in pregnancy is sometimes referred to as physiological anemia. This occurs as a result of increased plasma volume associated with normal pregnancy causing dilution of the whole blood without resultant effect of increase on cellular component of blood especially the red cells.[20,21] In present study anemia was present in 256(85.3%) pregnants. The result of this study showed significant reduction in Hb concentration in pregnancy in all 3 trimesters. This is in line with the results of previous studies undertaken in Karachi (Pakistan[9]), Bali (Indonesia[22]) ,Rural North India [23] and Ibadan, south-western Nigeria, by Akingbola et al in 2006.[19]

The ESR is one of the measurements of acute phase response. It is helpful in detecting presence of inflammation and its response to treatment. It is influenced by anemia. [14,15,24,25] In present study, the ESR revealed significant increase in the course of pregnancy from 1st to 3rd trimester and this confirms previous studies.[26-28]This was attributed mainly to increased fibrinogen levels during pregnancy[12]and partly due to anemia. It is known that anemia is one of the factors that could increase ESR, and this increased level might also be due to changes in protein and fibrinogen concentration and this will alter the fibrinogen-globulin ratio which will enhance rouleaux formation that occurs during sedimentation process [7, 19, 22.]

In 1921 Fahraeus measured ESR in pregnancy and obtained values of between 6 and 41mm/h.. Although ESR values of between 0-20mm/h for non-pregnant women below the age of 50 years are generally taken to be normal[5], even after extensive search of literatures, we were unable to find a definitive range of ESR values that is considered normal during pregnancy[26]. However, some studies have indicated that values of 4-57mm/h in 1st trimester, 7-47mm/h in 2nd trimester and 13-70mm/h in 3rd trimester were considered normal[6]. This is comparable with the results of present study that shows that the ESR values for 1st trimester were 5-60mm/h, for 2nd trimester were 9-67 mm/h, and for 3rd trimester were 15-116 mm/h.

In this study, an inverse correlation was found between mean Hb and ESR throughout the pregnancy, and this has been documented in other studies.[18-20] Another significant association was found between occupation and ESR in that more than 2/3 of the participants who had ESR more than 25mm/h were housewives and this may be explained by the large number of housewives participants in the present study. We couldn't find a comparable study regarding this subject. Although the study shows no significant association between smoking and ESR, it is worth to mention that all smokers (eleven cases) were of ESR value more than 20 mm/h.

No significant association was found between ESR and other socio-demographic features like maternal age, parity, educational status, socio-economic class and birth space. To our knowledge, there was no previous study correlating ESR with these variables.

Conclusions

This study shows that erythrocyte sedimentation rate increases during pregnancy and that both gestational age and hemoglobin concentration significantly influence erythrocyte sedimentation rate. Anemia was common in pregnant females. For the correct interpretation of ESR values obtained during pregnancy, gestational age and hemoglobin concentration must be taken into account.

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Table 1: Distribution of the 300 participant women according to the socio-demographic features.

Sociodemograhic data		No. (Total= 300)	Percentage (%)
Age	<17	10	3.3
	18-35	264	88.0
	>35	26	8.7
Parity	Primigravida	77	25.7
	1-4	156	52.0
	>4	67	22.3
Educational status	illiterate	73	24.3
	primary	92	30.7
	secondary	88	29.3
	higher education	47	15.7
Occupation	Housewife	252	84.0
	Employed	37	12.3
	Student	10	3.3
	Free business	1	0.3
Gestational age	=<13 Weeks	100	33.3
	14-26 Weeks	129	43.0
	>26 Weeks	71	23.7
Socioeconomic class	Low Status	73	24.3
	Medium Status	187	62.3
	High Status	40	13.3
Birth Space	<2 Years	76	25.3
	=>2 Years	139	46.3

Table 2: Distribution of the variables according to the mean and SD (n=300)

Variables	Minimum	Maximum	Mean	Std. Deviation
ESR	5.00	116.00	47.6900	25.00449
Gestational age (Weeks)	4.00	39.00	19.2433	9.74855
Hb	7.20	12.70	10.0973	0.91260
Age	15.00	41.00	26.6	5.8

Table 3: Distribution of the gestational age in relation to ESR

Gestational category			ESR_Category		Total	P value by chi X^2 and ANOVA
			< 20	≥ 20		
Gest. category	=<13 Weeks	Count	45	55	100	<0.001
		% within ESR Category	78.9%	22.6%	33.3%	
	14-26 Weeks	Count	9	120	129	
		% within ESR Category	15.8%	49.4%	43.0%	
	>26 Weeks	Count	3	68	71	
		% within ESR Category	5.3%	28.0%	23.7%	
Total		Count	57	243	300	
		% within ESR Category	100.0%	100.0%	100.0%	

- Chi square test X^2: used to determine whether there is a significant association between two categorical variables from a single population[15]
- ANOVA: used to determine whether there are any significant differences between the means of three or more independent (unrelated) groups[15]

Table 4 A: Distribution of the Hb level in relation to ESR

Hb Category			ESR Category		Total	P value by chi X^2
			< 20	≥ 20		
Hb Category	7-9.9 gm/dl	Count	26	97	123	
		% within ESR Category	45.6%	39.9%	41.0%	0.047
	10-10.9 gm/dl	Count	18	115	133	
		% within ESR Category	31.6%	47.3%	44.3%	P value by ANOVA 0.002
	=>11 gm/dl	Count	13	31	44	
		% within ESR Category	22.8%	12.8%	14.7%	
Total		Count	57	243	300	
		% within ESR Category	100.0%	100.0%	100.0%	

Table 4B: Mean of ESR in anemic & non-anemic pregnants.

	N	Mean	Std. Deviation	95% Confidence Interval for Mean		P value
				Lower Bound	Upper Bound	
Anemic	256	49.4375	25.71572	46.2724	52.6026	0.003*
Non-anemic	44	37.5227	17.37479	32.2403	42.8051	
Total	300	47.6900	25.00449	44.8490	50.5310	

*Statistically significant

Table 5 A: Distribution of ESR & Hb by gestational weeks

Gestational weeks		N	Mean	Std. Deviation	95% Confidence Interval for Mean		P value
					Lower Bound	Upper Bound	
ESR	≤13 Weeks	100	30.5600	18.39594	26.9098	34.2102	
	14-26 Weeks	129	53.3023	22.66833	49.3532	57.2514	<0.001*
	>26 Weeks	71	61.6197	24.04838	55.9276	67.3119	
	Total	300	47.6900	25.00449	44.8490	50.5310	
HB	≤13 Weeks	100	10.4160	.90417	10.2366	10.5954	
	14-26 Weeks	129	9.9070	.79551	9.7684	10.0456	<0.001*
	>26 Weeks	71	9.9944	1.01064	9.7552	10.2336	
	Total	300	10.0973	.91260	9.9936	10.2010	

*Statistically significant.

Table 5 B: ESR by gestational ages

Gestational category	Mean	Std. Deviation	Range
≤13 Weeks	30.5600	18.39594	5-60
14-26 Weeks	53.3023	22.66833	9-67
>26 Weeks	61.6197	24.04838	15-116
Total	47.6900	25.00449	5-116

P value< 0.001 (Statistically significant).

Table 6: Occupational distribution in relation to ESR

			ESR_Categ			
			< 20	≥ 20	Total	P value
Occupational	Housewife	Count	43	209	252	
		% within ESR_Categ	75.4%	86.0%	84.0%	
	Employed	Count	9	28	37	
		% within ESR_Categ	15.8%	11.5%	12.3%	0.05
	Student	Count	5	5	10	
		% within ESR_Categ	8.8%	2.1%	3.3%	
	Free business	Count	0	1	1	
		% within ESR_Categ	.0%	.4%	.3%	
Total		Count	57	243	300	
		% within ESR_Categ	100.0%	100.0%	100.0%	

Table 7: Distribution of age in relation to ESR

Age Category			ESR_Categ			
			< 20	≥ 20	Total	P value
Age_Categ	<17	Count	1	9	10	
		% within ESR_Categ	1.8%	3.7%	3.3%	
	18-35	Count	50	214	264	
		% within ESR_Categ	87.7%	88.1%	88.0%	0.668
	>35	Count	6	20	26	
		% within ESR_Categ	10.5%	8.2%	8.7%	
Total		Count	57	243	300	
		% within ESR_Categ	100.0%	100.0%	100.0%	

Table 8: Distribution of educational status in relation to ESR

			ESR_Categ			
			< 20	≥20	Total	P value
Educational status	illiterate	Count	14	59	73	
		% within ESR_Categ	24.6%	24.3%	24.3%	
	primary	Count	12	80	92	
		% within ESR_Categ	21.1%	32.9%	30.7%	0.320
	secondary	Count	20	68	88	
		% within ESR_Categ	35.1%	28.0%	29.3%	
	higher education	Count	11	36	47	
		% within ESR_Categ	19.3%	14.8%	15.7%	
Total		Count	57	243	300	
		% within ESR_Categ	100.0%	100.0%	100.0%	

Table 9: Distribution of socioeconomic status in relation to ESR

			ESR_Categ			
			< 20	≥20	Total	P value
SES_Categ	Low Status	Count	9	64	73	
		% within ESR_Categ	15.8%	26.3%	24.3%	
	Medium Status	Count	42	145	187	
		% within ESR_Categ	73.7%	59.7%	62.3%	0.137
	High Status	Count	6	34	40	
		% within ESR_Categ	10.5%	14.0%	13.3%	
Total		Count	57	243	300	
		% within ESR_Categ	100.0%	100.0%	100.0%	

Table 10: Distribution of the parity in relation to ESR

			ESR_Categ			
			< 20	≥20	Total	P value
Parity_Categ	Primigravida	Count	15	62	77	
		% within ESR_Categ	26.3%	25.5%	25.7%	
	1-4	Count	28	128	156	
		% within ESR_Categ	49.1%	52.7%	52.0%	0.869
	>4	Count	14	53	67	
		% within ESR_Categ	24.6%	21.8%	22.3%	
Total		Count	57	243	300	
		% within ESR_Categ	100.0%	100.0%	100.0%	

Table 11: Distribution of the Birth Space (Year) in relation to ESR

			ESR_Categ			
			< 20	≥20	Total	P value
BirthSpaceYear_Categ	<2 Years	Count	14	62	76	
		% within ESR_Categ	35.0%	35.4%	35.3%	0.557
	=>2 Years	Count	26	113	139	
		% within ESR_Categ	65.0%	64.6%	64.7%	
Total		Count	40	175	215	
		% within ESR_Categ	100.0%	100.0%	100.0%	

Table 12: Distribution of types of contraception in relation to ESR

			ESR_Categ			
			< 20	≥20	Total	P value
If para more than one	Natural	Count	24	94	118	
		% within ESR_Categ	68.6%	64.4%	65.2%	
	CCP	Count	5	22	27	
		% within ESR_Categ	14.3%	15.1%	14.9%	0.950
	IUCD	Count	4	22	26	
		% within ESR_Categ	11.4%	15.1%	14.4%	
	Injection	Count	2	8	10	
		% within ESR_Categ	5.7%	5.5%	5.5%	
Total		Count	35	146	181	
		% within ESR_Categ	100.0%	100.0%	100.0%	

Table 13: Distribution of the Previous mode of delivery in relation to ESR

			ESR_Categ			
			< 20	≥20	Total	P value
Pre.nod._delivery	c\s	Count	7	53	60	
		% within ESR_Categ	17.9%	31.4%	28.8%	0.067
	NVD	Count	32	116	148	
		% within ESR_Categ	82.1%	68.6%	71.2%	
Total		Count	39	169	208	
		% within ESR_Categ	100.0%	100.0%	100.0%	

Table 14: Distribution of types of contraception in relation to ESR

			ESR_Categ		Total	P value
			< 20	≥20		
If para more than one	Natural	Count	24	94	118	
		% within ESR_Categ	68.6%	64.4%	65.2%	
	CCP	Count	5	22	27	
		% within ESR_Categ	14.3%	15.1%	14.9%	0.950
	IUCD	Count	4	22	26	
		% within ESR_Categ	11.4%	15.1%	14.4%	
	Injection	Count	2	8	10	
		% within ESR_Categ	5.7%	5.5%	5.5%	
Total		Count	35	146	181	
		% within ESR_Categ	100.0%	100.0%	100.0%	

Table 15: Distribution of smoking in relation to ESR

Smoking			ESR_Categ		Total	P value
			< 20	≥20		
	yes	Count	0	11	11	
		% within ESR_Categ	.0%	4.5%	3.7%	0.094
	no	Count	57	232	289	
		% within ESR_Categ	100.0%	95.5%	96.3%	
Total		Count	57	243	300	
		% within ESR_Categ	100.0%	100.0%	100.0%	