Iraqi Journal of Science, 2026, Vol. xx, No. x, pp: xx
DOI: 10.24996/ijs.2026.67.11.1

ISSN: 0067-2904

Impact of hyperemesis gravidarum on hematological, renal, hepatic, and electrolyte levels in pregnant women: a comparative study

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Received: 24/1/2025 Accepted: 19/2/2026 Published: xx

Abstract

Hyperemesis gravidarum (HG) is a vomiting disorder that is triggered by pregnancy and results in a drastic modification of physiological and biochemical levels in pregnant women. The purpose of this study was to evaluate the impact of HG on most physiological and biochemical variables. This comparative study included Iraqi women aged between 20 and 35 years old, in the third month of pregnancy, divided into the following groups: 50 pregnant women with HG (HG group), 50 pregnant women without HG (NGH group), and 50 non-pregnant women as the control group. Hemoglobin, urea, creatinine, GOT, GPT, ALP, complement proteins (C_3 and C_4), and electrolytes (K^+, Ca^{2+}, HCO^{3-}, Cl^- and Na^+) were measured and compared among the groups. The study findings showed a significant decrease in Hb level in the HG group in compared with that in the NHG and control groups ($p < 0.0001$). Furthermore, plasma urea and creatinine levels were higher in the HG and NHG compared to control ($p < 0.05$). All GOT, GPT, and ALP levels were significantly increased in the HG group compared with those in the NHG and control groups ($p < 0.0001$). Non-significant difference between HG group and control group in C_3 and C_4 concentration. The levels of potassium, calcium, bicarbonates, chloride, and sodium significantly reduced in the HG group as compared to the NHG and control groups. The induced results explain the adverse outcome of HG on hematological, renal, hepatic, immune, and electrolyte parameters. The parameters indicate the intensity of the ill; hence, there is a dire need to diagnose HG in early gestational weeks to implement further treatment.

Keywords: Hyperemesis gravidarum, complement proteins, electrolytes, liver function, kidney function.

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تأثير القيء الحملي على وظائف الدم والكلى والكبد ومستوى الكهارل لدى النساء الحوامل: دراسة مقارنة

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الخلاصة

فرط القيء الحملي (HG) هو حالة تقيؤ ناتج عن الحمل، ويُسبب تغيرات ملحوظة في المعايير الفسيولوجية والكيميائية الحيوية لدى النساء الحوامل. هدفت هذه الدراسة إلى تقييم تأثير فرط القيء الحملي على العديد من المتغيرات الفسيولوجية والكيميائية الحيوية. شملت هذه الدراسة المقارنة نساءً عراقيات تتراوح أعمارهن بين 20 و35 عامًا، في الشهر الثالث من الحمل، مُقسَّمات إلى المجموعات التالية: 50 امرأة حامل مصابة بفرط القيء الحملي (مجموعة HG)، و50 امرأة حامل غير مصابة بفرط القيء الحملي (مجموعة NGH)، و50 امرأة غير حامل كمجموعة ضابطة. تم قياس الهيموغلوبين (Hb)، واليوريا، والكرياتينين، وGOT، وGPT، وALP، وبروتينات المتمم (C3 وC4)، والشوارد (+K، +Ca2، −HCO3، −Cl، وNa+) ثم مُقارنتها بين المجموعات. أظهرت نتائج الدراسة انخفاضًا ملحوظًا في مستوى الهيموغلوبين في مجموعة HG مقارنةً بمجموعة NHG والمجموعة الضابطة ($P < 0.0001$). علاوة على ذلك، كانت مستويات اليوريا والكرياتينين في بلازما الدم أعلى في مجموعة HG وNHG مقارنةً بالمجموعة الضابطة ($P < 0.05$). كما ارتفعت جميع مستويات GOT وGPT وALP بشكل ملحوظ في مجموعة HG مقارنةً بمجموعة NHG والمجموعة الضابطة ($P < 0.0001$). ولم يكن هناك فرق جوهري بين مجموعة HG والمجموعة الضابطة في تركيز C3 وC4. كما لوحظ انخفاض ملحوظ في مستويات البوتاسيوم والكالسيوم والبيكربونات والكلوريد والصوديوم في مجموعة HG مقارنةً بمجموعة NHG والمجموعة الضابطة. توضح النتائج المفروضة الآثار السلبية لفرط القيء الحملي (HG) على وظائف الدم والكلى والكبد والجهاز المناعي ومستوى الكهارل. تعكس هذه المؤشرات شدة المرض؛ لذا، من المهم جدًا تشخيص فرط القيء الحملي في الأسابيع الأولى من الحمل مع متابعة علاجية أكثر.

1. Introduction

Hyperemesis gravidarum (HG) is a serious form of nausea and vomiting which takes place in the early pregnancy [1]. It is regarded as the extreme of the continuum of pregnancy-associated nausea and vomiting, which develops into a clinical issue when it causes dehydration, electrolyte imbalances[2], or weight loss which is greater than 5 percent of body weight before pregnancy[3]. Hyperemesis gravidarum typically emerges during the first trimester around the 4th to 5th week of gestation [4]. The condition was first formally described in 1956 by a panel of the American Pharmaceutical and Chemical Boards in 1956. They defined HG as persistent and uncontrollable vomiting accompanied by serious complications such as fluid and electrolyte disturbances, significant weight loss, ketosis, ketonuria, neurological issues, liver dysfunction, retinal hemorrhage, and renal damage. More recently, an international consensus has outlined the following core features of HG: symptom onset before 16 weeks of gestation, severe nausea and/or vomiting, inability to maintain normal food and fluid intake, and substantial disruption of daily functioning [1]. In contrast, NVP is a much more common and less severe condition that affects up to 70% of pregnant women [5]. Nausea and vomiting

during pregnancy is a very common condition, typically starting between the 6th and 8th weeks of gestation and often subsiding by weeks 16 to 20 [6]. While most cases are mild to moderate, more severe symptoms can lead to hospitalization, where the condition may be classified as HG, a more serious clinical diagnosis [7]. NVP symptoms have a tendency to peak between the tenth and sixteenth weeks and generally resolve without medical intervention [8, 9]. About 95% of diseases women experience nausea and vomiting before and after midday, indicating a more continuous symptom pattern [10]. Globally, the prevalence of NVP varies widely based on cross-sectional studies [11]. Amongst NVP women experiencing, symptoms were reported 40% mild, 46% moderate, and 14% severe. The incidence of HG is much lower, affecting roughly 1.1% of pregnancies [9]. Certain demographic factors have been linked to higher NVP rates. For instances, it appears to be about 40% more common among women under the age of twenty, first-time mothers, those with less than twelve years of formal education, and non-smokers [12]. Researchers have observed associations between smoking, blood cell changes, and body weight, mainly among women with obesity, which may influence the likelihood or severity of symptoms [11]. Some less consistent factors such as family income, number of previous pregnancies, and prior use of oral contraceptives may also effect the severity of NVP [13]. NVP appears to be more common and often more intense during the first trimester in women carrying multiple features than in women with singleton pregnancies [14]. Interestingly, NVP has been linked to favorable pregnancy outcomes in many studies despite the discomfort it causes. A comprehensive meta-analysis establish that women experiencing NVP had a significantly lower risk of miscarriage [15]. This suggests that NVP may reflect a hormonally robust and viable pregnancy [16]. Though, severe NVP cases are not without risk. Women with more intense symptoms may be at greater risk of complications such as intrauterine growth restriction and low birth weight, likely due to the negative impact of prolonged nausea and vomiting on maternal nutrition and hydration [17]. In addition, the complement system is a crucial component of the immune system composed of approximately 25 interacting proteins that play a role in defending the body by targeting and removing antibody-coated pathogens [18]. Some studies, including those by Hinkle and colleagues, have also noted a potential association between pregnancy loss and NVP, particularly in severe cases [10]. This study aimed to investigate the effects of HG on various physiological and biochemical parameters in pregnant women. Specifically, electrolyte levels, alterations in immunological parameters including complement system elements such as C_3 and C_4(proteins within the complement system, a crucial part of the body's immune defense) and alterations in liver and kidney functions), are alterations in the complement system.

2. Materials and Methods

This comparative study evaluated the impact of HG on physiological and biochemical parameters in Iraqi women aged between 20 and 35 years in the third month of pregnancy divided into: pregnant women with HG (n = 50), pregnant women without HG (NHG; n = 50), and non-pregnant women (n = 50). The HG group included participants with a clinical diagnosis of HG, whereas the NHG group consisted of asymptomatic pregnant women. The control group comprised healthy nonpregnant women with no underlying health conditions. Participants with chronic diseases, those on medications affecting liver or kidney function, or with a history of substance use were excluded from the study.

Blood samples were collected between October and November 2023 from Ramadi Teaching Hospital and Ramadi Teaching Hospital for Women and Children. Blood samples were analyzed for various parameters, including Hb (measured in g/dL using the cyanmethemoglobin method), renal markers (urea via enzymatic colorimetric methods and creatinine via Jaffe's kinetic method, measured in mg/dL), liver enzymes (GOT, GPT, ALP, measured in U/L using a spectrophotometer) Kits, Biosystem com. Switzerland. Complement proteins (C_3 and C_4,

measured in mg/dL by ELISA) Kits SunLong Co., Ltd.chine and electrolytes (K^+, Ca^{2+}, HCO_3^-, Cl^- and Na^+) by Electrolyte Panel Lyophilized Kit, Tianjin MNCHIP Technology Co., Ltd.chine .

IBM® SPSS® statistical software (Version 26.0; IBM SPSS, Armonk, NY, USA) was used to analyze data. A p-value < 0.05 was considered statistically significant. Descriptive and comparative analyses were conducted using one-way analysis of variance with the least significant difference test for comparisons across the three groups. Pearson's correlation coefficients were calculated to observe the linear relationships between biochemical and electrolyte parameters among the groups under study. Receiver operating characteristic (ROC) curve analyses were also performed to evaluate the diagnostic performance of significant biochemical parameters in discriminating HG from normal pregnancy (NHG). AUC, sensitivity, and specificity at optimal cutoff values Informed consent was obtained from all participants enrolled in this study, and this study was approved by the ethical approval committee (reference number 22 on 30-1-2023) of the College of Science, University of Anbar.

3. Results

3.1. Effect of hyperemesis gravidarum on hemoglobin

The results showed a decrease in the Hb in the HG group (10.3 ± 0.8) mg/dL compared with the pregnancy (NHG) and control groups (11.4 ± 2.2 and 14.1 ± 2.1) mg/dL, respectively, as shown in Table 1. Results indicated a significant difference among the three studied groups: HG group, pregnancy(NHG) and control group in Hb value where P- value < 0.0001. The results of least significant difference (LSD) showed significant differences for the HG group compared with the pregnancy (NHG) and control groups.

3.2. Effect of HG on urea

Urea concentrations among the HG, pregnancy (NHG) and control group were (25 ± 4.598, 23 ±3.699 and 28 ±4.259) mg/dl, respectively (Table 1). Results indicated a non-significant difference between the HG and control groups in urea concentration (p-value = 0.07), while a significant decrease in pregnancy (NHG) was observed compared with the control group (p-value = 0.001).

3.3. Effect of hyperemesis gravidarum on creatinine levels

The concentration of creatinine among the hyperemesis gravidarum (HG) group, pregnancy (NHG), and control groups were (0.56±0.18, 0.64±0.28 and 0.94±0.18) mg/dL, respectively (Table 1). The results indicated a significant decrease in the hyperemesis gravidarum (HG) and pregnancy (NHG) in compares with control group, where (P < 0.0001 and P = 001, respectively).

3.4. Effect of HG on GOT, GPT, and ALP enzyme concentrations

Results indicated a significant increase in GOT, GPT, and ALP enzyme concentrations in the hyperemesis gravidarum group compared with those in the pregnancy and control group, where p < 0.0001. The GOT enzyme concentration in the HG group was (70.3±8.78) U/L compared with that in the pregnancy and control groups (45.7±11.54 and 40.8±6.12) U/L, respectively). The GPT enzyme concentration in the HG group was (60.6±15.2) U/L compared with that in the pregnancy and control groups (38.4±9.64 and 35.6±4.87) U/L, respectively). The ALP enzyme concentration in the HG group was (80.5±14.1) U/L compared with that in the pregnancy and control group (50.4±8.54 and 43.4±6.34) U/L, respectively (Table 1).

3.5. Effect of HG on Concentration C_3 and C_4 complement proteins

Concentration of C_3 among the three studied groups: hyperemesis gravidarum (HG) group, pregnancy (NHG), and control group (90.6±13.67, 80.9±10.06 and 85.6±7.43) mg/dL, respectively), and C_4 (30.9±8.6, 35.47±9.43 and 25.8±4.5) mg/dL, respectively) (Table 1). The results indicated a non-significant difference between HG group and control group in C_3 and C_4 concentration (p= 0.22 and p= 0.051), but significant increase in C_4 concentration in pregnancy (NHG) compare with control group(P= 0.001).

Table1: Comparison of Biochemical and Hematological Parameters Among the Study Groups

Parameter	Pregnant women with HG Mean ± SD	Pregnant women without HG Mean ± SD	Non-pregnant women Mean ± SD	ANOVA p-value
Hb (mg/dL)	10.3 ± 0.8	11.4 ± 2.2	14.1 ± 2.1	P < 0.001
Urea (mg/dL)	25 ± 4.6	23 ± 3.7	28 ± 4.3	P < 0.001
Creatinine (mg/dL)	0.56 ± 0.18	0.64 ± 0.28	0.94 ± 0.18	P < 0.001
GOT (U/L)	70.3 ± 8.8	45.7 ± 11.5	40.8 ± 6.1	P < 0.001
GPT (U/L)	60.6 ± 15.2	38.4 ± 9.6	35.6 ± 4.9	P < 0.001
ALP (U/L)	80.5 ± 14.1	50.4 ± 8.5	43.4 ± 6.3	P < 0.001
C3 (mg/dL)	90.6 ± 13.7	80.9 ± 10.1	85.6 ± 7.4	P < 0.001
C4 (mg/dL)	30.9 ± 8.6	35.5 ± 9.4	25.8 ± 4.5	P < 0.001

3.6 .Effect of hyperemesis gravidarum on potassium, calcium, and bicarbonate levels.

Significant decrease in the concentration of (K^+), in HG group (3.5±1.2) mmol/L) compared with that in the pregnancy and control group (4.3±1.03 and 4.6±0.3) mmol/L, respectively; p = 0.0018). Significant decrease in the concentration of Ca^{2+} in the HG group (5.3±1.03) mmol/L compared with that in the pregnancy and control groups (7.1±2.24 and 6.3±0.66) mmol/L, respectively, p = 0.0037. Significant decrease in the concentration of HCO_3^-, in HG group (15.87±2.78) mmol/L) compared with the pregnancy and control groups where were (20.4±3.67 and 25±1.98) mmol/L respectively, p < 0.0001, Table 2).

3.7. Effect of hyperemesis gravidarum on sodium and chloride levels

Significant decrease in the concentration of Na^+ in the HG group (90±12) mmol/L) compared with that in the pregnancy and control group (108±14 and 130±8) mmol/L respectively, p < 0.0001. Significant decrease in the concentration of (Cl^-), in HG group (80±20) mmol/L) compared with that in the pregnancy and control groups (97.7±17 and 98.6±5) mmol/L respectively, p < 0.0016, (See Table 2).

Table 2 : Comparison of electrolyte parameters among the study groups

Parameter (mmol/L)	Pregnant women with HG Mean ± SD	Pregnant women without HG Mean ± SD	Non-pregnant Women Mean ± SD	ANOVA p-value
Potassium (mmol/L)	3.5 ± 1.2	4.3 ± 1.03	4.6 ± 0.3	P < 0.001
Calcium (mmol/L)	5.3 ± 1.03	7.1 ± 2.24	6.3 ± 0.66	P < 0.01
Bicarbonate (mmol/L)	15.87 ± 2.78	20.4 ± 3.67	25 ± 1.98	P < 0.001
Sodium (mmol/L)	90 ± 12	108 ± 14	130 ± 8	P < 0.001
Chloride (mmol/L)	80 ± 20	97.7 ± 17	98.6 ± 5	P < 0.001

3.8. Receiver operating characteristic (ROC) analysis

To further evaluate the diagnostic concert of the measured biochemical and hematological parameters in discriminating pregnant women with hyperemesis gravidarum (HG) from those without HG (NHG), a receiver operating characteristic (ROC) curve analysis was performed based on the mean and standard deviation values of each parameter. The area under the curve (AUC) was used as a pointer of discriminative ability, where higher AUC values of parameters characterize better diagnostic presentation.

As shown in Figure 1, ALP, GOT, and GPT showed the highest diagnostic accuracy, with AUC values of 0.94, 0.92, and 0.88, respectively, representing excellent discriminatory power between the HG and NHG groups. Among the electrolyte parameters, bicarbonate (AUC = 0.85) and sodium (AUC = 0.83) had excellent diagnostic accuracy, reflecting the significance of electrolyte imbalance in HG. Hemoglobin (AUC = 0.80) similarly showed good performance, suggesting its value as a supportive marker of disorder severity. Potassium, calcium, and chloride showed moderate discrimination ability, whereas urea and creatinine presented comparatively weak predictive power for HG.

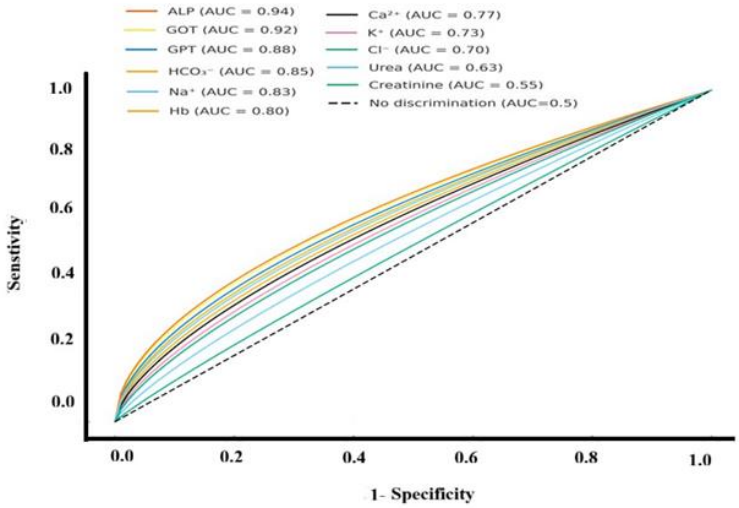


Figure 1: ROC curves for biochemical and hematological parameters in HG and NHG pregnant women

3.9. Pearson Correlation Analysis

The HG group presented several strong and significant correlations, as showed in Table 3 and Figure 2. Hemoglobin (Hb) was negatively correlated with the liver enzymes GOT ($r = 0.62$, $p < 0.001$) and GPT ($r = 0.58$, $p < 0.01$). Furthermore, bicarbonate was positively correlated with sodium ($r = 0.71$, $p < 0.001$) and potassium ($r = 0.64$, $p < 0.01$). On the other hand, the ALP enzyme showed a negative correlation with calcium ($r = 0.55$, $p < 0.01$).

Table 3: Pearson correlation coefficients (r) among the study factors in the HG and NHG groups

Parameter Pair	HG group (r, p)	NHG group (r, p)	Direction of Change
Hb vs. GOT	0.62 ($p < 0.001$)	–0.18 (ns)	Strengthened negative
Hb vs. GPT	0.58 ($p < 0.01$)	–0.12 (ns)	Strengthened negative
ALP is Ca^{2+}	0.55 ($p < 0.01$)	0.08 (ns)	Reversed correlation
HCO_3^- as Na^+	0.71 ($p < 0.001$)	0.40 ($p < 0.05$)	Strengthened positive
HCO_3^- as K^+	0.64 ($p < 0.01$)	0.32 (ns)	Strengthened positive
Na^+ is Cl^-	0.59 ($p < 0.01$)	0.50 ($p < 0.05$)	Slightly increased
GOT vs. GPT	0.68 ($p < 0.001$)	0.41 ($p < 0.05$)	Stronger hepatic correlation

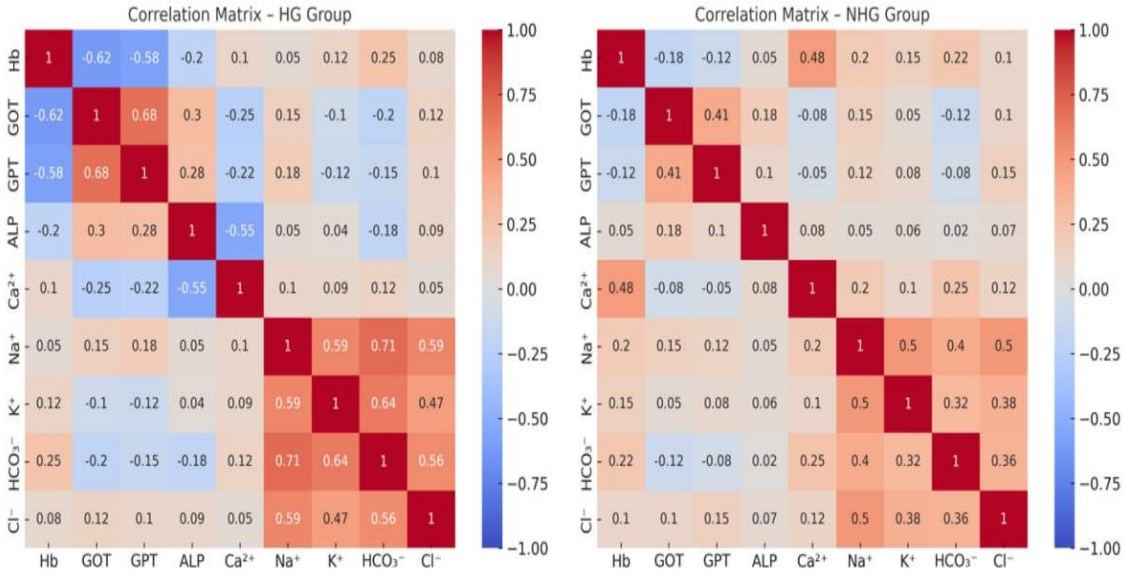


Figure 2: Dual heatmap visually contrasts the Pearson correlation results between the HG and NHG groups.

4. Discussion

Hypermesis gravidarum (HG) is a severe disorder characterized by prolonged nausea and vomiting during pregnancy, resulting in nutritional deficiencies and extreme physical depletion [19]. For this, the current study highlighted the possible relationships between HG and changes in physiological and biochemical factors, such as hemoglobin, urea, creatinine, liver enzymes (GOT,GPT and ALP), and complement proteins (C_3 and C_4) [2]. This study suggests that the decrease in hemoglobin level in HG may be due to one or more of the following. Inadequate intake of these nutrients results from the persistent vomiting that is linked with HG; these nutrients, such as iron and folate, are fundamental to hemoglobin production. Anemia, which results from iron deficiency, is worsened by the fact that the body has a higher rate of iron use during pregnancy [20]. What is more, physiological stress can be imposed by HG, which, consequently, can influence iron homeostasis to aggravate the degree of hemoglobin. These statistics should lead to a universal consideration of the necessity to evaluate and manage prenatal anemia in pregnant women with HG in a preemptive fashion and reduce potential risks of maternal and fetal morbidity. In pregnancy, an increase in urea concentrations is generally linked to expansion of blood volume and increased fluid filtration that is observed in normal pregnancy. The laboratory parameters, however, under the scenario of this study seem to indicate the impact of hyperemesis gravidarum (HG), especially dehydration and hemoconcentration. These changes are accompanied by relatively elevated urea levels, which may overshadow or mask the anticipated suppression of other biochemical markers [4, 15]. In addition, because HG results in less nutrient intake and less energy, the body stays in a catabolic state, which can worsen by increasing the breakdown of protein to make more urea [13]. A study found that differences in renal blood flow and glomerular filtration rates between normal pregnancy and HG also affect urea [1]. In HG, there may be a decrease in muscle creatinine generation resulting from decreased nutrient consumption and physical activity. Although renal function might also be affected in severe forms of HG, this is not often the primary issue in question. Monitoring constant creatinine levels associated with hydration and renal state is also important in the management of HG patients [3].

Changes in GOT, GPT, and ALP levels in HG indicate an effect on hepatic function in the liver enzyme levels. These could be due to dehydration affecting hepatic blood flow, hormonal changes, and nutritional status that affects liver metabolism [21,16]. Moreover, gallbladder dysfunction caused by HG can cause stress in the liver. Although significant liver injury in HG is uncommon, these changes should be carefully monitored to identify any early hepatotoxicity. Proteins C_3 and C_4 are components of the immune response produced by the liver that help the body defend against diseases. There is a relative shortage of research directly relating HG to complement proteins, but chronic stress, inflammation, and nutritional deficiencies in HG could affect these. Chaotic hormonal changes during pregnancy could also influence immune responsiveness and thus complement protein production [21,16].

The changes demonstrated that electrolyte deficiencies were considerably worse in pregnant women with HG than in women without HG (NHG) and nonpregnant controls. Based on our findings, the potassium level in the HG group significantly decreased because of excessive loss caused by persistent vomiting, which is characteristic of HG. Potential consequences of potassium loss include hypokalemic myopathy that causes weakness, cardiac arrhythmias, and other effects that render adequate maintenance of the potassium level clinically relevant [6]. Serum calcium concentrations also significantly decreased in the HG group partly because of poor dietary intake and malabsorption resulting from nausea and vomiting. There is a growing need to address nutrient deficiencies given their impacts on both the maternal bone health of an individual and the skeletal lineage of the fetus. Bicarbonate levels were also lower within the disease group, a sign of metabolic acidosis [22]. This could be due to depleted bicarbonate in the stomach due to vomiting. Both sodium and chloride were much lower in the disease group than in the control group, showing that the compound was lost more through vomiting.

The values of AUC that were significantly high in the ROC analysis of liver enzymes, predominantly ALP (0.94), GOT (0.92) and GPT (0.88) indicate that they are very sensitive and specific in the differentiation of HG and NHG pregnancy. These findings are in line with the previous reports that transient hepatic dysfunction is sometimes accompanied by severe vomiting and dehydration in HG which may be attributed to the altered hepatic perfusion and metabolic stress as a result of persistent nausea and vomiting. The high discriminative activity of these enzymes underscores the possible applications as biochemical pointers of the severity and progression of order[23]. This is represented by bicarbonate (AUC = 0.85) and sodium (AUC = 0.83) values of the ROC, which are significant indicators of the analytical value of electrolyte imbalance in HG. The apparent reduction in these electrolytes in HG pregnant women indicates metabolic acidosis and hyponatremia due to further vomiting and dehydration. These variables indicate the pathophysiological effects of HG and can be used as early warning of the onset of metabolic diseases that need medical intervention [24]. To a great extent, the hypothesis about the biochemical and electrolyte disorder being some of the primary pathophysiological prerequisites of HG is confirmed through the ROC analysis. It is therefore possible to consider the use of these biochemical markers in pregnancy screening protocols at an earlier age so that the early diagnosis, risk stratification, and the treatment of pregnancy with HG can be improved with the ultimate goal of enhancing maternal outcomes [25].

The Pearson correlation analysis is another analysis that gives more information concerning the physiological interdependence of biochemical deviations associated with hemoglobin. The pattern of correlation of these parameters was also significantly less strong and more physically stable in the normal pregnancy (NHG) group. The Hb and calcium and sodium and chloride had moderate positive relationships, which showed normal regulation of electrolytes. No significant correlations were found between liver enzymes and hematological parameters which

highlights the absence of hepatic stress during normal pregnancy[26]. In the HG group, strong and statistically significant correlations between hepatic enzymes and hematological or electrolyte indices mirror a systemic metabolic disorder persuaded by persistent vomiting, dehydration, and nutritional stress. The reverse relationship between Hb and liver enzymes suggests that as hepatic function becomes progressively stressed, hematological parameters drop, which is expected due to hemodilution and nutritional insufficiency [27].

The strong positive correlations among bicarbonate, sodium, and potassium detected in the HG group, compared to the weaker correlations in the normal pregnancy, indicate that HG severely alters electrolyte regulation. This pattern reflects the pathoclinical mechanism of metabolic acidosis and volume depletion, where disturbances in one electrolyte frequently cause changes in others to control plasma osmolarity[28]. In addition, the negative correlation between ALP and calcium in HG, absent in normal pregnancy, may reflect the changes in calcium metabolism secondary to starvation and declined gastrointestinal absorption during persistent vomiting. The strengthened correlations between hepatic enzymes, mainly GOT vs. GPT, further indicate a coordinated hepatic stress response, dependable with the elevated enzyme levels and high AUC values realized in the ROC analysis [29].

Combined, the disrupted correlation system in HG points to the systemic characteristics of the condition, which involves hematological balance, hepatic functioning, and electrolyte homeostasis. The NHG group validated physiologically balanced and weaker associations, made with adaptive yet stable metabolical regulation of normal pregnancy. The existing results emphasize the HG causes the change of physiological into pathological interactions between biochemical parameters and replicates the overall metabolic dysregulation.
Studies in many countries, such as Saudi Arabia and Ethiopia, agree with the current study [30-32] Additional unambiguous studies are yet to be done to clarify such relationships and their prognostic implications. Enriching the idea of the multiple effects of HG on maternal health, the current study emphasizes the necessity to find recommendations and measures to be applied to the integrated care of the mother, which should involve the prevention and treatment of dehydration, the acquisition of macro- and micronutrients deficiencies, and the metabolic disorders[33]. Thus, to minimize the impact, early proper interventions, including nutritional assistance, hydration, and comforting steps, should be used. It is recommended that further research should be undertaken on the biochemical alterations involved in HG particularly in the quest of possible maternal and fetal risks and benefits of the individual management strategies. In such a way, the paper has emphasized the need to have a clinical integration of the biochemical data in order to obtain optimal care to mothers with HG and their growing fetuses.

Conclusion

By examining these physiological and clinical indicators, which are reflected in the health of the fetus, the study concluded that hyperemesis gravidarum has a significant and dangerous impact on the health of pregnant women. This study provides conclusive evidence of the impact of malnutrition on the general health of pregnant women and their fetuses. This study attributed the physiological and biochemical effects of HG to the disease rather than to pregnancy by comparing it with a group of pregnant women without HG. The pregnant women with HG significantly deviated from both groups. ROC and Pearson correlation analyses had a clear vision about the diagnosis and follow-up of the disease and clarified the relationship between variables in the physiological state and their differences in the pathological state.

References

[1] W. I. A. Abd-alwahab, "Evaluate the Liver, and Kidney Function in Pregnant Women with Gestational Hypertension," *Journal of Science*, vol. 2, no. 3, pp. 17–22, 2024.

[2] M. S. AL-JANABY, M. Q. AL-ANI, and M. N. RASHEED, "RELATIONSHIP BETWEEN SOME IMMUNOLOGICAL FACTORS AND TYPE 2 DIABETES MELLITUS IN IRAQI PATIENTS," *Asian Journal of Pharmaceutical and Clinical Research*, vol. 11, no. 6, pp. 489–492, 2018.

[3] M. A. Alnabi and J. A. Al Mashikas, "Signs and symptoms of kidney disease in the critically ill pregnant patient," *The Kidney of the Critically Ill Pregnant Woman*, pp. 23–33, 2025.

[4] E. H. Emmott, "Re-examining the adaptive function of nausea and vomiting in pregnancy," *Evolution, Medicine, and Public Health*, vol. 12, no. 1, pp. 97–104, 2024.

[5] M. S. Fejzo *et al.*, "Nausea and vomiting of pregnancy and hyperemesis gravidarum," *Nature reviews Disease primers*, vol. 5, no. 1, p. 62, 2019.

[6] S. U. Felix, C. N. Pauline, N. Ogunkunle, and A. Lushaikyaa, "Acute Hypokalemia," *Periparturient Diseases of Cattle*, pp. 213–226, 2024.

[7] N. Gaba and S. Gaba, "Study of Liver Dysfunction in Hyperemesis Gravidarum," *Cureus*, vol. 12, no. 6, 2020.

[8] N. L. Schrager, S. E. Parker, M. M. Werler, and N. B. D. P. Study, "The timing, duration, and severity of nausea and vomiting of pregnancy and adverse birth outcomes among controls without birth defects in the National Birth Defects Prevention Study," *Birth Defects Research*, vol. 116, no. 4, p. e2334, 2024.

[9] S. N. Hinkle *et al.*, "Association of nausea and vomiting during pregnancy with pregnancy loss: a secondary analysis of a randomized clinical trial," *JAMA Internal Medicine*, vol. 176, no. 11, pp. 1621–1627, 2016.

[10] M. S. Hussain *et al.*, "Hematological Changes in Blood of Smokers of Cigarettes and Nargyle," *Indian Journal of Forensic Medicine & Toxicology*, vol. 14, no. 2, pp. 1771–1776, 2020.

[11] C. Liu *et al.*, "Emerging progress in nausea and vomiting of pregnancy and hyperemesis gravidarum: challenges and opportunities," *Frontiers in Medicine*, vol. 8, p. 809270, 2022.

[12] S. Patel, "Practice update: Management of nausea and vomiting in pregnancy and hyperemesis gravidarum," *The Australian Journal of Pharmacy*, vol. 106, no. 1254, pp. 70–77, 2025.

[13] H. Matsuki *et al.*, "Chronic kidney disease causes blood-brain barrier breakdown via urea-activated matrix metalloproteinase-2 and insolubility of tau protein," *Aging (Albany NY)*, vol. 15, no. 20, p. 10972, 2023.

[14] T. Zou, Z. Long, S. Wang, and Q. Yao, "Nausea and vomiting in pregnancy (NVP) in Chinese pregnant women: a cross-sectional study," *BMC Pregnancy Childbirth*, vol. 24, no. 1, p. 481, 2024.

[15] C. Nelson-Piercy *et al.*, "The Management of Nausea and Vomiting in Pregnancy and Hyperemesis Gravidarum (Green-top Guideline No. 69)," *An International Journal of Obstetrics & Gynaecology*, vol. 131, no. 7, pp. e1–e30, 2024.

[16] Y. S. Rasheed, M. S. Al-Janaby, M. M. Ahmed, and H. Y. Houmady, "Effect of lead on some clinical and immunological variables for gasoline station workers and cigarette smokers in Ramadi, Iraq," in *AIP Conference Proceedings, Vol. 3097, No. 1, p. 020005*, 2024.

[17] J. Uberos, S. Jimenez-Montilla, I. Machado-Casas, C. Laynez-Rubio, E. Fernández-Marin, and A. Campos-Martínez, "The association between restricted intra-uterine growth and inadequate postnatal nutrition in very-low-birth-weight infants and their neurodevelopmental outcomes: a 50-month follow-up study," *British Journal of Nutrition*, vol. 127, no. 4, pp. 580–588, 2022.

[18] F. Saber Nady Mohammed, A. Mohamed Ahmed Madkour, S. Sayed Mustafa Ibrahim, and A. Ahmed Abdelhafez, "Effect of Acupressure Band-Aid Combined with Expectancy Manipulation Instructions on Pregnancy related Nausea and Vomiting," *Egyptian Journal of Health Care*, vol. 15, no. 1, pp. 2131–2147, 2024.

[19] V. I. Medved, S. I. Zhuk, D. H. Konkov, S. K. Litvinov, and O. L. Ocheretna, "The evidence bases of etiopathophysiology and preventive clinical management of nausea and vomiting in pregnancy," *Reprod Health Women*, vol. 4, pp. 13–28, 2023.

[20] G. U. Obeagu, B. O. Altraide, and E. I. Obeagu, "Iron deficiency anemia in pregnancy and related complications with specific insight in Rivers State, Nigeria: a narrative review," *Annals of Medicine and Surgery*, vol. 87, no. 6, pp. 3435–3444, 2025.

[21] S. B. YILDIRIM, K. İ. A. YILMAZ, N. B. Altuntaş, and Y. B. Tekin, "Relationship between combined systemic inflammatory indices with presence and severity of hyperemesis gravidarum.," *European Review for Medical & Pharmacological Sciences*, vol. 27, no. 18, 2023.

[22] S. Zhu *et al.*, "Nausea and vomiting during early pregnancy among Chinese women and its association with nutritional intakes," *Nutrients*, vol. 15, no. 4, p. 933, 2023.

[23] K. Aicher, J. Cavasin, and J. A. Lidbury, *Hepatology, An Issue of Veterinary Clinics of North America: Small Animal Practice: Hepatology, An Issue of Veterinary Clinics of North America: Small Animal Practice, E-Book*, vol. 55, no. 4. Elsevier Health Sciences, 2025.

[24] S. Yadav, J. Yadav, S. Kumar, and P. Singh, "Metabolism of macro-elements (calcium, magnesium, sodium, potassium, chloride and phosphorus) and associated disorders," in *Clinical applications of biomolecules in disease diagnosis: A comprehensive guide to biochemistry and metabolism*, Springer, pp. 177–203, 2024.

[25] S. Cicek, E. I. Coskun, N. Abdurahmanova, and E. Yilmaz, "Inflammation-driven pathogenesis of hyperemesis gravidarum: assessing the role of pan-immune-inflammation value and hematologic parameters," *Archives of Gynecology and Obstetrics*, pp. 1–10, 2025.

[26] U. K. Lalramdinpuii, M. Mishra, A. Kumar, A. K. Singh, and P. K. Mishra, "IMPACT OF BIOCHEMICAL PARAMETERS ON PREGNANCY: A COMPREHENSIVE," *European Journal of Biomedical*, vol. 12, no. 2, pp. 152–156, 2025.

[27] T. Xia *et al.*, "Serum iron status is associated with all-cause mortality in metabolic dysfunction-associated steatotic liver disease: a prospective, observational study," *Frontiers in Endocrinology*, vol. 15, p. 1454193, 2024.

[28] T.-Y. Yang *et al.*, "Sodium bicarbonate treatment and clinical outcomes in chronic kidney disease with metabolic acidosis: a meta-analysis," *Clinical Journal of the American Society of Nephrology*, vol. 19, no. 8, pp. 959–969, 2024.

[29] W. Wu, Y. Guo, Q. Li, and C. Jia, "Exploring the potential of large language models in identifying metabolic dysfunction-associated steatotic liver disease: A comparative study of non-invasive tests and artificial intelligence-generated responses," *Liver International*, vol. 45, no. 4, p. e16112, 2025.

[30] M. M. Aslan, M. T. Yeler, İ. Bıyık, H. U. Yuvacı, A. S. Cevrioğlu, and S. Özden, "Hematological parameters to predict the severity of hyperemesis gravidarum and ketonuria," *Revista Brasileira de Ginecologia e Obstetrícia*, vol. 44, pp. 458–466, 2022.

[31] K. S. Hussein, "Hyperemesis gravidarum in first-trimester pregnant Saudi women: is Helicobacter pylori a risk factor?," *Frontiers in physiology*, vol. 11, p. 575, 2020.

[32] A. Worede, T. Deress, H. Wondifraw, G. Fetene, and A. Berie, "Electrolyte imbalance and liver function test abnormalities among pregnant women with hyperemesis gravidarum at Wag-himra zone public hospitals, Northeast Ethiopia, 2023: a comparative cross-sectional study," *Frontiers in Medicine*, vol. 11, p. 1451036, 2024.

[33] A. K. Kiani, K. Dhuli, K. Donato, B. Aquilanti, V. Velluti, G. Matera, ... & M. Bertelli, "Main nutritional deficiencies, " *Journal of preventive medicine and hygiene*, *63*(2 Suppl 3), E93, 2022.