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Adiponectin Hormone and Body Composition Changes in Healthy Pregnant Women

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ABSTRACT

Background: Pregnancy often leads to hyperlipidemia, increased water consumption, and physiological changes, affecting fetal growth and potentially reducing the chance of having low gestational age (LGA) or macrosomic babies.

Aim of the study: To estimate the changes in the body composition of pregnant women throughout the various stages of pregnancy.

Patients and Methods: The study involved 250 pregnant women in Mosul City, divided into two groups: 150 healthy pregnant women in different trimesters and 100 healthy non-pregnant women. The cases group had no medical problems, their body mass index (BMI) between 18.5 and 29.9 Kg/m^2, and no history of chronic drug intake. The control group was non-pregnant healthy women. An electronic digital scale that included bioelectrical impedance analysis was used for measuring the body composition in both cases and control groups (Beurer wellbeing BF105, Germany), and the serum adiponectin hormone level was estimated using the human adiponectin ELISA kit (Bioassay Technology Laboratory, China).

Results: The mean age was 25.81±6.07 for the pregnant group and 29.68±8.24 for the control group. Adiponectin levels were higher in the cases group compared to the controls but with no significance. The bio-electrical impendence analysis showed a significant association between the groups regarding fat mass percentage. Adiponectin levels had no significant correlation with body water mass and fat mass percentages.

Conclusion: As pregnancy progresses, fat mass increases while total body water decreases, and the Adiponectin levels and fat mass are inversely correlated.

INTRODUCTION

Pregnancy often leads to hyperlipidemia, a condition requiring increased lipids for a growing fetus. Maternal hyperphagia, increased blood insulin concentrations, and increased lipoprotein lipase activity in adipose tissue contribute to this increase, resulting in approximately 3.5 kg of fat accumulation throughout pregnancy [1].

During the third trimester of pregnancy when the fetal growth is at its peak, the reduced lipoprotein lipase (LPL) activity happens simultaneously with an increase in lipolytic and catabolic activity due to insulin resistance. As a result, the maternal blood's (triglyceride - TG) levels rise, while phospholipids and cholesterol levels fall, hastening the reduction of the fat deposits [2].

The fetus generally relies mostly on glucose oxidation as its primary source of energy generation. However, mitochondrial (fatty acid oxidation - FAO) plays a crucial role in the human fetus by serving as a primary source of metabolic energy for placental function and the growth of the fetus [3].

Pregnancy leads to increased daily water consumption due to physiological changes, such as the expansion of plasma volume, presence of amniotic fluid, and water content in the fetus, placenta, and reproductive organs. The body needs more water to compensate for expenses, such as sweating, increased urine output, hyperventilation in the respiratory system, and increased food intake. Water plays a crucial role in food metabolism, digestion, absorption, circulation, and elimination, making it essential for maintaining a healthy body [4, 5].

Bioelectrical impedance analysis (BIA) is a rapid, safe, non-expensive, and non-invasive clinical approach that is often accepted and tolerated well by the participants. BIA estimates total body water (TBW) by measuring impedance (Z), which results from resistance (R) and reactance (Xc) components. This relationship can be expressed using the equation $Z^2 = R^2 + Xc^2$. R represents the body's opposition to the flow of an alternating current, while reactance gauges the electrical charge stored in cell membranes. Impedance measurements can be obtained using single or multiple current frequencies. BIA calculates an individual's resistance to a weak electric current, enabling the estimation of a two-compartment model of body composition, which includes fat mass (FM) and fat-free mass (FFM), using empirically derived equations [6].

Excellent test repeatability during pregnancy has been shown in the Bai *et al.* research. Despite this, it is not recommended to utilize various bioimpedance measurement instruments interchangeably [7].

The BIA technique evaluates impedance or resistance value according to the variations in electrical conductivity of various types of biological tissue, such as muscles and fat [8].

The Bioelectrical Analyzer (BIA) technique measures the electrical resistance of biological tissues like muscles and fat using surface electrodes attached to a computer analyzer. It uses a weak electric current to measure the body's electrical resistance. BIA is used to predict gestational and post-partum outcomes, but it cannot distinguish between maternal and fetal tissues. BIA is used in pregnancy for gestational weight gain (GWG) monitoring, aiding in the prediction of future illnesses like obesity, type 2 diabetes, cardiovascular disorders, ischemic heart disease, and strokes [9, 10].

Adiponectin is a hormone that regulates metabolic adaptations and maintains homeostasis during pregnancy. It is primarily found in maternal adipose tissue and is abundant in the early stages of pregnancy. Adiponectin signaling plays a role in maintaining β-cell mass and function, stimulating the growth of β-cells by increasing the expression of placental lactogen. It enhances insulin sensitivity in both pregnant and non-pregnant women, indirectly through its anti-inflammatory effects and directly by promoting glucose consumption in skeletal muscle and lowering hepatic gluconeogenesis. However, high serum levels of maternal adiponectin can reduce insulin signaling in the placenta and decrease fetal growth, potentially reducing the chance of having LGA or macrosomic babies. Low levels of adiponectin during pregnancy are predictive of the development of insulin resistance and gestational diabetes mellitus (GDM) [10-12]. This study aimed to estimate the changes in the body composition of pregnant women throughout the various stages of pregnancy.

MATERIALS AND METHODS

Study Design:

A case-control prospective study using a simple random sampling from the period of October 2023 to February 2024. A total of 250 women were enrolled in this study. The cases were gathered from pregnant women who received antenatal care at primary health care centers in Mosul City (Al-Qadisyah PHCC, Al-Hadbaa PHCC, Al-Quds PHCC) and Al-Khansaa Teaching Hospital, Al-Batool Teaching Hospital, Al-Mosul General Hospital, and Al-Salam General Hospital in Mosul City throughout the study period.

The participants in this study were divided into two distinct groups: the cases group consisted of 150 healthy pregnant women and the control group consisted of 100 healthy non-pregnant women. The cases group was further subdivided into three separate groups:

1. Fifty pregnant women in the 1st trimester between 7 to 13 weeks of gestation,

2. Fifty pregnant women in the 2nd trimester between 14 to 26 weeks of gestation.

3. Fifty pregnant women in the 3rd trimester between 27 to 39 weeks of gestation.

The control group was also collected simultaneously with the cases group from the same mentioned places

Subjects, inclusion and exclusion criteria:

The inclusion criteria for the case group in this study include healthy non-smoker pregnant women with a single non-twin pregnancy. Their BMI is between 18.5 and 29.9 Kg/m^2, with no medical comorbidities or drug intake history. While those with age <18 years or > 45 years or having a twin pregnancy or those who are smokers or complaining from other medical conditions or with drug intake history were excluded from the study. Similar inclusion and exclusion criteria were applied to the control group, except they were non-pregnant women.

The data from the subjects were collected for the clinical history and physical examination records (name, age, address, occupation, height, weight, LMP, E.D.D., recent BMI and BMI before the period of pregnancy, and blood pressure).

The initial investigation for the assessment of the gestational age was performed by the U/S for the cases group in the same institution. The random blood sugar testing for both the cases and control groups was performed in the laboratory department of the same institution or manually by using (On.Call®plus, Germany) glucometer.

Sampling:

Five milliliters of venous blood were aspirated from each participant using a clean venipuncture needle. The blood was then placed into a sterile serum-separating gel tube (5ml). After centrifugation, the serum supernatant was drawn off and transferred into clean and labeled Eppendorf tubes. The samples were then stored in a deep freezer at -20◦C for later use in the ELISA test to measure adiponectin hormone levels in a single run.

Measurement of the Body Composition

An electronic digital scale that included bioelectrical impedance analysis was used for measuring the body composition in both cases and control groups (Beurer wellbeing BF105, Germany).

The electronic weight scale has eight electrodes that are integrated into the left footplate, right footplate, left-hand grip, and right-hand grip in addition to a high-resolution LCD screen with analytical graphs, which is considered the most accurate device in comparison to the other two and four electrode manufactured devices.

With a single frequency technique of 50 kHz and a small constant current of less than 1mA, the device is practical, user-friendly and portable delivering segmental body analysis on an average of 1.5 seconds and a reading closest to 0.1 sensitivity.

Informative details about the subjects, including their sex, age, height, and physical activity, are set in the device before the measurement is established.

During the measuring process, all participants were instructed to stand on the footplate in bare feet and light clothing while simultaneously holding the two hand grips with their arms straight ahead. Before the measurement, participants were asked if they had engaged in strenuous exercise within 12 hours. In addition, it is important to refrain from taking BIA measurements when participants are dehydrated, have consumed food and drink within the past 4 hours, or have a full bladder that has not been emptied. This could significantly impact the reading. Following the measurement process, the body composition parameters, including the fat mass percentage and body water percentage were gathered from the electronic scale device together with the BMI, which was calculated manually.

Statistical Analysis:

The data obtained during the search was organized into spreadsheets using Microsoft Excel 2016. The statistical analysis was conducted by IBM-SPSS version 26. The descriptive statistics include mean ±standard deviation (SD) for measurable variables and frequencies and percentages for categorical variables. Shapiro-Wilk analysis was used to check the normality of the data and the parametric tests were selected. The Chi-square test, Fisher Exact test, independent t-test of the two means, one-way ANOVA, and Pearson correlation test were used. A P-value less than or equal to 0.05 is considered statistically significant.

RESULTS

As demonstrated in (Table 1), the mean age for the pregnant cases group was 25.81±6.07 and the mean age for the control group was 29.68±8.24. Concerning the BMI measures, 30.0% of the cases and 33.0% of the controls had a BMI of 18.5-24.9 kg/m^2 with no statistically significant difference. While 70.0% of the cases and 67.0% of the controls had a 25.0-29.9 kg/m^2 BMI, there was no statistically significant difference (P value = 0.584). The participants were mainly from urban areas, and the difference was statistically non-significant (P value = 0.126). Among the cases, 94.7% were unemployed. 5.3% were employees, while among the controls, 99.0% were unemployed, and 1.0% were employees; the difference was statistically non-significant (P value = 0.090).

The mean of the adiponectin levels of the studied age groups were higher among cases than in the controls, but there was no statistically significant association as showed in (Table 2).

No significant differences were found between the studied groups concerning the means of serum adiponectin levels in all socio-demographic parameters as showed in (Table 3).

The bio-electrical impendence analysis (BIA) showed a statistically significant association among the means of studied groups regarding fat mass percentage (P value = 0.034). the real difference was found in the 3rd trimester which had a higher mean level in comparison to the other studied groups as shown in (Table 4).

The correlation of the adiponectin levels with the BIA parameters among the studied group showed in (Table 5). The means of the adiponectin levels (ng/ml) among pregnant women were directly correlated with body water mass percentage in the 1st trimester and controls and indirectly correlated in 2nd and 3rd trimesters while the adiponectin levels were directly correlated with fat mass percentage in all trimesters of pregnancy and indirectly among the controls. No statistically significant associations were found.

DISCUSSION

For maintaining a normal pregnancy, many alterations are needed. Pregnancy-related alterations in hormone and cytokine levels affect peripheral tissues' ability to withstand insulin and the pancreatic β-cells' compensatory responses. The results will lead to intensified (glucose-stimulated insulin secretion - GSIS), decreased apoptosis, and increased proliferation of fetal tissues [13].

BIA is a quick, portable, and noninvasive way to estimate body composition. It is a beneficial tool for use in clinical settings, and it provides a broad spectrum of investigations during pregnancy [14].

Initially, adiponectin was identified as the most abundant protein produced exclusively by adipocytes. It seems to play a key regulatory role in numerous physiological pathways, mediating a variety of vascular activities and controlling the metabolism of fats and carbohydrates. Adiponectin plasma concentration is inversely correlated with blood pressure, triglycerides, (low-density lipoprotein - LDL) cholesterol, and body weight in the general population. It is favourably correlated with HDL-cholesterol levels. Contrary to expectations, it decreased in individuals with obesity, insulin-resistant conditions such as diabetes and metabolic syndrome, hypertension, and coronary heart disease [15]. Later on, and throughout pregnancy, fetal adiponectin is discovered to promote fetal growth and fat deposition, whereas maternal adiponectin decreases. It is hypothesized that the action of circulating adiponectin in adults is counteracted by fetal adiponectin, while the presence of fetal adiponectin may intensify insulin resistance and appear to encourage fetal growth. In the second trimester, there is an inverse correlation between the levels of fetal adiponectin and maternal blood glucose. As a result, fetal adiponectin has been shown to enhance maternal obesity [16].

The studied sample was 250 participants; 150 (60%) of the total studied sample were cases and 100 (40%) were controls. Of the cases sample; (76%) were allocated in the age group of 18 to less than 30 years, versus (53%) of the control group, being categorized in this age group. While (24%) and (47%) of the cases and controls respectively were categorized in the age group of 30-45 years. The mean age for the cases group was 25.81 ± 6.07, while the mean of the control group was 29.68 ± 8.24, and the difference between the cases and controls is statistically significant and the sample was distributed randomly. This occurred due to limited time for data collection and the available pregnant ladies in the study setting during the period of data collection.

The study compared the means of different body compositions of fat mass percentage and body water mass percentage among pregnant ladies from different trimesters, with the means of the control ladies who were not pregnant. Concerning the body composition change, generally, the studies show inconsistent results. Factors which may contribute to these inconsistencies include variations in the estimation methods, ethnicity, dietary intake, exercise levels, individual variability in fat and muscle deposition, and higher percentage of overweight/ obese subjects in different societies [17]. Much increase in body fat percentage can predict gestational diabetes [18, 19].

In this study, the mean of fat masses tended to increase as pregnancy progresses and there is a statistically significant association when comparing the mean values of cases fat mass versus control fat mass.

From the other point of view; the other body parameters which include the mean of body water mass percentage during different trimesters, show no statistically difference measures when compared with the mean of the corresponding control parameter. This is related to the nature of this study; which depends on a single reading from each subject and control without prospectively following up here to see if the reading is changed. Furthermore; the serum adiponectin's mean levels were compared with the means of different body compositions (Fat mass percentage and Body water mass percentage). among both pregnant ladies from different trimesters (cases) and with the means of ladies who were not pregnant (controls). No one of the mentioned items shows a statistically significant association. These findings, indirectly lead to the conclusion that there are confounders for example amniotic fluid mass, placental tissue mass, body inflammatory situation and subject ethnic group, which need to be adjusted before we can exactly know the future risky or protective nature of the relationships which are relate these parameters with the gestational complications.

Depending on the location of the study setting. The investigator found that; ninety-four (62.7%) of the cases and seventy-two (72%) of the controls resided in urban areas, on the other hand, fifty-six (37.8%) of the cases and twenty-eight (28%) of the controls were residing in the rural area. In spite of these differences, it is statistically not significant. The majority of cases and controls were found to be unemployed, which were 142 (94.7%) of the cases and ninety-nine (99%) of the controls. Meanwhile; employed pregnant found to be eight (5.3%) of the cases and one (1%) of the controls. These results were statistically not significant and it appears like this due to the cultural characteristics of Mosul city, as most of the Mosulian families refuse the idea of marriage before getting higher education or being employed [20].

Regarding the adiponectin relation to the socio-demographic characteristics. First of all, in the first trimester, the mean levels of maternal adiponectin appeared to be higher than the control then its means decreased little by little as the pregnancy progressed. Same findings were shown by Baratto *et. al.* in a study which was done at São Paulo Federal University, Brazil in 2019 [21]. Despite this fact, the differences between mean levels of cases and controls were statistically not significant.

Hypoadiponectinemia gradually occurred as the pregnancy progresses. Interestingly, adiponectin plasma concentration was found to be lower in pregnant women who developed GDM later in their pregnancy compared to euglycemic pregnancies in a series of previous cross-sectional case-control studies [22, 23].

Adiponectin means' levels showed to be higher among the urban cases than that of controls and its median levels were lower in cases than controls among rural addressed cases. Comparative results were found in a study conducted in India in 2018 [24]. However, no statistically significant association was found regarding this entity. Again, no statistically significant association was found between the mean levels of adiponectin and maternal occupation. No comparative study has been conducted yet.

LIMITATIONS

The limited study time prevented continuous follow-up of pregnant women for the three trimesters of the pregnancy period. Therefore, we collected samples for each trimester of the pregnancy period separately, which negatively affected the accuracy of the results. In addition to the lack of similar studies in our country, we were not able to compare this study with other local studies.

CONCLUSION

The levels of adiponectin hormone progressively drop down with the progression of the pregnancy. The body composition parameter (fat mass increases with the progression of pregnancy while total body water decreases with different trimesters of pregnancy. Negative correlation between adiponectin level and fat mass, but it is still statistically non-significant. No significant correlation between adiponectin and total body water.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

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TABLES

Table 1: The Distribution of socio-demographic characteristics between the studied groups

Parameter		Pregnant (n=150) No. (%)	Control (n=100) No. (%)	P value
Age (years)	Mean ± SD	25.81±6.07	29.68±8.24	0.000*
	18 – 30	114(76.0)	53(53.0)	0.000**
	30 – 45	36(24.0)	47(47.0)	
Residence	Urban	94(62.7)	72(72.0)	0.126*
	Rural	56(37.3)	28(28.0)	
Occupation	Employed	8(5.3)	1(1.0)	0.090***
	Unemployed	142(94.7)	99(99.0)	

* Independent t-test; ** Chi-square test; *** Fisher-exact test

Table 2: The distribution of serum adiponectin levels according to the studied groups

Parameter	1st Trimester (n=50) Mean ± SD	2nd Trimester (n=50) Mean ± SD	3rd Trimester (n=50) Mean ± SD	Control (n=100) Mean ± SD	P value*
Adiponectin (ng/ml)	7.11±5.53	6.62±5.79	5.87 ±2.44	5.79±2.71	0.241

*One Way ANOVA test was used

Table 3: Comparison of mean Adiponectin levels among the studied groups concerning the socio-demographic parameters

Parameter		Adiponectin (ng/ml) 1st Trimester (n=50) Mean ± SD	2nd Trimester (n=50) Mean ± SD	3rd Trimester (n=50) Mean ± SD	Control (n=100) Mean ± SD	P value*
Age (years)	18 - 30	6.82±4.96	6.46±6.35	5.54±2.26	5.76±2.60	0.819
	30 - 45	8.01±7.23	7.02±4.20	7.18±2.78	5.83±2.86	0.483
BMI	18.5 - 24.9	6.16±3.05	6.88±6.62	5.94±2.35	5.56±2.61	0.951
	25.0 - 29.9	7.73±6.67	6.01±3.17	5.58±2.87	6.26±2.89	0.714
Residence	Urban	8.16±6.25	6.53±3.55	6.02±2.12	5.56±2.72	0.147
	Rural	4.86±2.43	6.73±8.03	5.62±2.93	6.39±2.62	0.318
Occupation	Employed	7.59±5.64	8.83±---	5.25±2.35	7.44±---	0.622
	Unemployed	7.06±5.58	6.57±5.84	5.91±2.46	5.78 ±2.72	0.828

* One Way ANOVA test was used.

Table 4: Distribution of the BIA parameters among the studied group.

Parameter	1st Trimester (n=50) Mean± SD	2nd Trimester (n=50) Mean± SD	3rd Trimester (n=50) Mean± SD	Control (n=100) Mean± SD	P value*
Fat mass %	28.89±6.48 A	28.78±6.72 A	31.23±5.86 B	28.07±6.00 A	**0.034**
Body water mass %	56.64±5.96	56.63±6.12	56.34±6.16	56.58±6.09	0.994

* One-way ANOVA test with post Hoc test (the same letters mean no significant association while different letters mean significant association)

Table 5: The correlation of Adiponectin levels with body water mass percentage and fat mass percentage.

Adiponectin (ng/ml)		1st Trimester (n=50)	2nd Trimester (n=50)	3rd Trimester (n=50)	Control (n=100)
Body water mass%	*r*	0.043	-0.118	-0.102	0.059
	P value*	0.766	0.414	0.483	0.559
Fat mass %	*r*	0.063	0.040	0.115	-0.103
	P value*	0.666	0.785	0.427	0.307

* Pearson correlation test