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The Relationship Between some Adipokines with Vitamin D_3 in Preeclampsia Pregnant Women in Mosul City-Iraq

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ABSTRACT

Preeclampsia is a medical condition that occurs during pregnancy, usually after the 20th week. It is characterized by hypertension and protein in the urine (proteinuria). This study aimed to evaluate the concentration of vitamin D_3 and some adipokines (chemerin, lipocalin-2 and omentin) in the serum of infected pregnant women with preeclampsia. The study included pregnant women of different ages and in the second and third trimester of pregnancy compared with healthy pregnant women in the city of Mosul, to determine the relationship between D_3 deficiency and preeclampsia in the serum of 90 blood samples from pregnant women infected with preeclampsia and hypertension during pregnancy. Their ages ranged between (20-40) year, from visits to both Al-Batoul and Al-Khansaa Teaching Hospital for obstetrics and gynecology in in Mosul City, who were diagnosed with this disease, by obstetricians and gynecologists, as well as 50 healthy pregnant women without preeclampsia or hypertension and from the same ages and stages of pregnancy, who were considered as a control group.

The results of current study showed a significant decrease in vitamin D_3 and omentin concentration. The percentage of vit. D_3 and omentin in the serum of infected with preeclampsia by 61% and 43% respectively. The second and third stage pregnant women with preeclampsia by 60% and 55% respectively compared to control. The results showed also the percentage decrease of vit. D_3 and omentin in serum of infected pregnant women in the age group (31-40) and (20-30) year were 56%, 60% and 40%, 59% respectively compared to healthy pregnant women of the same age group. The results showed a direct correlation or a strong (positive) relationship between omentin and vitamin D_3 deficiency. The results of this study showed a significant increase in the chemerin and lipocalin-2 concentration. The percentage of chemerin and lipocalin-2 in the serum of infected women with preeclampsia by 81% and 266% respectively. and for second and third stage pregnant women with preeclampsia by 148%, 117% and 232%, 162% respectively compared to control of the same stage. The results showed also the percentage decrease of chemerin and lipocalin-2 in serum of infected pregnant women in the age group (31-40) and (20-30) year were 139%, 123% and 279%, 167% respectively compared to healthy pregnant women of the same age group. The results showed that they were inversely related or a weak (negative) relationship between them and vitamin D_3 deficiency.

Keywords: Preeclampsia, vitamin D_3, adipokines, chemerin, lipocalin-2, omentin.

INTRODUCTION

Preeclampsia (PE) is a complication of pregnancy, as the pregnant suffers from hypertension, or a high level of protein in the urine (proteinuria), which indicates kidney damage, or other indicators of organ damage (Amit and Dilip, 2021). Preeclampsia begins after a period of 20 weeks from its beginning, in women whose blood pressure was normal before pregnancy, with or without protein edema, preeclampsia affects about (5-10) % of pregnant women, which is the causative factor for the onset of the disease (Baoquan *et al*., 2024). It is a disorder that causes hypertension after the twentieth week of pregnancy, as it is characterized by a sudden rise in blood pressure, accompanied by edema of the face, and upper and lower extremities. The appearance of protein in the urine, indicates preeclampsia, especially if it is accompanied by hypertension (Modzelewski *et al*., 2023), in addition to inefficient kidney function, an increase in the activity of liver enzymes in the blood (Touyz *et al*., 2018), weakness of the lining of blood vessels, especially in the lung, is one of the main causes of cardiovascular system disorder (Vasan *et al*., 2019).

Women with preeclampsia also suffers from pain in the upper right side of the abdomen and neurological symptoms such as visual disturbances, tendon hyperreflexia, decreased fetal growth, a decrease in the platelets count and breakdown of red blood cells, as well as the possibility of convulsive seizures (epilepsy). This condition is called eclampsia. It is a dangerous condition for the mother and her fetus (Ferreira *et al*., 2020). One of its causes is the placenta. Hypertension during pregnancy is attributed to the placenta. Hypertension is common in women who become pregnant for the first time, especially after the age of 35 years, or when pregnant with twins, or when there is a family history of hypertension. Gestational hypertension begins with pregnant women become infected with it during their pregnancy, in the second trimester, and it continues to increase, especially in the third trimester (last weeks) of pregnancy (Wadhwani *et al*., 2020). Such an increase in blood pressure disappears during the three months after birth and is not accompanied by the appearance of protein in the urine and watery edema in the extremities (Baoquan *et al*., 2024).

Vitamin D_3 is a fat-soluble vitamin that promotes the absorption of calcium and phosphorus from the intestine and their deposition in the bones. Its deficiency due to malnutrition or lack of exposure to sunlight leads to decalcification from the bones, osteomalacia, and rickets (Fogacci *et al*., 2020). It is a vital element in fetal formation, fetal skeletal development, and calcium level balance. However, normal pregnancy contributes to metabolic changes to maternal Vitamin D_3 for the purpose of encouraging fetal growth, as its levels depend greatly on maternal stores (Alsaeed *et al*., 2020). The vitamin needs increase during pregnancy and low level is associated with an increased prevalence of congenital heart defects in offspring, increased risk of miscarriage, bacterial vaginal infections, preeclampsia, premature birth, low birth weight of children, increased insulin resistance and poor insulin secretion, as well affects the maturity of the fetus. It is involved in anti-inflammatory and immunomodulatory processes in many organs, it also plays a role in regulating signals, genes in the early stages of placental development, and placental angiogenesis. Its receptors also support endothelial cell integrity by reducing oxidative stress, which is one of the factors associated with preeclampsia (Rahnemaei *et al*., 2020).

Chemerin is one of the adipokines, so it is a multi-functional protein secreted in the human body and other animals by the white and brown adipose tissue, the liver, the pancreas, and the female reproductive system (represented by the ovary, cervix, uterine lining, and placenta). It plays an important role in metabolism and the immune system (Lucy *et al*., 2023). Therefore, it is described as an important regulator of many physiological processes such as obesity, metabolism, blood pressure control, immunity, angiogenesis and inflammation through receptors (Katarzyna and Pankiewicz, 2023). Chemerin secretion is affected by several factors, including: Obesity, infections, protease, and the reproductive system. Then may have effects on health and reproductive health, as chemerin and its receptors are expressed in various reproductive tissues and cells, such as ovaries, placenta, testes, sperm (Tan *et al*., 2022; Kabbani *et al*., 2023).

Lipocalin-2 (LCN-2) is expressed in neutrophilic leukocytes, and at lower levels in the kidney, prostate, respiratory tract, and gastrointestinal tract. It binds to bacterial iron carriers, which

is essential in the innate immune response to bacterial infection. The secreted lipocalin-2 inhibits bacterial growth by sequestering iron-containing siderophores, which results in reduced bacterial growth. Lipocalin-2 also plays the role of a growth factor (Yang *et al*., 2023; Al-Jaberi *et al*., 2021).

Omentin is one of the adipokines, with a molecular weight of (38-40) kDa, secreted by adipose tissue mainly from mature adipocytes, which include adipocytes, macrophages, lymphocytes and endothelial cells. The structure of omentin is a secretory glycoprotein consisting of 295 amino acids linked by disulfide bonds and oligosaccharides, and its basic structural unit is homologous. Omentin is produced predominantly by the vascular endothelial portion of visceral adipose tissue. Omentin is found in two forms, Omentin-1 and Omentin-2 (Xu *et al*., 2020). Its production is regulated by glucose and insulin. Its expression and secretion are known to be altered in several pathological conditions, such as obesity and insulin resistance. Omentin-1 expression is also altered in inflammatory conditions and preeclampsia (Alves *et al*., 2022).

This study aimed to evaluate the level of vitamin D_3 and some adipokines (Chemerin, lipocalin-2 and omentin) in the serum of infected pregnant women with preeclampsia. It included pregnant women of different ages and in the second and third trimester of pregnancy compared with healthy pregnant women in the city of Mosul, to determine the relationship between D_3 deficiency and Preeclampsia.

MATERIALS AND METHODS

Chemical material used

The study used ready-made analysis kits from various international companies to estimate the levels of vitamin D_3 and some adipokines (chemerin, lipocalin-2, and omentin), which were prepared by the Chinese company BT-LAB and the French company Bio-Mérieux.

Location and duration of study

The study was conducted on pregnant women with preeclampsia at Al-Batoul and Al-Khansaa Teaching Hospital for obstetrics and gynecology in Mosul City for the period from January to July (2024). The total number of study samples was 140 samples, divided into 90 blood samples from pregnant women suffering from preeclampsia and high blood pressure who were diagnosed with this disease by obstetricians and gynecologists, and 50 blood samples from healthy pregnant women who did not suffer from hypertension, and any health problems and chronic diseases, from the same ages and stages of pregnancy, as a control group. Their ages ranged between (20-40) year, according to a special questionnaire prepared for this purpose. Pregnant women were classified according to the stages of pregnancy into two stage includes: The second stage (which includes the second trimester of pregnancy, any from 3-6 months), and the third trimester (which includes the last third of pregnancy, any from 6-9 months), The women were also classified based on their age into two categories: The first category, those from (20-30) year, and the second category, those from (31-40) year.

Blood sample collection and preservation

It was drawn 5 ml of venous blood from healthy pregnant women and those suffering from preeclampsia, taking into account the exclusion of any hemolysis blood sample, which gives false results, and put this blood in clean jell tubes with tight, dry caps, and empty of any anticoagulant, then the tubes were left at room temperature for 20 minutes, and the blood was separated by a centrifuge at a speed of 3000 rpm for 15 minutes, to obtain blood serum. It was withdrawn using a micro-pipette, divided into parts, and placed in dry, sterile plastic Eppendorf tubes. The serum was stored in a deep freezer at (-20) °C until tests were conducted for adipokines and vitamin D_3 estimation.

Statistical analysis

The current study was conducted using a completely randomized design (C.D.R.). Differences between groups of healthy pregnant women and those with preeclampsia were determined using a t-test for the studied variables at a probability level of ($p \leq 0.01$). Differences between the studied groups according to pregnancy stage and age group were determined using Duncan's multiple range

test for all studied variables at a probability level of ($p \leq 0.05$). Significant differences were determined using different alphabetical order and using the available statistical software (IBM® SPSS statistics

version 24) and the minitab-19 software to calculate the mean ± standard error (Hinton, 2004).

RESULTS AND DISCUSSION

Vitamin D_3 concentration

The results in (Table 1) showed a significant decrease at a probability level of ($p \leq 0.01$) in the vitamin D_3 concentration in the serum of infected pregnant women with preeclampsia by 61% compared to healthy pregnant women with normal blood pressure (control). The results in (Table 2) also showed a significant decrease in the vitamin D_3 concentration at ($p \leq 0.05$) according to Duncan's test in the serum of pregnant women according to stages of pregnant with this disease, with the percentage decrease in the vitamin D_3 concentration in the serum of infected second and third stage pregnant women with preeclampsia by 60% compared to control. The results in (Table 3) also showed a significant decrease in vitamin D_3 concentration in serum of infected pregnant women in the age group (31-40) year, where the percentage of decrease was 56% compared to healthy pregnant women of the same age group, and the percentage of decrease of vitamin D_3 concentration in the age group (20-30) year by 60% compared to healthy pregnant women.

The results of the current study are consistent with the findings (Karpa *et al*., 2022; Qasim, 2022) that there is a significant decrease in the vitamin D_3 concentration in serum pregnant women with preeclampsia compared to healthy pregnant women with normal blood pressure, in the city of Mosul (Albakaa *et al*., 2020). They also pointed out that a decrease level of vitamin D_3 increases the likelihood of a pregnant woman developing preeclampsia by five times compared to a pregnant woman who has normal levels of vitamin D_3 and normal blood pressure. The study conducted by (Sadek *et al*., 2021) indicated the great importance of vitamin D_3 in the development of preeclampsia and associated hypertension in pregnant women throughout pregnancy and the relationship between vitamin D_3 deficiency and preeclampsia.

Vitamin D_3 deficiency is a public health problem worldwide. A normal maternal level of vitamin D_3 is important during pregnancy for both the pregnant women and the developing fetus, Vitamin D_3 deficiency may serve as a biomarker of an unhealthy metabolic state. Decrease levels of vitamin D_3 are attributed to several factors, including hormonal and physiological changes, vasculitis, kidney dysfunction, obesity and overweight, dietary patterns and lack of exposure to sunlight, and the relationship between this vitamin and blood pressure. There is evidence that vitamin D_3 plays a role in regulating blood pressure by affecting the renin-angiotensin system. Low levels contribute to hypertension, which increases the risk of preeclampsia (Chen *et al*., 2023). Preeclampsia and hypertension can be associated with increased levels of inflammation in a pregnant woman's body, which affects the absorption and use of vitamin D_3.

Table 1: Total concentration of vitamin D_3 some adipokines in serum of infected pregnant women with preeclampsia compared with control.

Studied Groups	Control			Patients		
Variables	**Mean ± S.E.**	**%**	**%**	**Mean ± S.E.**	**%**	**%**
Vitamin D_3	**24.26±3.88	100	0	9.57±6.48	39	61 -
Chemerin	*265.09±56.13	100	0	480.5±40.9	181	81 +
Lipocalin-2	**43.46±22.61	100	0	159.15±32.76	366	266 +
Omentin (ng/ml)	**197.85±18.36	100	0	112.99±26.61	57	43 -

- The numbers followed by the sign (**) indicate significant differences at ($p \leq 0.01$) according to (T-Test).
- The sign (+) means an increase.
- The sign (-) means a decrease.

Chemerin concentration

The results in (Table 1) showed a significant increase at a probability level of ($p \leq 0.01$) according to (T-Test) in the chemerin concentration in the serum of infected pregnant women with preeclampsia by 81% compared to healthy pregnant women with normal blood pressure (control). The results in (Table 2) also showed a significant increase in the chemerin concentration at ($p \leq 0.05$) according to Duncan's test in the serum of pregnant women according to stages of pregnant with this disease, with the higher increase percentage in the chemerin concentration in the serum of infected second stage by 148% and third stage pregnant women with preeclampsia by 117% compared to control. The results in (Table 3) also showed a significant increase in chemerin concentration in the serum of infected pregnant women in the age group (31-40) year, where the percentage of increase was 139% compared to healthy pregnant women of the same age group, and the percentage of increase of chemerin concentration in serum of pregnant women patients in the age group (20-30) year by 123% compared to healthy pregnant women. The results in (Table 4) showed that chemerin was inversely related or a weak (negative) to vitamin D_3 deficiency.

The results of this study are consistent with the findings of (Chen *et al*., 2023), that there is a significant increase in the chemerin concentration in the serum of infected pregnant women with preeclampsia, as increase chemerin concentration in the serum of pregnant women with preeclampsia increases blood pressure, especially in the second and third trimesters of pregnancy compared to healthy pregnant women (Emeruwa *et al*., 2023). The reason for hypertension is due to the increased the chemerin concentration which leads to constrict the blood vessels, it also increases the body mass index (BMI), which leads to the deposition of lipids in the blood vessels. The increased concentration of chemerin is attributed to increased metabolic rates and accumulation of free radicals and oxidants during pregnancy (Bartho *et al*., 2023). Chemerin is one of the most recently identified adipokines and through its known effects, it may be thought to act in different pathways leading to insulin resistance and metabolic-related inflammatory events (Hamdan *et al*., 2022).

The results of the current study are also consistent with the findings of (Lucy *et al*., 2023), where vitamin D_3 deficiency increases the chemerin concentration in the serum of pregnant women with preeclampsia, due to the strong association between the efficiency of vitamin D_3 and adipokines that act as endocrine glands in the body and their effect on nearby or adjacent cells, especially in pregnant women over the age of 35 years, which increases the risk of preeclampsia (Ji *et al*., 2022).

Table (2): Concentration of vitamin D_3 and some adipokines in serum of infected second and third stage pregnant women with preeclampsia compared with control.

Stages of pregnancy	Second stage						Third stage					
Studied groups	Control			Patients			Control			Patients		
Variables Studied	# Conc. Mean ± S.E.	% Cons.	% Change	Conc. Mean ± S.E.	% Cons.	% Change	Conc. Mean ± S.E.	% Cons.	% Change	Conc. Mean ± S.E.	% Cons.	% Change
Vitamin D_3 (ng/ml)	23.40± 4.27b	100	0	9.36± 5.90c	40	60-	24.55± 3.71a	100	0	9.78± 4.08d	40	60-
Chemerin (ng/ml)	210.52± 58.33d	100	0	522.03± 56.62a	248	148+	200.95±55.98c	100	0	436.66± 76.39b	217	117+
Lipocalin-2 (ng/ml)	47.34± 14.75a	100	0	157.16± 33.36bc	332	232+	61.54± 25.41b	100	0	161.25± 32.32cd	262	162+
Omentin (ng/ml)	248.60 ±83.61b	100	0	111.52± 28.69a	45	55-	260.02± 81.93cd	100	0	114.55± 24.38b	45	55-

The numbers followed by different letters horizontally indicate a significant difference at ($p \leq 0.05$) according to Duncan's test.

- The sign (+) means an increase.
- The sign (-) means a decrease.

Lipocalin-2 concentration

The results in (Table 1) showed a significant increase at a probability level of ($p \leq 0.01$) according to (T-Test) in the lipocalin-2 concentration in the serum of infected pregnant women with preeclampsia by 266% compared to healthy pregnant women with normal blood pressure (control). The results in (Table 2) also showed a significant increase in the lipocalin-2 concentration at ($p \leq 0.05$) according to Duncan's Test in the serum of pregnant women according to stages of pregnant with this disease, with the higher increase percentage in the lipocalin-2 concentration in the serum of infected second stage by 232% and third stage pregnant women with preeclampsia by 162% compared to control. The results in (Table 3) also showed a significant increase in lipocalin-2 concentration in the serum of infected pregnant women in the age group (31-40) year, where the percentage of increase was 279% compared to healthy pregnant women of the same age group, and the percentage of increase of lipocalin-2 concentration in serum of pregnant women patients in the age group (20-30) year by 167% compared to healthy pregnant women. The results in (Table 4) showed that lipocalin-2 was inversely related or a weak (negative) to vitamin D_3 deficiency.

Table 3: Concentration of vitamin D_3 and some adipokines in serum of infected pregnant women with preeclampsia according to age groups compared with control.

Age	(20-30) year						(31-40) year					
Studied groups	Control			Patients			Control			Patients		
Variables studied	#Conc. Mean±S. E.	% Cons.	% Change	Conc. Mean±S. E.	% Cons.	% Change	Conc. Mean±S. E.	% Cons.	% Change	Conc. Mean±S. E.	% Cons.	% Change
Vitamin D_3 (ng/ml)	27.40± 3.75b	100	0	11.04± 2.34a	40	60-	23.68± 5.93c	100	0	10.34± 4.19d	44	56-
Chemerin (ng/ml)	200.42± 54.33d	100	0	445.9± 80.26ab	223	123+	222.1± 65.13c	100	0	530.4± 63.43b	239	139+
Lipocalin-2 (ng/ml)	59.23± 21.65a	100	0	158.1± 32.63cd	267	167+	42.36± 13.01b	100	0	160.5± 33.30d	379	279+
Omentin (ng/ml)	271.23± 79.80d	100	0	111.3± 27.58a	41	59-	192.3± 55.85c	100	0	115.3± 25.26b	60	40-

The numbers followed by different letters horizontally indicate a significant difference at ($p \leq 0.05$) according to Duncan's Test

- The sign (+) means an increase.
- The sign (-) means a decrease.

The results of the current study agree with what was reached by (Creswell *et al*., 2023) that there is an increase in the concentration of lipocalin-2 in the serum of pregnant women with hypertension, vitamin D_3 deficiency, and high body mass index in the second and third stages of pregnancy.

The increased lipocalin-2 concentration in serum of pregnant women with preeclampsia may be due to inflammation, kidney tissue damage, changes in placental function, and oxidative stress. These factors lead to increased production and secretion of lipocalin-2 as part of the body's response to deal with the stress and damage associated with preeclampsia, it is associated with many factors, including inflammation and oxidative stress (Masnavi *et al*., 2022). Lipocalin-2 such as NGAL (Neutrophil Gelatinase-Associated Lipocalin-2) act as protective agents against oxidative damage (i.e., have an endogenous antioxidant role), and thus their concentration increases as a defense response. In addition, lipocalin-2 plays an important role in the inflammatory response, and their concentration may increase as a result of increased inflammatory stimulation. Kidney tissue damage, renal injury, and preeclampsia can cause kidney damage, as preeclampsia increases levels of oxidative stress (Virzì *et al*., 2023).

Omentin concentration

The results in (Table 1) showed a significant decrease at a probability level of ($p \leq 0.01$) according to (T-Test) in the omentin concentration of infected pregnant with preeclampsia by 43% compared to healthy pregnant women with normal blood pressure (control). The results in (Table 2) also showed a significant decrease in the omentin concentration in the serum of pregnant women according to stages of pregnant with this disease, with the decrease percentage in the omentin concentration in serum of infected second and third stage pregnant women with preeclampsia by 55% compared to control. The results in (Table 3) also showed a significant decrease in omentin concentration in the serum of infected pregnant women in the age group (31-40) year, where the percentage of increase was 59 % compared to healthy pregnant women of the same age group. and the percentage of decrease of omentin concentration in serum of pregnant women patients in the age group (20-30) year by 40 % compared to healthy pregnant women. The results in (Table 4) showed a direct correlation between omentin and vitamin D_3 deficiency. The results in (Table 6) also showed a strong (positive) relationship between the concentration of vitamin D_3 and omentin in serum of infected pregnant women with preeclampsia, while the correlation coefficient value reached (+0.570).

The results of the current study are consistent with the findings of (Sun *et al*., 2020) that there is a significant decrease in the omentin concentration in the serum of infected pregnant women with preeclampsia (Papathanasiou *et al*., 2021), compared to healthy pregnant women. they can be explained by the fact that this decrease in the concentration of the omentin is a result of hypertension, increase the levels of glucose and insulin (Davide *et al*., 2022; Al-Zobaey and Al-Hadidy, 2023; Al-Zobaey and Al-Hadidy, 2024) indicated an inverse relationship between the omentin concentration in the blood and the BMI, and a direct relationship between the omentin concentration and a decrease in the vitamin D_3 concentration in the blood of infected pregnant women with hypertension during pregnancy (Al-Azzawi and Jankeer, 2024).

Clinical studies have indicated the use of omentin as a biomarker for obesity and metabolic disorders including insulin resistance, diabetes mellitus, metabolic syndrome, preeclampsia and atherosclerosis-associated cardiovascular disease (Al-Ali and Jankeer, 2020). Omentin may also be used as a biomarker for bone metabolism, inflammatory diseases, cancers, sleep apnea syndrome, preeclampsia and polycystic ovary syndrome. Moreover, decrease of omentin concentration are generally associated with these diseases (Jankeer and Al-Attar, 2020). The decrease of omentin concentration the serum in pregnant women with preeclampsia and hypertension reflects a complex interaction between inflammation (Hamed *et al*., 2021), oxidative stress, hormonal changes and vascular functions related to placental function. These combined factors lead to changes in omentin levels, which contribute to the development and worsening of preeclampsia and hypertension (Abdul-Fattah *et al*., 2009).

Table 4: The total correlation coefficient between vitamin D_3 and some adipokines concentration in serum of infected pregnant women with preeclampsia

Adipokines conc. Studied	Total correlation coefficient for vitamin D_3
Vitamin D_3 (ng/ml)	1
Chemerin (ng/ml)	$- 0.208^{**}$
Lipocalin-2 (ng/ml)	$- 0.510^{**}$
Omentin (ng/ml)	$+ 0.570^{**}$

- The sign (+) means a strong.
- The sign (-) means a weak.

CONCLUSIONS

It was concluded from the current study that preeclampsia has a significant effect on the decrease in vitamin D_3 levels and the increase in the levels of some adipokines (chemerin and lipocalin-2) accompanied by a decrease in the level of omentin in the serum of pregnant women with preeclampsia. Both chemerin and lipocalin-2 showed an inverse association with vitamin D_3 deficiency, while omentin showed a direct association with vitamin D_3 deficiency.

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العلاقة بين بعض الحركيات الدهنية وفيتامين D_3 لدى النساء الحوامل المصابات بتسمم الحمل في مدينة الموصل – العراق

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الملخص

هدفت هذه الدراسة إلى تقدير تركيز فيتامين د3 وبعض الحركيات الدهنية (الكيميرين، الليبوكالين–2، والأومينتين) في مصل النساء الحوامل المصابات بتسمم الحمل. شملت الدراسة نساء حوامل من مختلف الأعمار وفي الثلث الثاني والثالث من الحمل مقارنة بالنساء الحوامل السليمات في مدينة الموصل، وذلك لتحديد العلاقة بين نقص فيتامين د3 وتسمم الحمل في مصل 90 عينة دم من النساء الحوامل المصابات بتسمم الحمل وارتفاع ضغط الدم أثناء الحمل. تراوحت أعمارهنَّ بين (20–40) سنة، من زياراتهنَّ لمستشفى البتول التعليمي، بالإضافة إلى 50 امرأة حامل سليمة غير مصابة بتسمم الحمل كمجموعة سيطرة. أظهرت النتائج انخفاضاً كبيراً في تركيز فيتامين د3 والأومينتين. إذ بلغت نسبة فيتامين د3 والأومينتين في مصل المصابات بتسمم الحمل 61% و43% على التوالي. وللنساء الحوامل في المرحلتين الثانية والثالثة المصابات بتسمم الحمل بنسبة 60٪ و55٪ على التوالي مقارنة مع مجموعة السيطرة. وأظهرت النتائج أيضاً أنَّ نسبة انخفاض فيتامين د3 والأومينتين في مصل النساء الحوامل المصابات في الفئة العمرية (31–40) و (20–30) عامًا كانت 56٪ و60٪ و40٪ و59٪ على التوالي مقارنة بالنساء الحوامل الأصحاء من نفس الفئة العمرية. وأظهرت وجود ارتباط مباشر أو علاقة قوية (إيجابية) بين الأومينتين ونقص فيتامين د3. أظهرت نتائج هذه الدراسة زيادة كبيرة في تركيز الكيميرين والليبوكالين–2. إذ بلغت نسبة الكيميرين والليبوكالين–2 في مصل النساء المصابات بتسمم الحمل 81٪ و266٪ على التوالي. وللنساء الحوامل في المرحلتين الثانية والثالثة المصابات بتسمم الحمل بنسبة 148٪ و117٪ و232٪ و162٪ على التوالي مقارنة مع مجموعة السيطرة في نفس المرحلة. كما أظهرت النتائج أنَّ نسبة انخفاض الكيميرين والليبوكالين–2 في مصل النساء الحوامل المصابات في الفئة العمرية (31–40) و(20–30) سنة بلغت 139% و123% و279% و167% على التوالي مقارنة بالنساء الحوامل السليمات من نفس الفئات العمرية. كما أظهرت أن لهما علاقة مباشرة أو علاقة ضعيفة (سلبية) بينهما ونقص فيتامين د3.

الكلمات الدالة: تسمم الحمل، فيتامين د3، الحركيات الدهنية، الكيميرين، الليبوكالين–2 والأومينتين.