

Pregnant Women with Type 2 Diabetes Mellitus and Hypertension: A Physiological Overview

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Abstract

Background: Diabetes is one of the most common medical complications of pregnancy and it carries significant risk for the fetus and the mother. **Objectives:** This study includes hematological variables on type 2 diabetes mellitus (T2DM) in pregnant women that rely on insulin intake. **Materials and Methods:** In this study, there are 60 pregnant individuals with insulin-dependent T2DM and severe hypertension (HTN). In the governorate of Erbil, patients are seen in the medical labs of the Layla Qasim Center, Maternity Hospital, and Rizgary Teaching Hospitals. The control group consists of 20 healthy women. **Results:** The results demonstrate that pregnant women with diabetes, who are dependent on insulin intake, have a mean systolic blood pressure measurement of 153.8 ± 0.11 mm Hg, which is significantly higher than that of the control group. Blood levels of random glucose are significantly linked with HTN. Females with diabetes have a tiny bit fewer red blood cells (RBCs) than females without the disease. The hemoglobin (Hb) levels of pregnant patients with T2DM diabetes revealed lower levels compared to nondiabetic female group. Estimated sedimentation rate (ESR) levels are greater in T2DM than in the control group. The white blood cell (WBC) count is significantly higher in pregnant women with T2DM, particularly in the monocyte subtype of leukocyte, which exhibits a significantly elevated level. However, there is no difference observed in the proportion of high-type neutrophils in diabetes pregnant patients. The lymphocytes of pregnant T2DM patients who are dependent on insulin consumption do not demonstrate any relevance. **Conclusion:** Patients with hyperglycemia dramatically changed their total and differential leukocyte counts. This outcome was caused by an acute infection. Females with diabetes have fewer RBCs than those in the control group. High significance correlation exists between HTN and random blood glucose levels.

Keywords: Complete blood count, hypertension, pregnant women, type 2 diabetes mellitus

INTRODUCTION

Diabetes is a chronic disease that occurs when the pancreas does not produce enough insulin, or alternatively, when the body cannot effectively use the insulin it produces. Insulin is a hormone produced in the pancreas that allows glucose resulting from the breakdown of food to enter the body's cells, where it is converted into energy needed by muscles and tissues to function. Diabetes increases the risk of heart disease and stroke. Fifty percent of people with diabetes die of cardiovascular disease, primarily heart disease and stroke. In addition, diabetes is among the leading causes of kidney failure.^[1]

Diabetes in pregnancy is a serious condition that is unique to women because of its potential to affect the

health of both the mother and her unborn child.^[2,3] The reason for the lack of insulin or the low level of secretion is due to a faulty immune system response, one that revolves around destroying the beta cells of the pancreatic islets of Langerhans; these cells are specialized in making the insulin hormone, and are acted upon by the faulty immune system as if they were foreign antigens.^[4]

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Type 1 diabetes occurs when the immune system mistakenly attacks and kills the beta cells of the pancreas. Type 2 diabetes occurs when the body cannot properly use the insulin that is released or does not make enough insulin. Type 2 diabetes more often develops in adults, but children can be affected. In this situation, the pancreas is not making enough insulin or there is insulin resistance whereby the cells that are normally targeted by insulin show a decreased response to insulin.^[5] A third type of diabetes, gestational diabetes, is a temporary condition that occurs during pregnancy and involves an increased risk of developing diabetes for both mother and child.^[6] The condition arises because the action of insulin is blocked, probably by hormones produced by the placenta.^[7]

Sometimes people are diagnosed with diabetes; they have developed complications such as the eye damage known as retinopathy, due to an effect of diabetes on small blood vessels (microvascular disease).^[8] Hypertension (HTN) is present in more than 50% of patients with diabetes mellitus (DM) and significantly contributes to both micro- and macrovascular diseases in DM.^[9] Indeed, the risk for cardiovascular disease is fourfold higher in patients with both DM and HTN as compared to the normotensive nondiabetic controls.^[10,11]

Type 2 diabetes is a heterogeneous disorder characterized by two interrelated metabolic defects: weight loss and physical activity, and some medications are thought to improve both insulin sensitivity and secretion.^[12] In contrast, a recent analysis of the National Health and Nutrition Examination Survey (NHANES) 1999–2008 data revealed that the Erbil-Iraq populations, who have a high prevalence of DM, have a lower risk of coexistent uncontrolled HTN and DM when compared with Baghdad-Iraq and Caucasian participants.^[13] Currently, limited data are available on the incidence of coexistent HTN and DM among Asians in the United States.^[14,15] Women with diabetes are at much greater risk for heart disease than the nondiabetic population or men with diabetes. Many scales have been developed to assess the quality of life among DM patients, but unfortunately, none can be considered the gold standard.^[16]

Type 2 DM (T2DM) is considered an inflammatory disease because inflammation can trigger the insulin signaling, assumingly by promoting beta cell death.^[17,18] A few studies have been conducted on the relationship between blood parameters and blood sugar levels in pregnant women with HTN. Therefore, this study was conducted on insulin-dependent DM (IDM) patients in Erbil city.

MATERIALS AND METHODS

Patient's selection

This study involves 60 people with gestational diabetes who are IDM. All of the patients who suffer from diabetes and severe HTN are from various neighborhoods in

Erbil. The medical labs at the Layla Qasim Center, Maternity Hospital, and Rizgary Teaching Hospitals in the governorate of Erbil performed the complete blood count (CBC) and the glucose test. A properly sized cuff should be used to take the patient's upper arm blood pressure while they are seated. The patient should be at rest for at least a few minutes. A second reading of the blood pressure, taken at least 20 min later or even separately, should be used to corroborate the initial value. The HTN, which is considered when blood pressure readings are at least 140/90 mm Hg, should be recorded occasionally. A 20-min interval, or possibly longer, should be allowed between the blood pressure readings to ensure accuracy when compared with another reading.

Control samples

Before comparing the random blood sugar (RBS) measures for pregnant patients with DM and their blood parameter measurements, 20 healthy females were randomly chosen to serve as the nondiabetic control group in this investigation.

CBC examination of hematological and immunological parameters

A CBC was performed according to standard protocol. List the integers for various significant values. Normally, it contains every blood component. Some of these blood parameters were used in the analysis of the data to see if there was any correlation between them and the blood sugar levels of female patients with DM who were taking insulin and had high blood pressure.

RBS, which is the most discreet method of checking blood sugar, is used for this study's glucose levels and diabetes screening blood tests. Patients who were pregnant had their blood taken from a vein, generally on the wrist or elbow. According to hospital records, the majority of the patients were pregnant women with T2DM and HTN issues.

Systolic blood pressure, which is used to calculate blood pressure, measures the pressure in blood vessels during the heartbeats. The heart muscle is contracting (squeezing) and pumping oxygen-rich blood into the blood vessels. Blood pressure is measured using a mercury sphygmomanometer. The diastolic blood pressure gauges the pressure in the blood arteries between heartbeats. It represents the pressure on the blood vessels when the heart muscle relaxes. The study's initial metric was taken into account. When taking more significant measures in this study, a value more than 140 mm Hg is regarded as HTN in pregnant women with DM who depend on daily insulin ingestion. Different parameters are determined using the auto analyzer, the hematological analyzer, and other relevant instruments.

Statistical analysis

Analysis employing frequency increasing and decreasing in amount of blood parameters in accordance with the standard level for the normal samples measurements in the control group was used to statistically assess all data. Application of statistical analysis based on the correlation between those with high blood pressure and a healthy group and those with blood sugar levels (diabetic mellitus reliant on insulin). The Statistical Package for Social Sciences program was used to statistically analyze the collected data.

Ethical consideration

The study was conducted in accordance with the ethical principles that have their origin in the Declaration of Helsinki. The study was conducted after obtaining verbal and written consent from the patients before samples were taken. The study protocol, the patient information, and consent form were reviewed and approved by the Ethics Committee of Hawler Medical

University under the permission number: HMU-PH-EC 170325-2021.

RESULTS

Daily subcutaneous insulin administration and high blood sugar levels in patients with T2DM are associated with high blood pressure in certain groups, including patients, pregnant women, and healthy women. The diagram from this study [Figure 1] makes this evident.

RBS values in pregnant female patients with diabetes average 186.96 ± 3.27 mg/dL compared to 102.50 ± 1.74 mg/dL in nondiabetic females (control) [Tables 1 and 2 and Figure 1]. It is very significant, with a *P* value of 0.000, that the random blood glucose count is greater in diabetic female patients [Table 2].

The minimum 140 mm Hg is the systolic blood pressure of HTN. The result shows that the mean of systolic measurement for 60 diabetic pregnant women, who rely on insulin intake, is 153.8 ± 0.11 mm Hg [Table 1 and Figure 1],

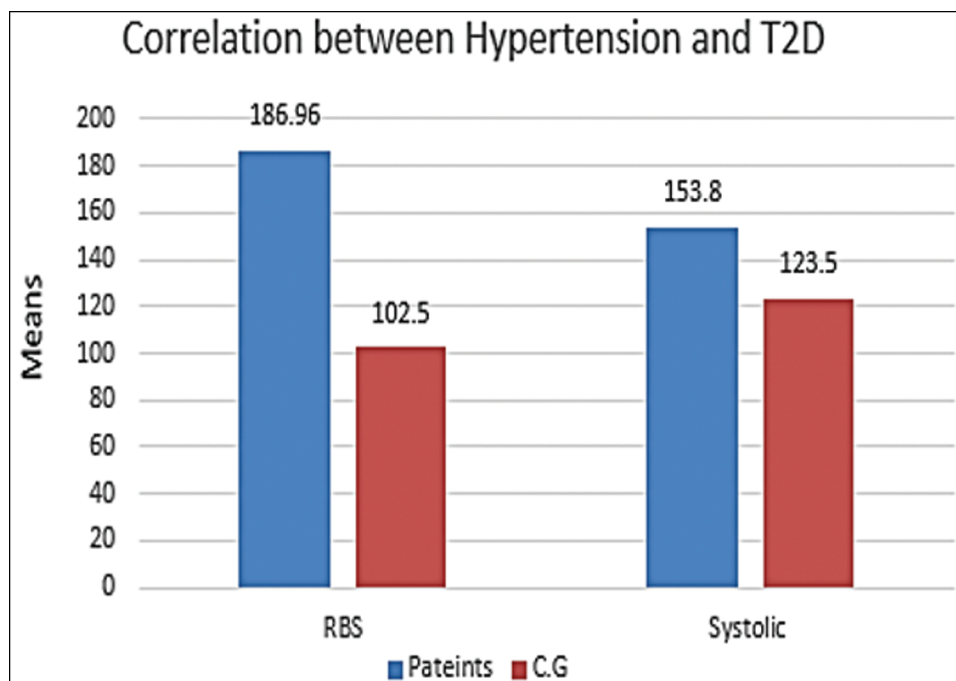


Figure 1: The relationship between type 2 diabetes and HTN (mmHg) in pregnant patients and the control group

Table 1: The mean blood pressure and type 2 diabetes in relation to several blood parameters in both pregnant women patients (T2DM) and control groups

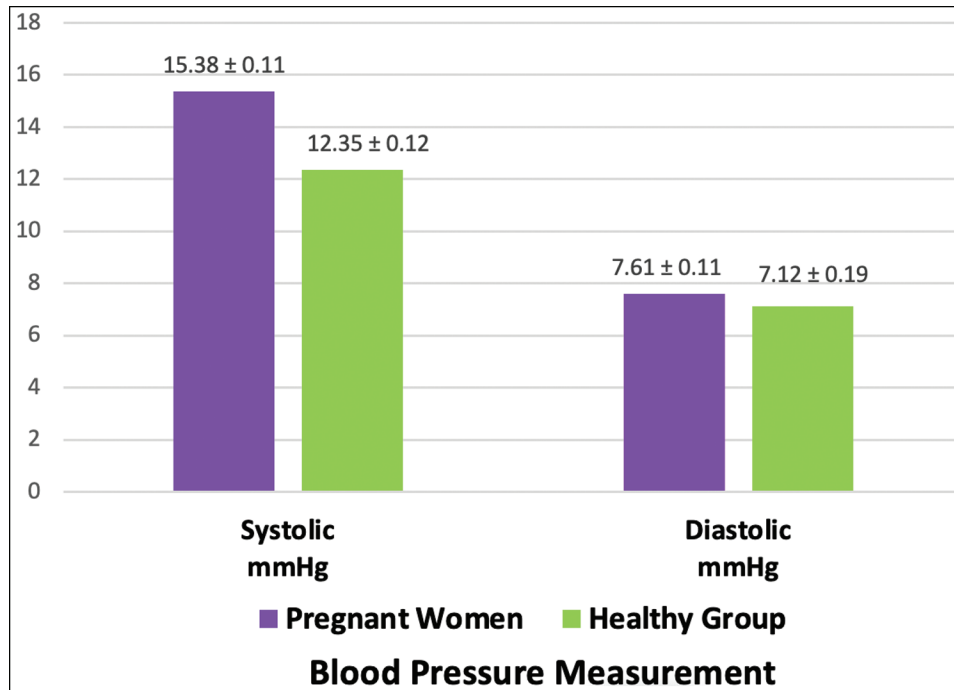
	Level of blood sugar	HTN		RBC			WBC			
		Diastolic (mmHg)	Systolic (mmHg)	No. RBC/ 10^3	Hb (%)	ESR	Total/UL	Neutrophil (%)	Lymphocyte (%)	Monocyte (%)
T2DM	186.96 ± 3.27	7.61 ± 0.11	15.38 ± 0.11	4.03 ± 0.07	11.25 ± 0.25	12.13 ± 0.94	9.24 ± 0.32	54.91 ± 0.78	29.57 ± 0.54	3.50 ± 0.26
Control group	102.50 ± 1.74	7.12 ± 0.19	12.35 ± 0.12	4.26 ± 0.09	12.03 ± 0.24	7.45 ± 0.95	7.62 ± 0.32	52.63 ± 0.97	28.10 ± 1.08	1.98 ± 0.26

ESR: estimated sedimentation rate, T2DM: type 2 diabetes mellitus, HTN: hypertension, RBC: red blood cell, UL: microliter, WBC: white blood cell, Hb: hemoglobin

Table 2: The correlation between the RBS level in pregnant patients and the control using the *t* test, probability, and level of significance

Hematological parameter	No.	Pregnant women (mean \pm SE)	No.	Control group (mean \pm SE)	<i>t</i> test <i>P</i> value	<i>P</i>
RBS (mg/dL)	60	186.96 \pm 3.27**	20	102.50 \pm 1.74	0.000	HS**

RBS: random blood sugar, SE: standard error, *P*: probability, ***P* < 0.05: significant; ****P* < 0.01: highly significant

**Figure 2:** Systolic and diastolic measurements in the insulin intake and control groups for pregnant women with DM

which is highly significant. The HTN is significantly correlated with the blood glucose level, yielding a mean of 186.96 ± 3.27 g/dL for the same patients.

A systolic blood pressure of at least 140 mm Hg or a diastolic blood pressure of at least 90 mm Hg is considered to be HTN. Figure 2 compares the systolic blood pressure measurements for diabetic patient pregnant women and nondiabetic controls to highlight the differences between the two. With the primary measurement at 15.38 ± 0.11 mm Hg in the patient group and 12.35 ± 0.12 in the control group, the values are extremely significant.

Figure 2 compares pregnant diabetic patients with nondiabetic women who had their diastolic blood pressure measured to be at least 90 mm Hg in each case. The major measurement is marginally significant at 7.61 ± 0.11 mm Hg in the patient group and 7.12 ± 0.19 in the control group.

Females with diabetes have fewer red blood cells (RBCs) than females without the disease. Females without diabetes have a RBC count of $4.26 \pm 0.09 \times 10^6$ mm³, whereas diabetic females have a RBC count of $4.03 \pm 0.07 \times 10^6$ mm³ [Figure 3]. However, this fluctuation in the overall statistics is meaningless.

Patients with diabetes who are expecting have a lower hemoglobin (Hb) count compared to nondiabetic patients. Figure 3 shows that the Hb count in diabetes patients is 11.25 ± 0.25 g/dL, as opposed to 12.03 ± 0.24 g/dL in nondiabetic patients. The RBC count in female patients compared to control group showed a marginally significant level of relevance.

Females with diabetes experience a count of roughly 12.13 ± 0.94 mm/h, compared to nondiabetic females' 7.45 ± 0.95 mm/h [Figure 3]. These findings demonstrate a high level of relevance.

When pregnant diabetic patients are compared to nondiabetic women as a control group, there is a highly significant difference in the white blood cell (WBC) count. As can be observed in Figure 4, WBCs are more prevalent in pregnant women with diabetes who take insulin, reaching about 9.24×10^3 vs. 7.62×10^3 in the nondiabetic control group.

DISCUSSIONS

Pregnancy and HTN: In the current study, 60 pregnant women who depended on insulin intake and were diagnosed with diabetes and HTN and were taking medication at

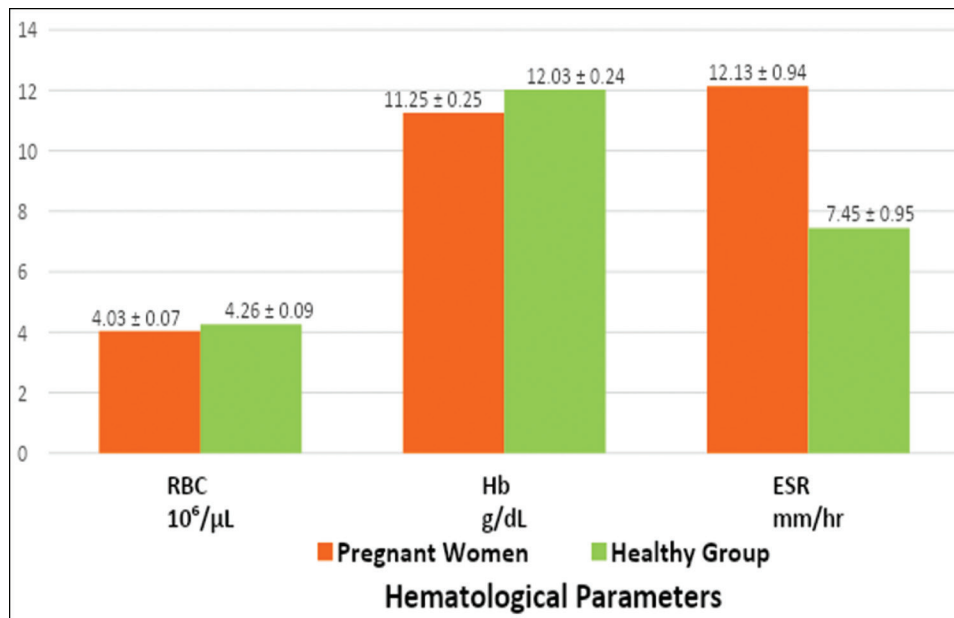


Figure 3: Measurements of RBC count, Hb, and ESR in pregnant patients with DM receiving insulin and controlling their blood sugar

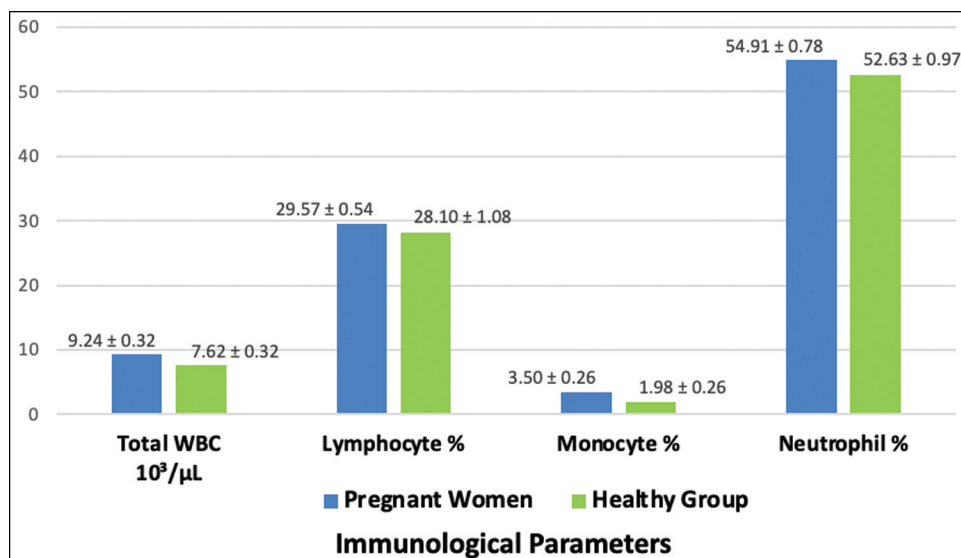


Figure 4: WBC count, lymphocyte percentage, monocyte percentage, and neutrophil percentage in pregnant women with diabetes are correlated with the control group

the Maternity, Rezgari, and Layla Qasim hospitals were used. The study compared these two risk factors to the 20 healthy women in the control group. To determine a correlation or link between these factors, some CBC blood values were added. A systolic blood pressure of at least 140 mm Hg or a diastolic blood pressure of at least 90 mm Hg is considered to be indicative of HTN.^[19]

Numerous consequences of diabetes, such as diabetic eye disease and renal disease, can be caused by high blood pressure, or it can worsen these issues.^[20-22] Most T2DM patients eventually develop high blood pressure in addition to other cardiac and circulation issues. According to this study, there is a very strong association between the two of them.

However, there is no evidence that a threshold lower than at least 115/75 mm Hg exists, despite the fact that hematological and physiological parameters are closely related to blood pressure across a larger range of blood pressure levels and diabetes. Since this effect is well documented, there is little information about the hematological and physiological events in women with rising blood pressure and newly diagnosed diabetes.^[23] Up to 10% of pregnancies worldwide are complicated by hypertensive disorders of pregnancy, which are also the main cause of morbidity and mortality in pregnant women, fetuses, and newborns.^[24]

According to the results of the current study, women with diabetes had less RBCs than women without the

disease. Females without diabetes have a RBC count of $4.26 \pm 0.09 \times 10^6 \text{ mm}^3$, whereas diabetic females have a RBC count of about $4.03 \pm 0.07 \times 10^6 \text{ mm}^3$. However, this fluctuation in the overall statistics is meaningless. The erythrocyte is a special type of nuclear cell that carries 95% of the body's supply of hemoglobin, the protein that carries oxygen from the lungs to all other parts of the body. The erythrocyte must move through the circulatory system, including the microcirculation, where it comes into contact with tiny capillary gaps and strong shear forces to carry hemoglobin and subsequently oxygen to all cells.^[25]

T2DM in pregnancy was formerly known as adult-onset diabetes, but more teenagers are increasingly developing type 2 diabetes as a result of the epidemic of fat and overweight children. T2DM is typically a less severe form of diabetes than type 1. T2DM, however, can still result in serious health issues, particularly in the tiniest blood arteries that supply the kidneys, nerves, and eyes. The risk of heart disease and stroke is also increased by T2DM. In fact, higher hemoglobin and hematocrit levels are thought to be potential risk factors for women with HTN.^[26] Those with diabetes have higher ESR counts than women without diabetes. Females with diabetes experience a count of around $12.13 \pm 0.94 \text{ mm/h}$ compared to nondiabetic females' $7.45 \pm 0.95 \text{ mm/h}$. These findings demonstrate a high level of relevance.

Possible contributors to T2DM and chronic low-grade inflammatory resistance include insulin pathogenesis. T2DM is correlated with a high WBC count, a sign of inflammation.^[27] The current study supported this assertion. The study's findings are important. When pregnant diabetic patients are compared to nondiabetic women as a control group, there is a highly significant difference in the WBC count. WBCs count in individuals with diabetes receiving insulin is around $9.24 \pm 0.32 \times 10^3$ and 7.62 ± 0.32 in controls. According to Ubeid,^[28] diabetic females have higher percentages of monocytes and neutrophils but lower percentages of lymphocytes.

However, it has been noted that WBC and other inflammatory indicators cluster in families, which clearly suggests that factors related to the immune system's activation are involved. However, it is impossible to distinguish between relatives since they share environmental factors, such as exposure to infection, in addition to genetic determinants.

Assess whether the causes of familial relationships are environmental or genetic.^[29,30] The current investigation showed that in patients with hyperglycemia, from a stable condition to ketoacidosis, the total and differential leukocyte counts were considerably affected. This outcome was caused by an acute infection that caused the total WBC and neutrophil counts to elevate to a greater extent. Clearly, increased WBC and insulin resistance indicate that the immune system is responding.

Insulin resistance has been linked to the powerful WBC differentiation factor interleukin-6 (IL-6), which is mostly generated in adipose tissue.^[31] This is corroborated by research showing an increased WBC and worse insulin sensitivity to be linked to a single-nucleotide polymorphism in the IL-6 gene.^[28]

Additionally, the statistical analysis shows no significant variations in WBCs neutrophils type between diabetic pregnant women patients and nondiabetic groups in their respective percentages of $54.91 \pm 0.78\%$ and $52.63 \pm 0.97\%$. Nearly the same proportion of insulin-dependent lymphocytes is present in nondiabetic control females as in diabetic female patients. When compared to diabetic female patients, who have a percentage of 29.57% , the proportion for healthy people is reported as $28.10 \pm 1.08\%$; statistical analysis does not reveal any relevance. In T2DM women patients, the monocyte type of leukocyte exhibits a relatively significant degree, giving $3.50 \pm 0.26\%$ compared to $1.98 \pm 0.26\%$ in nondiabetic females.

CONCLUSIONS

From a stable condition to ketoacidosis, patients with hyperglycemia dramatically changed their total and differential leukocyte counts. This outcome was caused by an acute infection that caused the total WBCs and neutrophil counts to elevate to a greater extent. The findings did demonstrate a substantial difference in the inflammatory system between diabetic and nondiabetic individuals, highlighting the significance of such a system in the body's reaction to loss of control. The number of WBCs is higher in diabetic pregnant women who take insulin. Between diabetic pregnant women patients and nondiabetic groups, WBCs of the neutrophil type exhibit a significant percentage difference. Similar percentages of insulin-dependent lymphocytes are present in diabetic female patients. The monocyte leukocyte type shows a highly significant level. Values for systolic blood pressure are significant, and there is a highly significant difference in RBS between diabetic female patients and others.

There is a statistically significant relationship between HTN and random blood glucose levels. The HTN is significantly correlated with high blood glucose levels. This study shows that the mean of systolic measurement for diabetic pregnant patient women whose insulin intake is highly significant level.

Those with diabetes had higher ESR counts than women without diabetes. According to the results of the current study, women with diabetes had a lower number of RBCs compared to women without the disease.

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Conflicts of interest

There are no conflicts of interest.

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