Role of Biochemical Parameters on Hypertension in Pregnant Females

Jipi Varghese[1], Corrien Van Belkum[2], Samia Khan[3], Maryam Ranta[4], Alishba Talpur[5], Nadine N. Abdelhadi[6], Maryam Khalid[7*], Elhaga Ibrahim Eldesouky Mohamed[8]

1. Assistant Professor, College of Health Sciences, Department of Nursing, University of Fujairah, Fujairah, UAE.
2. Dean Associate Professor, College of Health Sciences, Department of Nursing University of Fujairah, UAE
3. Simulation Center Specialist, College of Health Sciences Department of Nursing University of Fujairah UAE
4. Abbasi Shaheed Hospital (Karachi Metropolitan University), Pakistan
5. Isra University, Hyderabad, Pakistan
6. PhD, Department of Clinical Pharmacy and Pharmacy Practice. Faculty of Pharmacy, Aqaba University of Technology, Jordan.
7. Senior Lecturer Medical Lab Technology Department, Iqra University, Chak Shahzad Campus, Islamabad, Pakistan*
8. Associate Professor in Medical Surgical Nursing, Nursing Faculty, Isra University Jordan, Assistant Professor in Medical Surgical Nursing, Porsaid University

*Corresponding author's email: maryamkh191@gmail.com

KEYWORDS
Serum calcium, uric acid, TSH, pregnancy-induced hypertension (PIH).

ABSTRACT
Pregnancy is a physiological state that involves significant alterations in metabolic, biochemical, physiological, and hematological processes. Pregnancy-induced hypertension (PIH) includes a spectrum of disorders ranging from mild hypertension to severe multi-organ failure. This study aims to investigate the biochemical and demographic variables in pregnant women who are more than 20 weeks' gestation. Additionally, it seeks to compare the biochemical parameters of patients with pregnancy-induced hypertension to those of normotensive subjects. The study comprised 160 participants, with 80 women classified as hypertensive and 80 as normotensive. Serum levels of calcium, uric acid, and thyroid-stimulating hormone (TSH) were assessed in both groups. Demographic and biochemical parameters were analyzed using the t-test, considering a p-value of <0.05 as statistically significant. The levels of serum calcium, uric acid, and TSH were measured using spectrophotometry and ELISA techniques. The results revealed a statistically significant reduction in serum calcium levels among hypertensive women compared to their normotensive counterparts. In contrast, the hypertensive group exhibited higher levels of uric acid and TSH relative to the normotensive group. Our findings indicate significant differences in serum calcium, uric acid, and TSH levels between the two groups. Although these factors may not directly influence the development of PIH, their interrelationship should not be overlooked. Further research into the underlying pathological mechanisms associated with PIH could improve diagnostic capabilities in future studies

INTRODUCTION

Pregnancy is a physiological state that involves significant alterations in metabolic, biochemical, physiological, and hematological processes. These changes are typically reversible and occur within days to months after delivery if there are no complications (1). The transition to parenthood during pregnancy necessitates adequate perinatal care, guidance, and knowledge, as the postpartum phase presents considerable challenges for mothers due to both physical and psychological changes (2). Pregnancy, also referred to as gestation, is the period during which an embryo develops within the mother's uterus. It begins with the fertilization of an ovum by a spermatozoon, resulting in the formation of a zygote. The average gestational period lasts approximately 40 weeks and is divided

into three trimesters (3). This developmental phase is crucial and influenced by various genetic and environmental factors that can impact an individual's life positively or negatively (4). The first trimester starts from conception and lasts until the 12th week. During this time, the fertilized egg undergoes cell division and implants into the uterine lining as a blastocyst. By the end of this trimester, many organs have begun to form, and the embryo transitions into a fetus measuring about 2.5 cm in length (5). The second trimester marks significant fetal development, including the fusion of eyelids and the appearance of eyebrows and lashes. By its conclusion, the fetus typically measures between 13 to 16 inches long. The third trimester is critical for maternal care as the fetus changes position in preparation for delivery. During this stage, prenatal visits become more frequent as the mother's body adapts to accommodate the growing baby (6). While pregnancy is often viewed as a joyful experience, it can also present numerous complications that threaten both maternal and fetal health.

Common complications include pre-eclampsia and eclampsia, miscarriage, hemorrhage, infections (such as urinary tract infections and sexually transmitted infections), gestational hypertension, vaginal bleeding, and preterm labor. Adequate perinatal care, nutrition, exercise, and emotional support are essential for ensuring the well-being of both mother and child. Pregnancy-induced hypertension (PIH) is one such maternal condition that adversely affects both mother and fetus. This disorder is associated with high morbidity and mortality rates and is often observed in first-time pregnancies or among women carrying multiples or those with a history of hypertension. The World Health Organization estimates that complications related to pregnancy-induced hypertension claim one woman's life every seven minutes (7). PIH encompasses a spectrum of conditions ranging from mild hypertension to severe multi-organ dysfunction. Early detection and management of PIH are critical to preventing life-threatening complications. PIH is characterized by elevated blood pressure readings of 140 mmHg or higher after 20 weeks of gestation, often accompanied by proteinuria. Each case presents unique histories and progression paths that complicate treatment outcomes. The occurrence of PIH is influenced by multiple factors beyond a single pathological event; placental dysfunction plays a significant role in its development (8). Research indicates that women with elevated blood pressure prior to or during early pregnancy are at higher risk for developing gestational hypertension and pre-eclampsia. Globally, PIH affects approximately 5-10% of pregnancies and remains one of the most common yet least understood disorders encountered during pregnancy. Its incidence is notably higher in developing countries where access to healthcare may be limited (9). Understanding the complexities surrounding pregnancy-induced hypertension is vital for improving maternal-fetal health outcomes. This study aims to further investigate these relationships by examining biochemical markers associated with PIH.

METHODOLOGY

This study utilized a cross-sectional design to assess the biochemical and demographic variables in pregnant women. A total of 160 participants were included, with 80 hypertensive women and 80 normotensive women. Participants were selected using a non-probability purposive sampling technique. The research was conducted at Amjad Naeem Hospital, Rawalpindi, over a period of six months following approval from the research board. The inclusion criteria for the study were females aged 18-40 years, pregnant women beyond 20 weeks of gestation with blood pressure readings greater than 140/90 mmHg, and those with normal blood pressure readings. The exclusion criteria included multiple gestations, patients in active labor, individuals with hepatic, renal, or cardiovascular diseases, and those with known chronic hypertension. Approximately 5 mL of venous blood was collected from each participant in red-top vials for the estimation of serum calcium, uric acid, and thyroid-stimulating hormone (TSH). Blood samples were allowed to clot, and serum was separated by centrifugation at 5000 rpm for five minutes. Questionnaires were used

to collect demographic data such as age, weight, gestational age, miscarriage history, and health status. Serum calcium levels were measured using the fully automated Selectra, based on spectrophotometry principles governed by Beer's Law. Uric acid levels were also analyzed using the same machine and principle. TSH levels were determined using a BECKMAN COULTER analyzer employing the ELISA approach. This method utilizes TSH-specific antibodies to detect and quantify the hormone in the sample. Data analysis was performed using SPSS statistical software and Graph Pad Prism 9. The dataset was checked for missing values and outliers before analysis. Descriptive statistics such as mean, standard deviation, and frequency distributions were computed for age, gestational age, and biochemical variables (serum calcium, uric acid, TSH). Biochemical variables of hypertensive and normotensive women were compared graphically to illustrate their relationships. An independent sample t-test was conducted to calculate p-values and determine statistical significance.

RESULTS

The present study comprises of 80 normotensive women having means age of 28.712±3.218 years and 80 hypertensive women with mean age 30.48±3.9118 as shown in the table 2. The lowest and highest value of calcium among hypertensive women was 5.03-10.2mg/dl and 40% were in the range of 8.03-9.02 Showing peak value of calcium was between 8.03-9.02. The lowest to highest limit of uric acid of hypertensive women was 5.21-8.34.and 43% were in the range of 6.21-7.21mg/dl. The lower to upper limit of TSH was 1.98-3.56mU/L 34% were in range of 2.48-2.98 showing peak value of TSH was between 2.48-2.98. In our study, we investigated the relationship between age and gestational age in hypertensive and normotensive groups. The average age of participants in the hypertensive group was 28.96 years (± 4.26 years), while in the normotensive group, it was 29.98 years (± 4.19 years). Additionally, the average gestational age in the hypertensive group was 32.32 weeks (± 3.08 weeks), whereas in the normotensive group, it was 33.34 weeks (± 3.06 weeks). These findings suggest that there is a slight difference in age and gestational age between hypertensive and normotensive groups, with the normotensive group having slightly higher average age and gestational age compared to the hypertensive group. Next the relationship of blood pressure in hypertensive and normotensive women. Systolic (106 ±10.4) and diastolic blood pressure (101±8.14) showed a significant increase (P 0.01) in hypertensive women as compared to normotensive women. In comparing serum calcium, uric acid and TSH between hypertensive and normotensive women significant differences were observed. Serum calcium showed a notable increase in normotensive women (8.868±1.12mg/dl) as compare to hypertensive women (7.953±1.16mg/dl). Uric acid level significantly rose (P 0.001) in hypertensive women (6.826±0.76mg/dl) as compared to normotensive women (4.766±0.95mg/dl). However, in terms of TSH level, there was a significant increase (P 0.001) in hypertensive women (2.842±0.37) as compared to normotensive women.

Table 1 Demographic features of study population

Parameters		**Hypertensive**	**Normotensive**
Gravity	**Primigravida**	10%	12%
	Multigravida	90%	88%
Miscarriage History	**None**	15%	71%
	(2-4)	85%	29%
Socioeconomic Status	**Poor**	75%	28%
	Middle	25%	60%
	High class	0%	12%
Supplementa	**Regular**	30%	60%

ry calcium intake	**Irregular**	70%	40%
Past history of PIH		10%	3%
Family history of PIH		20%	6%
Period of gestation	**(25-30)**	33%	41%
	(30-35)	60%	51%
	(35-40)	7%	8%

Table 2 Comparison of parameters in Hyper and normotensive women

Parameters	**Hypertensive (N=80)**	**Normotensive (N=80)**	**p-value**
Age (Years)	28.9 ± 4.26	29.9 ± 4.19	0.241
Gestational Age	32.3 ± 3.08	33.3 ± 3.06	0.833
Blood pressure (Diastolic)	100.6±8.14	105±7.91	<0.01
Blood pressure (Systolic)	150±10.4	70.5±7.8	<0.01
Calcium (mg/dl)	7.95±1.16	8.86±1.12	< 0.001
Calcium (mg/dl)	7.95±1.16	8.86±1.12	< 0.001
TSH (mIU/L)	2.84±0.37	2.28±0.99	< 0.001

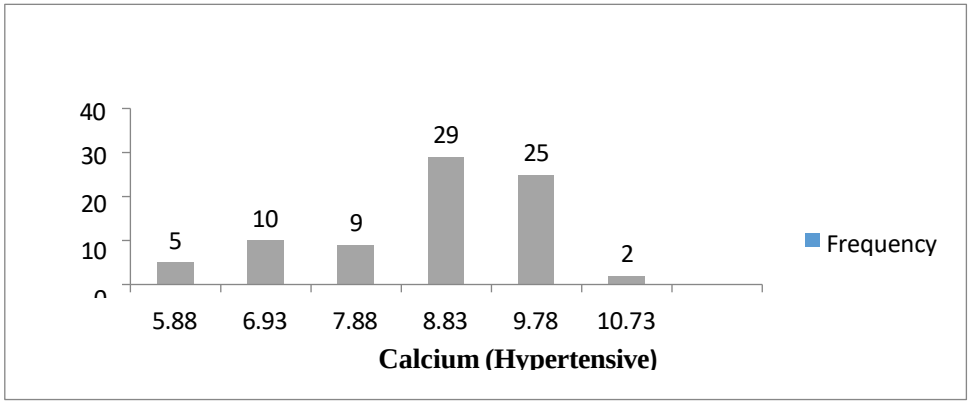

Figure: 1 Calcium level in Hypertensive women

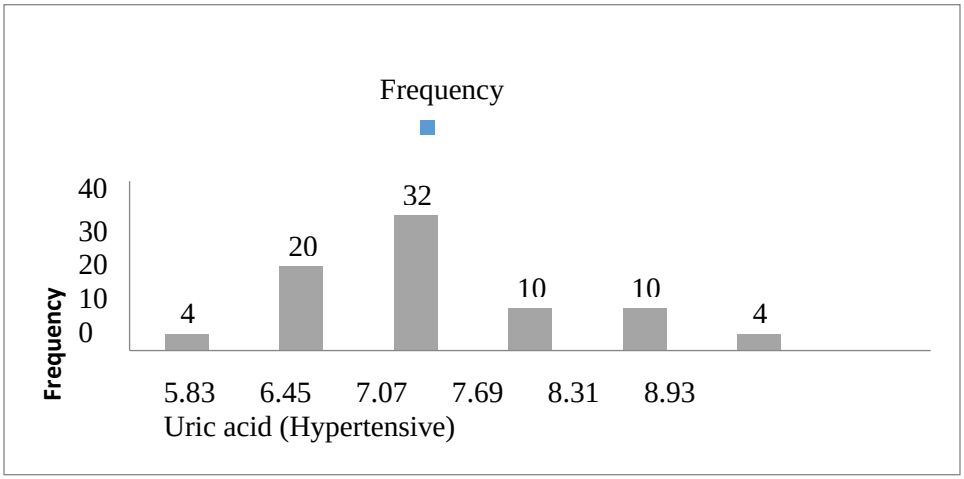

Figure 2 Uric acid level in Hypertensive women

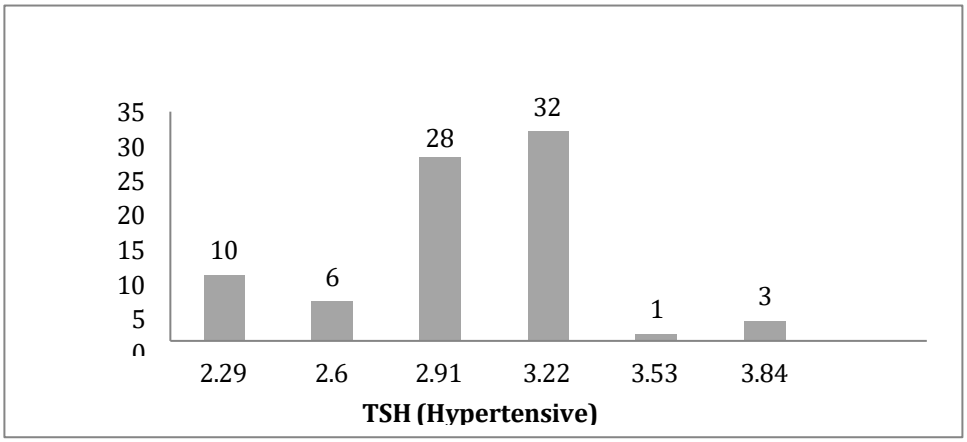

Figure 3 TSH level in Hypertensive women

DISCUSSION

The findings of this study provide significant insights into the biochemical differences between hypertensive and normotensive pregnant women, emphasizing the potential role of serum calcium, uric acid, and thyroid-stimulating hormone (TSH) in pregnancy-induced hypertension (PIH). The results demonstrated statistically significant differences in these parameters, highlighting their potential as markers for identifying and managing hypertensive disorders during pregnancy. The average age and gestational age of hypertensive women were slightly lower than those of normotensive women. While the difference was not substantial, it aligns with previous studies suggesting that younger maternal age and shorter gestational periods may be associated with hypertensive complications during pregnancy (1). This supports the hypothesis that early identification of at-risk individuals could improve maternal and fetal outcomes. A significant reduction in serum calcium levels was observed among hypertensive women compared to normotensive women. This finding is consistent with prior research indicating that hypocalcemia may contribute to increased vascular resistance, leading to elevated blood pressure (2). Calcium plays a vital role in vascular smooth muscle contraction and relaxation, and its deficiency has been linked to impaired endothelial function. The peak calcium levels observed in normotensive women suggest that adequate calcium intake during pregnancy may help mitigate the risk of developing PIH. These results underscore the importance of calcium supplementation as a preventive measure for hypertensive disorders in pregnancy. Conversely, uric acid levels were significantly elevated in hypertensive women compared to normotensive women. Elevated uric acid is a well-established marker of oxidative stress and endothelial dysfunction, both of which are critical factors in the pathogenesis of PIH (3). The peak uric acid range observed in 43% of hypertensive participants further supports its role as a potential biomarker for hypertension during pregnancy. This finding aligns with previous studies that have highlighted hyperuricemia as an early indicator of preeclampsia and other hypertensive disorders (4). Monitoring uric acid levels could aid in the early detection and management of PIH.

TSH levels were also significantly higher in hypertensive women compared to normotensive women. Thyroid dysfunction has been implicated in adverse pregnancy outcomes, including preeclampsia and gestational hypertension (5). Elevated TSH levels may indicate subclinical hypothyroidism or thyroid dysregulation, which can exacerbate vascular dysfunction during pregnancy. The observed peak TSH values among hypertensive participants highlight the need for routine thyroid function testing as part

of prenatal care for high-risk pregnancies. Addressing thyroid imbalances through appropriate interventions could potentially reduce the severity of hypertensive complications. The significant differences observed in serum calcium, uric acid, and TSH levels suggest that these biochemical parameters may serve as valuable tools for identifying pregnant women at risk for PIH. While these factors alone may not directly cause PIH, their associations with hypertension during pregnancy cannot be overlooked. Further research is warranted to explore the underlying mechanisms linking these parameters to PIH development and progression. This study highlights the importance of monitoring serum calcium, uric acid, and TSH levels in pregnant women as part of routine prenatal care. Early identification of abnormalities in these parameters could facilitate timely interventions to prevent or manage PIH effectively. Future studies should focus on larger cohorts and longitudinal designs to validate these findings and explore their diagnostic utility further.

CONCLUSION

It is concluded that in Pakistan, hypertensive disorders of pregnancy are associated with significant alterations in serum calcium, uric acid and TSH levels. Through these factors during pregnancy cannot be pin pointed as risk factors for development of PIH but their relationship cannot be denied. This may help to investigate underlying pathological process of PIH in future projects for diagnostic utility**.**

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