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Studying the effect of mineral levels and kidney function in pregnant women with high blood pressure in the city of Fallujah

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ABSTRACT

Background: Hypertensive disorders during pregnancy increase maternal and fetal health risks. Altered levels of essential minerals and impaired kidney function may contribute to these conditions. However, their relationship with blood pressure across different pregnancy trimesters remains unclear. **Objective:** To investigate the association between serum mineral levels, kidney function, and hypertension, and to compare these parameters between the first and third trimesters in hypertensive pregnancies.

Materials and Methods: A case control study was carried out at Fallujah Teaching Hospital, Anbar Governorate, Iraq, after October 15 till December 15, 2024. The study involved 70 pregnant women aged 25–45 years including; 35 with hypertension (cases) and 35 normotensive controls. Blood samples were obtained, and serum levels of iron (Fe), magnesium (Mg), potassium (K), sodium (Na) and kidney function markers (creatinine, urea) were assessed. Statistical comparisons were performed using independent t-tests, with significance defined as $p \leq 0.05$.

Results: Hypertensive women exhibited significantly lower serum iron levels (42.31 ± 4.26 µg/dL vs. 105.65 ± 14.21 µg/dL; $p < 0.001$) and elevated Mg, K, and Na (1.905 ± 0.509 mg/dL, 4.812 ± 0.409 mmol/L, 145.17 ± 4.51 mmol/L, respectively) compared to controls (Mg: 1.504 ± 0.241 mg/dL; K: 3.901 ± 0.341 mmol/L; Na: 130.71 ± 7.09 mmol/L; $p < 0.001$). Kidney function markers were significantly impaired in the hypertensive group (creatinine: 0.912 ± 0.141 mg/dL vs. 0.618 ± 0.106 mg/dL; urea: 47.69 ± 2.39 mg/dL vs. 28.91 ± 3.91 mg/dL; $p < 0.001$). No significant differences in mineral levels were observed between first- and third-trimester hypertensive women.

Conclusions: Hypertensive pregnancies are associated with marked iron deficiency, elevated Mg/K/Na levels, and reduced kidney function compared to healthy pregnancies. These findings underscore the importance of monitoring mineral homeostasis and renal health in prenatal care to mitigate hypertension-related complications. Further longitudinal studies are warranted to elucidate trimester-specific dynamics.

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1. INTRODUCTION

Pregnancy is one of the important stages in a woman's life through which she can express her prominent social role. The symbolism of fertility and the ability to procreate is represented at this stage, which enables her to feel competent and rise to a new and sensitive role, which is motherhood, too much is considered one of the most important roles in society, as through it she maintains and contributes to the continuation of the race [1] .

As for blood pressure, it is the pressure exerted by the blood inside the arteries, which maintains the presence of a compressive force that leads to pushing blood through the circulatory system to all parts of the body [2]. High blood pressure during pregnancy can lead to problems for the fetus, including intrauterine growth restriction (poor fetal growth and miscarriage). If it is not treated, severe gestational hypertension may cause serious seizures and even death in the mother and fetus. Because of these risks, it may be necessary for the baby to be born early, before 37 weeks, which requires careful monitoring of blood pressure during the pregnancy. In the event of it being very high, the mother must receive the necessary treatment and appropriate medical care to prevent potential problems and to ensure her safety and the safety of the fetus [3] .

High blood pressure is a very serious disorder that increases the risk of mortality and cardiovascular disease. Many people have difficulty controlling it because they ignore the related health risks. According to current estimates, 1.56 billion adults are expected to develop high blood pressure in 2025, That is, one in every 3 adults. Worldwide, high blood pressure causes about 7.5 million deaths, which constitutes about 12.8% of the total number of deaths and is a major risk factor for coronary heart disease and , stroke and bleeding cases [4] . In addition, the heart and blood vessels can tolerate high blood pressure for several months and even several years. The heart may begin to enlarge and enlarge, eventually becoming a condition called (cardiomegaly). Sometimes it may weaken to the point of failure. Blood vessel injury may also occur in several cases. Parts of the body such as the brain, kidneys, and eyes [5] .

Minerals are natural nutrients that the body needs in specific amounts compared to other nutrients. They can be found from soil, from water sources in lakes and oceans, or from plants that animals consume. Minerals of various types play an effective and important role in maintaining the health of the human body, It contributes to building bones and teeth, controlling various body fluids inside and outside cells, and converting digested food into energy that the body uses to carry out its various vital tasks [6] .

Potassium is an essential mineral in the body and plays a vital role in muscle contraction and nerve function. It contributes to balancing blood pH and maintaining water balance within cells. Potassium can be obtained from food sources such as fruits and vegetables, and the daily requirement for adults is 4700 mg per day [7] . A study has proven that consuming an appropriate amount of potassium helps lower blood pressure. However, it is recommended to avoid excessive use of potassium supplements and obtain them from natural food sources [8] .

As for the mineral magnesium, it has an active and complex role in the body, and its mechanism of action depends on the organ system in question and the composition used. Magnesium is the fourth most common element in the body, and the majority of magnesium is found inside cells. Magnesium plays a vital and effective role in more than 300 reactions, including the metabolism process to obtain energy. It participates in binding hormone receptors, nervous activity, releasing neurotransmitters, and stimulating the heart, and is necessary for transport. Active for several minerals such as potassium and calcium across the cell membrane [9] .

Iron is one of the important essential elements that plays a crucial role in the body's metabolic processes, including energy production, oxygen transport, and immune responses [10] . In addition, iron deficiency is a condition that occurs when the level of iron in the body is insufficient to support the normal functions of metabolism. Iron is one of the most common nutrient deficiencies in the world, and is considered the primary cause of anemia in approximately 2 billion people around the world [11].

Kidney functions include urea and creatinine. Urea is the main end product of nitrogen metabolism in various parts of the body, as amino groups (NH2) are removed from the amino acids that make up proteins, and these amino groups are converted into ammonia (NH3), a toxic substance; So the liver converts it into urea, and the urea is eventually excreted by the kidneys in the urine, and excreted in various body fluids. The level of urea in urine ranges from 7 to 20 mg/dL, which rises significantly under different pathophysiological conditions, providing basic information about kidney function, diagnosing various kidney and liver disorders, and increasing urea levels in the body, which is also referred to as Uremia It usually occurs in chronic kidney disease due to the gradual loss of kidney function, and hence there is an urgent need to determine the percentage of urea in biological body fluids to diagnose these diseases in their early stages of infection [12] . Through the increase in the level of minerals and kidney function, the current research aims to study the effect of the level of minerals and kidney function in pregnant women with blood pressure in the city of Fallujah.

2. METHOD

The samples were for the current research were collected from pregnant women with high blood pressure in Anbar Governorate for the period from (10/15/2024 to 12/15/2024). 70 samples were collected from women whose ages ranged between (25-45) years from the visits. To the gynecology unit at Fallujah Teaching Hospital in Anbar Governorate, the samples were divided into:

- **Patient group**: (35) samples were from pregnant women with high blood pressure.
- **Control group**: It was (35) a sample of healthy women.

-After that, blood was collected from a group of patients and healthy people, and it was separated by a centrifuge. Then, biochemical variables were measured, which included (iron, magnesium, potassium, sodium), in addition to kidney function.

2.1 Estimating the level of Iron in both groups:

Iron concentration was calculated using a colorimetric method that converts trivalent iron ions into ferrous ions in a weakly acidic medium, and forms a colored complex of the iron(II) ion with Ferrozine [13].

2.2 Estimating the level of Magnesium in both groups:

The concentration of magnesium in blood serum was determined using the enzymatic method using a ready-made kit from the French company Biolabo [14] .

2.3 Estimating the level of Potassium in both groups:

The concentration of sodium level in blood serum was measured using the ready-made kit for sodium determination from the company French manufacturer Biolabo based on the enzymatic method [15] .

2.4 Estimating the level of Sodium in both groups:

The concentration of sodium level in blood serum was measured by using a ready-made kit for sodium determination from the French manufacturer Biolabo based on the enzymatic method [16] .

2.5 Estimating the level of Urea in both groups:

The concentration of urea in blood serum was estimated using a ready-made kit for determining urea in blood serum [17] .

2.6 Estimating the level of Creatinine in both groups:

The concentration of creatine in the blood serum was estimated by using a ready-made kit based on the colorimetric method of Jaffe and Henry [18] . which depends on the reaction of the creatine present in the sample with picric acid ions in a basic medium to produce a red-colored complex of creatine pellets.

2.7 Statistical analysis

The results of the current study were analyzed using the statistical program SPSS to find the mean and the value of the standard deviation ± SD. The averages were also determined for the group of pregnant women with high blood pressure compared to the control group (healthy people) using a T-test and at the probability level (P 0.001).

3. RESULTS AND DISCUSSION

• Measurement of biochemical and mineral levels in the two study groups as shown in Table 1.

Table 1. Shows the mean ± standard deviation (Mean ± SD) of biochemical and mineral levels in the two study groups

Groups /Parameter	Mean ± SD		P-Value
	Control No=35	Patients No=35	
Iron (µg/dl)	105.65±14.21	42.31±4.26	P ≤ 0.001
Magnesium (mg/dL)	1.504±0.241	1.905±0.509	P ≤ 0.001
Potassium (mmol/L)	3.901±0.341	4.812±0.409	P ≤ 0.001
Sodium (mmol/L)	130.71±7.09	145.17±4.51	P ≤ 0.001
Urea (mg/dl)	28.91±3.91	47.69±2.39	P ≤ 0.001
Creatinine (mg/dl)	0.618 ± 0.106	0.912 ± 0.141	P ≤ 0.001

The results of the current research showed a significant increase in each of the levels (Magnesium, Potassium, Sodium, and Kidney function) in the blood serum of pregnant women with high blood pressure compared to a control group (healthy people), and at its level the probability of P ≤ 0.001, and as in the following figures:

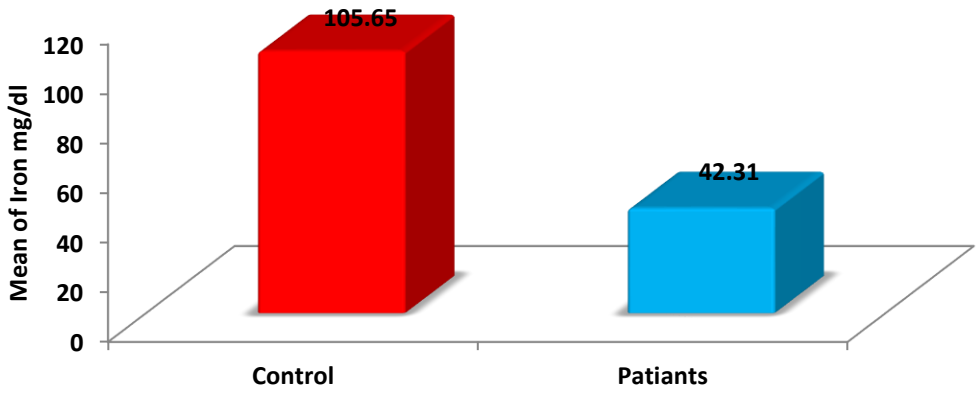

Figure 1. Iron in the group of patients and healthy people

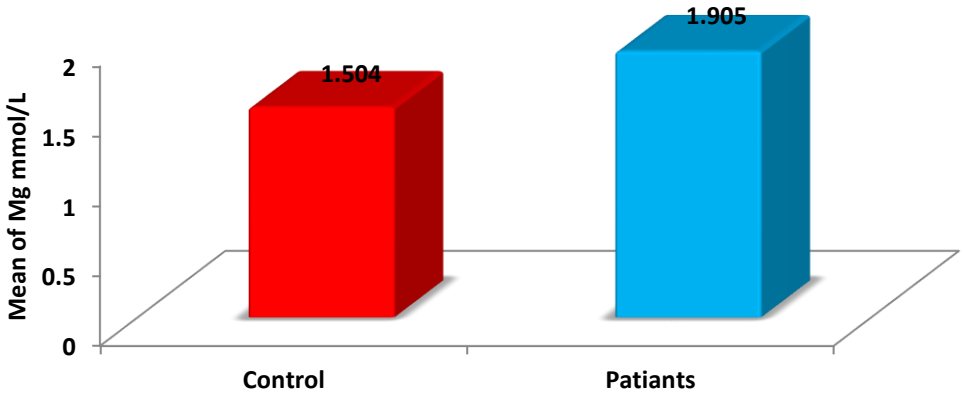

Figure 2. Mg in the group of patients and healthy people

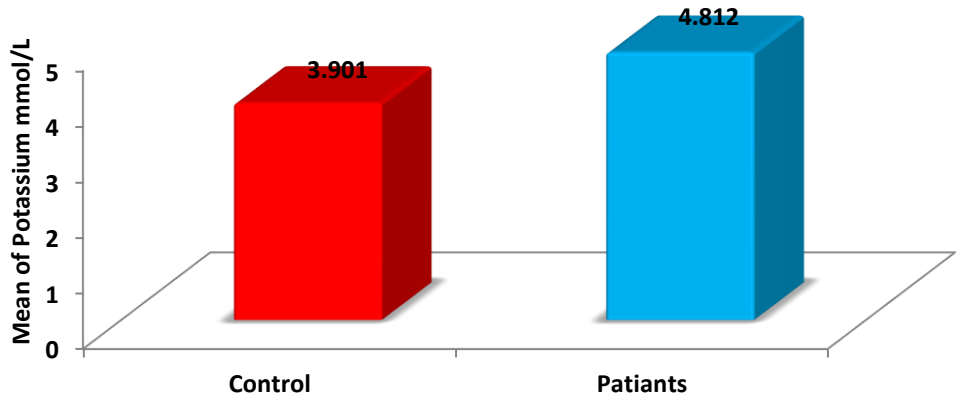

Figure 3. Potassium in the group of patients and healthy people

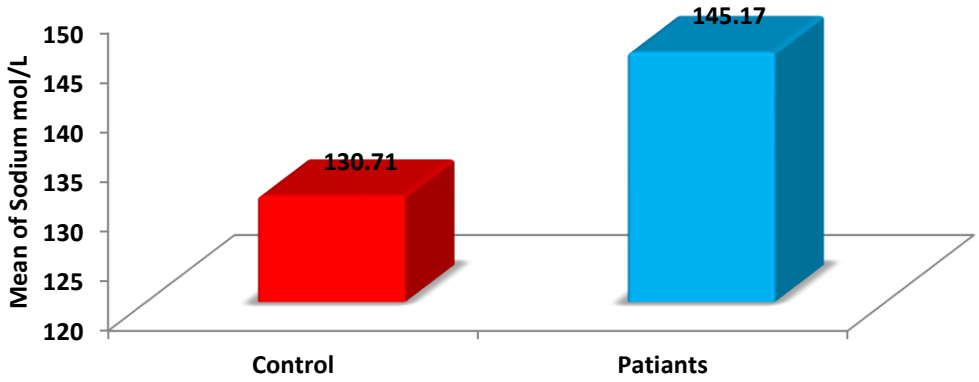

Figure 4. Sodium in the group of patients and healthy people

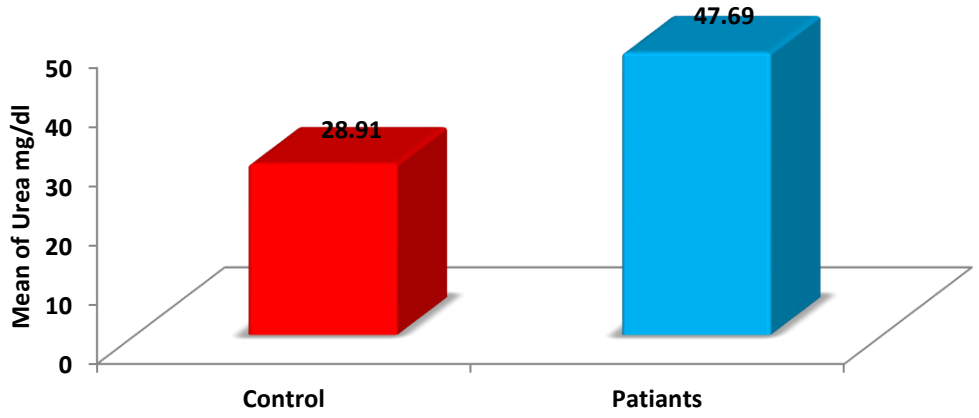

Figure 5. Urea in the group of patients and healthy people

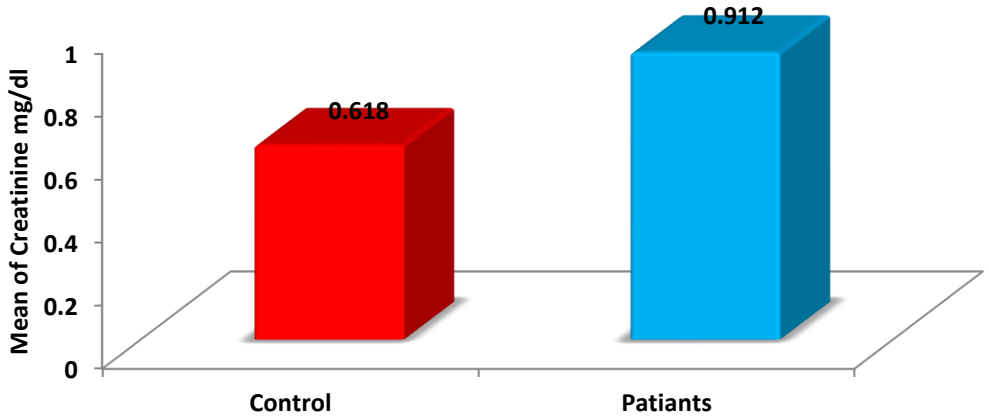

Figure 6. Creatinine in the group of patients and healthy people

Discussion:

High blood pressure is the main cause of cardiovascular disease and even premature death around the world. The prevalence of High blood pressure has increased significantly in recent years, especially in low- and middle-income countries. This increasing prevalence is attributed to many factors associated with life style and nutrition, such as eating large amounts of sodium (salt) in food, insufficient potassium in food consumed found in fruits and vegetables, which contributes to regulating blood pressure. Obesity, large alcohol consumption, physical inactivity, and unhealthy nutrition are also factors that increase the possibility of high blood pressure [19] .

Iron deficiency negatively affects the health of the mother and the fetus, as it is linked to increased rates of disease and fetal death. Affected mothers often suffer from breathing difficulties, fainting, fatigue, palpitations, and difficulties sleeping. The deficiency might caused because many may be that many mothers can go through pregnancy without Meet their body's iron needs through food [20] . The results of this study were consistent with the results of the study of Rohilla et al [21] . It has been noted that there is a relationship between iron deficiency and gestational high blood pressure and the occurrence of its disorders leading to preeclampsia, and gestational high blood pressure may interfere with iron metabolism in the placenta, which may increase the risk of anemia in children [22] . As for magnesium, it is a mineral that is naturally present in the body and is also found in the foods that we eat daily. Magnesium plays an important role in many body functions, including protein formation, bone health, blood pressure control, and nervous system functions [23] . Whereas the results of the current research showed a significant increase in the serum of pregnant women with high blood pressure compared to the control group, the results of our study agree with the results of (Zhang) et al [24], In their study, they indicated that there is a relationship between high blood pressure during pregnancy and changes in magnesium levels in the body. In addition, there are studies that indicate a link between magnesium intake and deaths resulting from cardiovascular diseases in non-pregnant women, as it works to reduce the risk of these diseases. In addition, the reason for the high level may be due to taking nutritional supplements containing magnesium to reduce The danger of high blood pressure.

The increase in the level of potassium in patients with high blood pressure may be due to their consumption of supplementary foods that contain potassium among their components, as potassium is the ion found in abundance within cells in the body, as it regulates blood pressure, as nutritional supplements that contain potassium It can lower blood pressure in normal and hypertensive patients, as potassium channels, along with Na-K ATPase, also known as the Na Pump, are essential in determining resting membrane potential and cell size, since the potassium concentration is much higher in the medium. Inside cells rather than outside cells, and that the activation and successive opening of potassium channels leads to hyperpolarization in the plasma membrane, thus, changing the electromotive force for Na reabsorption in the distal nephron of the kidneys, and this is consistent with the results of the current study [25] .

Persistent hypokalemia was common among patients with high blood pressure and was associated with increased mortality from cardiovascular diseases, and correcting hypokalemia by increasing its input to the body was linked to increased chances of survival [26] .

In addition, Sodium showed a significant increase, and this increase is positively associated with an increased risk of hypertensive disorders during pregnancy. The relationship between sodium consumption and high blood pressure is well known, as consuming large amounts of sodium can negatively affect the control of high blood pressure, as most guidelines recommend a dose of 2 grams of sodium per day. However, it was found that most individuals consume approximately twice this recommended daily dose, and this is what the results of the current study agree on [27]. Sodium is an essential chemical element and plays a critical role in several processes in the body, including transport in cellular membranes. Water balance in the body and muscle contraction. Sodium is the most abundant extracellular cation. Sodium can be found in many food sources such as salt, processed foods, meat, milk, eggs, and vegetables [28].

Kidney functions include urea and creatinine, as the concentration of urea in the serum indicates the balance between the production of urea in the liver and its excretion through the kidneys in the urine. The reason for the high concentration of urea in the plasma may be due to increased urea production, decreased elimination, or a combined effect of the two , A high glomerular filtration rate (GFR) indicates a decrease in kidney function, and it is an important indicator of kidney health, as there is a close connection between the glomerular filtration rate and the condition of the kidneys, as a low GFR is linked to chronic kidney problems [29].

Creatinine is considered an independent risk factor for the development of high blood pressure disorders during pregnancy. As for non-pregnant women who suffer from high blood pressure, they appear to have creatinine levels similar to the normal range. There may be a decrease in creatinine clearance, but clinical symptoms have not yet appeared, as it has been observed that a high mortality rate is observed in patients with cardiovascular disease who suffer from dysfunction Chloe [30]. The result of high creatinine levels in pregnant women with blood pressure is consistent with the results of the study of Rajdev et al [31].

In addition, high creatinine levels usually indicate a defect in kidney function. Possible causes of high creatinine may be attributed to glomerulonephritis, the presence of kidney stones blocking the urinary tract,

and the occurrence of kidney failure. In addition, There are other factors that can temporarily raise blood creatinine levels, such as pregnancy, dehydration, and consuming large amounts of protein from food or nutritional supplements. There are some medications that can temporarily increase blood creatinine levels or lead to kidney damage. In addition, some conditions such as diabetes, high blood pressure, and heart disease can cause kidney damage and increase creatinine levels [32].

4. CONCLUSION

The findings of this study confirm the initial hypothesis presented in the Introduction, demonstrating a clear alignment between expected and observed outcomes. The Introduction posited a critical link between essential mineral imbalances, kidney dysfunction, and hypertensive disorders in pregnancy, which was substantiated in the Results and Discussion. Specifically, pregnant women with hypertension showed significantly lower serum iron levels, elevated magnesium, potassium, and sodium levels, and impaired kidney function compared to normotensive controls.

This study provides a foundational clinical profile that can inform prenatal care protocols. The consistent pattern of mineral dysregulation and renal impairment suggests that routine monitoring of these parameters may enable early risk identification and management in hypertensive pregnancies.

Future longitudinal research is recommended to clarify the causal relationships and trimester-specific progression of these biomarkers. Investigating targeted interventions—such as controlled mineral supplementation, dietary adjustments, and renal protective strategies—could help translate these findings into clinical practice. Expanding the research to include broader populations, distinct hypertensive subtypes (e.g., preeclampsia), and underlying molecular mechanisms would further enhance the applicability and impact of these results on maternal and neonatal health outcomes.

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