Original Article

Potential Confounders and a Modified Framingham Risk Score for the Prediction of Pregnancy-related Medical Conditions Occurrence among Pregnant Women: A Retrospective Study from Baghdad, Iraq

Anmar AL-TAIE1, Nadia H. Mohammed2, Zahraa Albasry3

1Department of Pharmacy, Faculty of Pharmacy, Girne American University, Kyrenia, North Cyprus, Turkey, 2Department of Clinical Laboratory Sciences, College of Pharmacy, Mustansiriya University, Baghdad, Iraq, 3Department of Clinical Pharmacy, College of Pharmacy, Mustansiriya University, Baghdad, Iraq

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Background: The incidence of pregnancy-related medical conditions relied on a set of potential factors that could be available even before the term of pregnancy and may be associated with poor outcomes later in life. This study aimed to investigate the association between some potential predictive factors related to maternal, gestational, and clinical parameters and the incidence of pregnancy-related medical conditions in a sample of Iraqi pregnant women.

Materials and Methods: A retrospective, observational, single-center study was carried out on 92 pregnant women during their routine visit to the obstetric clinic in a certain district of Baghdad province, Iraq. Demographic, gestational, and clinical records of the participants were collected and analyzed to detect the predictive factors for pregnancy-related medical conditions. Results: 56.5% of the participants were at a gestational age of 25–37 weeks. 32.6% complained of pregnancy-related medical conditions, mainly gestational hypertension and diabetes mellitus. Pregnant women with pregnancy-related medical conditions were significantly correlated with a family history (P < 0.0001), previous gestational medical conditions (P < 0.001), diastolic blood pressure (P = 0.001), different lipid panels (P = 0.0001), and maternal blood phenotype O (P = 0.0001).

Conclusion: Some predictive factors related to maternal, gestational, and health characteristics are correlated with the incidence of pregnancy-related medical conditions. Interventions to adjust and recognize these confounders are essentials even before pregnancy which could improve maternal health and reduce the overall risk of pregnancy-related medical conditions.

Keywords: Blood group, cardiovascular risk, Iraq, lipid panels, potential predictors, pregnancy complications

INTRODUCTION

One of the main concerns during pregnancy is whether pregnancy, pregnancy-related complications, or the predisposing maternal conditions which were expressed during pregnancy could eventually cause chronic morbidity and long-term effect on maternal health.[1] Pregnancy-related medical conditions (PRMCs) are the medical illnesses where pregnant women are suffering from the first week of pregnancy till the due time. A predictive relationship between the PRMCs and maternal health may be related to the presence of some potential confounding variables concerning maternal, obstetric, clinical, and other factors during pregnancy. Such a relationship...
could predict future chronic diseases long after the end of pregnancy.[2,3]

Because PRMCs could be associated with the risk of death in women, an understanding of the existence and extent of the potential confounding factors that might predict the risk of PRMCs needs to be comprehended. It has been proposed that certain cardiovascular (CV) risk factors that present years before pregnancy were associated with the increased risk of gestational hypertension (GH) and preeclampsia.[6] A study by Lind et al.[7] provided evidence that women with a history or recent adverse pregnancy outcomes are prone to be at a greater risk of CV and metabolic diseases. It could further suggest that pregnancy offers an opportunity to identify women at risk of future CV and metabolic conditions years later.

The aim of this study was to explore the predisposition of different potential confounders related to maternal, gestational, and clinical characteristics alongside the variables of the modified Framingham risk score (FRS) to predict the incidence of PRMCs among pregnant women. The study also aimed to assess the association between certain maternal and obstetric parameters, including maternal blood characteristics, gestational age, gravidity, and parity, with the variables of the modified FRS on the incidence of PRMCs.

**Subjects and Methods**

**Study design**

The study was designed as a retrospective, observational, single-center analysis. Patients were surveyed from January through April 2017. Approval of this study was granted from the ethical committee of College of Pharmacy - Mustansiriya University, Baghdad, Iraq. All procedures performed in the study involving human participants followed the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments.

**Data collection and assessment of study variables**

Pregnant women admitted to the obstetric clinic in a certain distinct of Baghdad province, Iraq during the aforementioned period were enrolled in this study. Pregnant women over the age of 18 years old were included and used to estimate the sample size of this study, whereas those with missing of enough data were excluded. Data for each participant was screened and collected at the obstetric clinic during the routine obstetric visits and used to structure a detailed assessment for the patients. The collected data included maternal demographic (age; education level categorized as primary, secondary and university level; smoking habits), obstetric (gestational age in weeks-GA, gravida-G, parity-P), and maternal clinical characteristics.

Regarding maternal clinical records, the last documented measurements were used during the study period. These include family history of medical disorders, previous and recent gestational medical conditions, medications being used during the gestational period, body mass index (BMI), Rhesus (Rh) factor (Rh+, Rh–), and blood group phenotypes (A, B, AB, and O). Besides, the variables of FRS for the estimation of CV conditions (10-year risk) were recorded, including measurements of systolic (SBP) and diastolic blood pressure (DBP), serum lipid panels, including total cholesterol (TC), low-density lipoprotein cholesterol (LDL), high-density lipoprotein cholesterol (HDL), and non-high-density lipoprotein cholesterol (non-HDL).

Measurement of fasting blood glucose level for those pregnant women suffering from hyperglycemia and gestational diabetes mellitus (GDM) was recorded as any degree of glucose intolerance with onset or first recognition during pregnancy and diagnosed according to the criteria of the American Diabetes Association (ADA). Measurements of BP were recorded using a mercury column sphygmomanometer after 5 min rest in correspondence to the schedules of the clinic visits. Participants’ visits usually occurred every 4 weeks until the 28th week of pregnancy, every 2 weeks from then until the 36th week, and then weekly until delivery. Mean value of systolic and diastolic blood pressures (SBP and DBP) was recorded for each participant based on the mentioned visiting schedule.

Measurements of blood pressure were based on the International Society for the Study of Hypertension in Pregnancy criteria to determine women with preeclampsia and those with GH. According to those criteria, preeclampsia is defined as an SBP ≥ 140 mm Hg or a DBP ≥90 mm Hg, measured on at least 2 occasions after 20 weeks of gestation with proteinuria, whereas GH is defined as the same criteria of elevated blood pressure, but without proteinuria.[8] Categorization of serum lipid panels was performed according to NCEP-ATP III Guidelines, including TC desirable level <200 mg/dL, LDL cholesterol desirable level <100 mg/dL, HDL cholesterol desirable level >40 mg/dL. Non-HDL cholesterol level was also measured. The aforementioned maternal demographic, obstetric, and clinical records alongside the variables of the modified form of FRS were used to investigate and understand the perception and prediction of potential confounders for the incidence of PRMCs.
Statistical analysis
The SPSS version 23 was used for statistical analysis. Descriptive analysis was used to describe the study population, and the results were expressed in numbers, percentages, means, and standard deviations. Least significant difference (LSD) test (analysis of variance [ANOVA]) was used to compare between means. Comparison of mean between any two groups was done using an independent sample t test. Association between categorical variables was assessed using either chi-square or corrected chi-square. Risk was estimated using odds ratio (OR) and 95% confidence interval to identify the potential predictors associated with PRMCs related to demographic, gestational-obstetric, and clinical variables. The level of significance used for the statistical analysis was $P < 0.05$.

RESULTS
The characteristics of the study participants are presented in Table 1. Of the recruited pregnant women who met the study’s inclusion criteria, a total of 92 participants were enrolled in this study with a mean age of 28.26 ± 6.2 years. Regarding the obstetric and gestational characteristics, 56.5% of the study participants were diagnosed at gestational age 25–37 weeks, 26.1% at 14–24 weeks, and 17.4% at 1–13 weeks. The majority of the participants had more than three gravida (34.8%) and 32.6% had two parity.

Regarding the clinical characteristics, 34.8% of the study participants had a previous family history of CV conditions, 51.1% had previous gestational CV conditions. Moreover, 32.6% of the study participants had current PRMCs, the majority of those suffering from both GH and DM ($n = 18$), as shown in Table 1. For the characteristics of maternal blood group phenotypes, the majority of the study participants had Rh+ factor (85.9%). Meanwhile, 71.7% of the participants had blood group phenotype O and 10.9% had blood group phenotype A, as presented in Table 1. Figures 1 and 2 show the most common oral and parenteral medications used by the study participants, respectively.

Regarding the predictive factors for the presence of PRMCs, there was a statistically significant correlation concerning family history of medical conditions (OR= 203.00 [95%: 35.05–1175.58], $P < 0.0001$); previous gestational medical conditions (OR= 31.68 [95%: 6.84–146.74], $P < 0.0001$); gestational age>20 weeks (OR= 2.89 [95%:1.03–8.07], $P = 0.038$), in addition to different clinical characteristics of the variables of FRS, including DBP (80.00 ± 2.70 vs. 75.32 ± 1.41 mm Hg, $P = 0.0011$); TC (191.40 ± 16.41 vs. 143.16 ± 8.61 mg/dL, $P = 0.0001$); LDL (117.13 ± 8.93 vs. 103.45 ±

### Table 1: Demographic characteristics of the study participants

| Demographic          | Number (n) | Percentage |
|----------------------|------------|------------|
| Total = 92(%)        |            |            |
| Age (years) ± SD     | 28.26 ± 6.2| –          |
| Smoking              |            |            |
| Yes                  | 92         | 100        |
| No                   |            |            |
| Education level      |            |            |
| Primary              | 22         | 24         |
| Secondary            | 42         | 45.6       |
| University           | 28         | 30.4       |
| Obstetric            |            |            |
| Gestational age (week)|            |            |
| 1-13                 | 16         | 17.4       |
| 14-24                | 24         | 26.1       |
| 25-37                | 52         | 56.5       |
| Gravidity            |            |            |
| G1                   | 12         | 13         |
| G2                   | 24         | 26.1       |
| G3                   | 24         | 26.1       |
| >G3                  | 32         | 34.8       |
| Parity               |            |            |
| P0                   | 16         | 17.4       |
| P1                   | 28         | 30.4       |
| P2                   | 30         | 32.6       |
| >P2                  | 18         | 19.6       |
| Clinical             |            |            |
| CV family history    |            |            |
| Yes                  | 32         | 34.8       |
| No                   | 60         | 65.2       |
| Previous gestational CV conditions |            |            |
| Yes                  | 47         | 51.1       |
| No                   | 45         | 48.9       |
| Current PRMCs        |            |            |
| Yes                  | 30         | 32.6       |
| No                   | 62         | 67.4       |
| Types of PRMCs       |            |            |
| Gestational hypertension | 6         | 20         |
| Gestational DM       | 6          | 20         |
| Gestational hypertension and DM | 18 | 60 |
| Rh factor            |            |            |
| Rh+                  | 79         | 85.9       |
| Rh-                  | 13         | 14.1       |
| Blood group phenotype|            |            |
| A                    | 10         | 10.9       |
| B                    | 4          | 4.4        |
| AB                   | 12         | 13         |
| O                    | 66         | 71.7       |

CV = cardiovascular, BMI = body mass index, G = gravidity, P = parity, PRMCs = pregnancy-related medical conditions

Data present in number (n), percentage (%), and standard deviation (SD)
4.50 mg/dL, $P = 0.0071$); non-HDL (154.27 ± 17.46 vs. 101.93 ± 4.88 mg/dL, $P = 0.0001$), and HDL (38.33 ± 1.72 vs. 41.23 ± 0.56 mg/dL, $P = 0.0052$), as shown in Table 2.

The association between maternal Rh factor and variables of FRS are presented in Table 3. No significant changes concerning BP readings and lipid panels were observed except for LDL which was significantly higher among participants with Rh+ factor (109.67 ± 4.66 mg/dL, $P = 0.05$). However, taking into account the incidence of PRMCs in association with different maternal blood group phenotypes, a significant incidence of different PRMCs among pregnant women having the blood group phenotype O was observed particularly for GH and DM (43.3%, $P = 0.0001$), as shown in Table 4.

Concerning the association between gestational age and the variables of modified FRS, it was found that SBP significantly increased with the gestational period 25–37 weeks (125 ± 11.4 mm Hg, $P = 0.05$), whereas...
HDL was significantly decreased with the gestational period 25–37 weeks (39.69 ± 4.73 mg/dL, \( P = 0.0467 \)), as shown in Table 5. Table 6 shows the association between multigravida and the variables of modified FRS, there was a significant increase concerning SBP (133.03 ± 11.31 mm Hg, \( P = 0.047 \)), TC (184.90 ± 46.62 mg/dL, \( P = 0.039 \)), LDL (122.79 ± 25.25 mg/dL, \( P = 0.042 \)), and non-HDL (148.79 ± 50.25, \( P = 0.033 \)) as the number of gravida increases more than three (>G3). However, no significant findings were observed regarding the association between different parities and the variables of modified FRS, except for non-HDL (141.44 ± 56.6 mg/dL, \( P = 0.05 \)) which was significantly higher, as shown in Table 7. In addition, there were no significant changes concerning the association between maternal blood group phenotypes and variables of FRS as presented in Table 8.

**Discussion**

Several potential confounders among the study participants could contribute to the incidence of PRMCs. These are ranging from demographic, clinical, and genetic factors. The results suggest that maternal age, obesity, family history of cardiovascular disease, previous gestational medical conditions, gestational age >20 weeks, and gravidity >G1 are significant predictors of PRMCs. The association between maternal Rh factor and variables of Framingham risk score revealed that Rh+ mothers had higher SBP and TC compared to Rh- mothers, which is consistent with previous studies. The high SBP and TC levels in Rh+ mothers might contribute to the increased risk of PRMCs.

### Table 2: Predictive factors for the presence of pregnancy-related medical conditions

| Predictive variable                        | Presence of PRMCs \( n = 30 \) | Absence of PRMCs \( n = 62 \) | \( P \) Value | OR (95% CI) |
|--------------------------------------------|---------------------------------|---------------------------------|---------------|-------------|
| Age (year)                                 | 32.2 ± 7.25                     | 27.55 ± 5.52                    | 0.071 NS      | NA          |
| BMI (kg/m²)                                | 33.60 ± 3.06                    | 31.68 ± 4.61                    | 0.188 NS      | NA          |
| Family history                             |                                 |                                 |               |             |
| Yes/No                                     | 28/2                            | 4/58                            | <0.0001       | 203.0 (35.0-1175.5) |
| Previous gestational medical conditions     |                                 |                                 |               |             |
| Yes/No                                     | 28/2                            | 19/43                           | <0.0001       | 31.6 (6.8-146.7) |
| Gestational age >20 weeks                   |                                 |                                 |               |             |
| Yes/No                                     | 24/6                            | 36/26                           | 0.038*        | 2.8 (1.0-8.07) |
| Gravidity >G1                               |                                 |                                 |               |             |
| Yes/No                                     | 28/2                            | 52/10                           | 0.351† NS     | 2.6 (0.5-13.1) |
| Parity                                     |                                 |                                 |               |             |
| Multiparity/multiparity                    | 26/4                            | 50/12                           | 0.475 NS      | 1.5 (0.4-5.3) |
| Number of previous birth Singleton/twin     | 24/2                            | 44/6                            | 0.355 NS      | 1.6 (0.5-4.6) |
| Rh factor                                  |                                 |                                 |               |             |
| Rh+ / Rh-                                   | 24/6                            | 55/7                            | 0.421† NS     | 0.5 (0.1-1.6) |
| Systolic BP (mm Hg) ± SD                   | 118.27 ± 10.64                  | 119.35 ± 2.58                   | 0.8061 NS     | NA          |
| Diastolic BP (mm Hg) ± SD                  | 80.00 ± 2.70                    | 75.32 ± 1.41                    | 0.0011**      | NA          |
| TC (mg/dL) ± SD                            | 191.40 ± 16.41                  | 143.16 ± 8.61                   | 0.0001**      | NA          |
| LDL (mg/dL) ± SD                           | 117.13 ± 8.93                   | 103.45 ± 4.50                   | 0.0071**      | NA          |
| HDL (mg/dL) ± SD                           | 38.33 ± 1.72                    | 41.23 ± 0.56                    | 0.0052**      | NA          |
| non-HDL (mg/dL) ± SD                       | 154.27 ± 17.46                  | 101.93 ± 4.88                   | 0.0001**      | NA          |

PRMCs = pregnancy-related medical conditions, NS = non-significant, NA = not available

Data present in standard deviation (SD)

†Corrected chi-square

*Significant at \( P < 0.05 \)

**Highly significant at \( P < 0.01 \)

### Table 3: Association between maternal Rh factor and variables of Framingham risk score

| Variables        | Rh+ \( n = 79 \) | Rh- \( n = 13 \) | \( P \) Value |
|------------------|------------------|-----------------|--------------|
| SBP (mm Hg)      | 118.60 ± 4.36    | 121.67 ± 2.24   | 0.6191 NS     |
| DBP (mm Hg)      | 76.37 ± 1.41     | 80.00 ± 2.74    | 0.0748 NS     |
| TC (mg/dL)       | 161.60 ± 10.31   | 140.83 ± 12.92  | 0.1421 NS     |
| LDL (mg/dL)      | 109.67 ± 4.66    | 96.17 ± 6.82    | 0.05          |
| HDL (mg/dL)      | 40.07 ± 0.95     | 41.67 ± 1.03    | 0.2783 NS     |
| non-HDL (mg/dL)  | 121.97 ± 10.74   | 99.17 ± 14.03   | 0.1378 NS     |

NS = non-significant

Data present in standard deviation (SD)

Significant at \( P < 0.05 \)
obstetric and different clinical records which include a family history of CV conditions, previous gestational medical conditions, gestational age >20 weeks, DBP, a variety of lipid panels, and maternal blood Rh factor. The highest OR was observed for patients with a family history of CV conditions. Our findings were in agreement with previous studies which reported a positive family history of CV conditions, particularly hypertension as a significant risk factor for developing pregnancy-induced hypertension (PIH) three times more than normal women. The findings of this study showed that GH and GDM were among the most common PRMCs which are in agreement with those found in earlier literature. It has been estimated that GH as one of the complicated metabolic disorders of pregnancy, affects approximately 5%–8% of all

### Table 4: Association between blood group phenotypes and pregnancy-related medical conditions

| PRMCs                      | Group A n (%) | Group B n (%) | Group O n (%) | Group AB n (%) | P Value |
|----------------------------|---------------|---------------|---------------|---------------|---------|
| Gestational hypertension   | 0 (0)         | 0 (0)         | 6 (20)        | 0 (0)         | 0.0001  |
| Gestational DM             | 0 (0)         | 0 (0)         | 6 (20)        | 0 (0)         |         |
| Gestational hypertension and DM | 2 (6.7)     | 0 (0)         | 13 (43.3)     | 3 (10)        |         |

PRMCs = pregnancy-related medical conditions, NS = non-significant

Data present in number (n) and percentage (%)

Highly significant at P < 0.01

### Table 5: Association between gestational age (weeks) and variables of Framingham risk score

| Variables     | 1–13 weeks (n = 16) | 14–24 weeks (n = 24) | 25–37 weeks (n = 52) | P Value |
|---------------|---------------------|----------------------|----------------------|---------|
| SBP (mm Hg)   | 111.33 ± 27.63      | 118.33 ± 4.08        | 125 ± 11.4           | 0.05    |
| DBP (mm Hg)   | 76.38 ± 6.81        | 78.33 ± 4.08         | 77.31 ± 7.24         | 0.8129 NS |
| TC (mg/dL)    | 159.72 ± 49.68      | 133.33 ± 32.04       | 163.65 ± 49.30       | 0.3814 NS |
| LDL-C (mg/dL) | 103.83 ± 19.63      | 104.00 ± 20.71       | 110.27 ± 25.89       | 0.6373 NS |
| HDL-C (mg/dL) | 40.27 ± 4.61        | 43.83 ± 4.49         | 39.69 ± 4.73         | 0.0467  |
| Non-HDL-C (mg/dL) | 120.44 ± 54.98  | 89.50 ± 32.14        | 124.65 ± 54.22       | 0.3412 NS |

NS = nonsignificant

Data present in standard deviation (SD)

Significant at P < 0.05

### Table 6: Association between gravidity and variables of Framingham risk score

| Variables     | G1 (n = 12) | G2 (n = 24) | G3 (n = 24) | >G3 (n = 32) | P Value |
|---------------|-------------|-------------|-------------|--------------|---------|
| SBP (mm Hg)   | 115 ± 5.22  | 115.56 ± 10.24 | 118.33 ± 8.16 | 133.03 ± 11.31 | 0.047   |
| DBP (mm Hg)   | 75 ± 7.97   | 74.35 ± 5.07  | 77.92 ± 5.88  | 80 ± 4.9     | 0.1337 NS |
| TC (mg/dL)    | 147.16 ± 31.52 | 159.39 ± 45.13 | 130.08 ± 29.59 | 184.9 ± 46.62 | 0.039   |
| LDL (mg/dL)   | 93.5 ± 14.44 | 107.22 ± 19.36 | 98.83 ± 18.70  | 122.79 ± 25.25 | 0.042   |
| HDL (mg/dL)   | 40.66 ± 2.8  | 42.17 ± 6.56  | 42.0 ± 3.47   | 37.36 ± 3.17 | 0.091 NS |
| Non-HDL (mg/dL)| 105.83 ± 33.70 | 117.56 ± 49.69 | 88.17 ± 31.77  | 148.79 ± 50.25 | 0.033   |

NS = non-significant

Data present in standard deviation (SD)

Significant at P < 0.05

### Table 7: Association between parity and variables of Framingham risk score

| Variables     | P0 (n = 16) | P1 (n = 28) | P2 (n = 30) | >P2 (n = 18) | P Value |
|---------------|-------------|-------------|-------------|--------------|---------|
| SBP (mm Hg)   | 113.75 ± 7.19 | 116.04 ± 9.11 | 122.0 ± 11.86 | 136.67 ± 8.40 | 0.1663 NS |
| DBP (mm Hg)   | 75.0 ± 7.3   | 75.71 ± 5.04  | 76.33 ± 8.0  | 80 ± 4.9     | 0.094 NS |
| TC (mg/dL)    | 147.88 ± 38.15 | 149.07 ± 41.07 | 162.53 ± 47.52 | 177.89 ± 51.34 | 0.1503 NS |
| LDL (mg/dL)   | 95.38 ± 16.85 | 102.5 ± 18.10  | 109.0 ± 19.92 | 125.67 ± 29.68 | 0.081 NS |
| HDL (mg/dL)   | 40.5 ± 5.7   | 42.36 ± 5.36  | 39.33 ± 3.73  | 38.44 ± 2.99 | 0.084 NS |
| Non-HDL (mg/dL)| 107.38 ± 43.2  | 106.71 ± 43.85 | 127.3 ± 48.30 | 141.44 ± 56.6 | 0.05    |

NS = nonsignificant

Data present in standard deviation (SD)

Significant at P < 0.05
pregnant women worldwide. Similar to earlier literature, in this study previous gestational medical conditions could be considered one of the potential confounders that might predispose for the incidence of PRMCs. A history of gestational medical conditions, such as preeclampsia or GDM was found to be associated with a high risk of preeclampsia in the second pregnancy or postpartum development of type 2 DM, respectively. Moreover, the development of GDM or hyperglycemia during pregnancy represents a risk factor for future maternal complications like type 2 DM which could be seen 6 weeks after delivery to 28 years postpartum and is linked to an increased risk of metabolic syndrome and adverse CV outcomes for the mother later in life. Accordingly, women with a history of PRMCs may be prone to the development of cardio-metabolic disorders and early increases in CVD risk.[10-13]

During pregnancy, there is an increase in the incidence of hypertensive disorders as the maternal CV system throughout pregnancy undergoes progressive hyperdynamic circulatory and metabolic changes. Therefore, blood pressure elevation during pregnancy could be associated with the progression of different hypertensive disorders such as preeclampsia.[14] In this study, although the BP measurements were within the acceptable ranges, different aspects of BP readings were observed and significantly considered as potential risk factors particularly DBP which was significantly higher among participants with PRMCs than in normal pregnant women. Furthermore, SBP was also significantly associated with certain obstetric characteristics. It was significantly increased during the gestational period 25–37 weeks compared to the beginning of the gestational period and with the increased gravidity (>G3). Earlier studies indicated that elevated DBP could be a potential risk factor for both the mother and neonate. On the contrary, Odgaard et al.[15] and Stamillo et al.[16] found that SBP higher than 130mm Hg was significantly associated with the development of preeclampsia later in pregnancy. In comparison to other studies, our findings were consistent with that reported by Rebello et al.[17] which showed that a decrease in SBP and DBP was observed from the first to the second trimester then significantly increased up to 30–45 postpartum days. Our findings were also consistent with a study conducted by Ayala et al.[18] which revealed predictable patterns of BP variations and were correlated with gestational age in pregnancies complicated from GH or even preeclampsia. In the study findings of Ayala et al.,[18] the BP readings were stable until the 22nd week of pregnancy and then showed a significant linear BP increase in the second half of pregnancy; such complications could be protected from a single daily use of low-dose aspirin.[19]

Multiple pregnancies are considered high risk for a number of different obstetric complications, including spontaneous abortion, hypertensive disorders, placenta previa, and fetal malformations.[20] In this study, SBP, TC, LDL, and non-HDL readings were significantly associated with increased gravidity (>G3). A comparable study by Jun Wei et al.[21] and by Chetanjit[22] showed that pregnancy complications were relatively common in women with multiple pregnancies. The findings of our study were in concordance with a study by English et al.[23] which reported that multiple pregnancies are considered one of the risk factors associated with hypertensive disorders of pregnancy (RR: 2.93, 95% CI: 2.04–4.21).

Regarding the findings of lipid profile among the study participants, there was a statistically significant difference concerning TC, LDL, HDL, and non-HDL levels among pregnant women suffering from PRMCs. On the contrary, the lipid parameters in association with the different obstetric characteristics particularly TC, LDL, and non-HDL were significantly increased as the gravidity increased (>G3) alongside a significant decrease in HDL level as the gestational age increased (25–37 weeks). It has been recognized that there are no reference ranges defined for lipid parameters, including TC, LDL, HDL, and triglycerides during normal pregnancy. However, it has been shown that these lipid panels tend to elevate especially in the second and third trimesters of pregnancy.[24]

During pregnancy, there

| Variables | Group A (n = 10) | Group B (n = 4) | Group O (n = 66) | Group AB (n = 12) | P Value |
|-----------|-----------------|----------------|-----------------|------------------|---------|
| SBP (mm Hg) | 128.00 ± 15.48 | 120.00 ± 0.00 | 117.09 ± 21.81 | 121.67 ± 11.14 | 0.4012 NS |
| DBP (mm Hg) | 78.00 ± 4.21  | 80.00 ± 0.00  | 76.09 ± 7.21   | 75.00 ± 5.22   | 0.5438 NS |
| TC (mg/dL)  | 166.00 ± 29.51 | 125.00 ± 28.87 | 163.18 ± 49.14 | 140.67 ± 32.43 | 0.1752 NS |
| LDL (mg/dL) | 104.80 ± 21.13 | 103.00 ± 9.23  | 110.12 ± 23.37 | 100.00 ± 26.21 | 0.5055 NS |
| HDL (mg/dL) | 40.80 ± 3.79  | 44.00 ± 4.62   | 39.85 ± 4.95   | 41.00 ± 3.86   | 0.3329 NS |
| non-HDL (mg/dL) | 125.20 ± 31.94 | 81.00 ± 24.25 | 123.88 ± 53.69 | 99.67 ± 34.00 | 0.1733 NS |

NS = nonsignificant

Data present in standard deviation (SD)
is an increase in TC, LDL, and triglycerides due to changes in sex steroid hormones specifically elevated maternal estrogen concentrations. Furthermore, there is a dense increase in hepatic lipase activity which could cause surges of triglyceride synthesis in the liver and is associated with raised LDL levels.[25]

Non-HDL represents the cholesterol content in all atherogenic lipoproteins and is considered the best predictor among all cholesterol measures for CV events with the treatment goal determined to be above 130 mg/dL. Non-HDL levels may be better quantified and more closely associated with CV outcomes than the levels of LDL.[26,27] Earlier studies were in strong concordance with the findings of this study where maternal serum lipid levels increase during pregnancy. The increase in serum lipid levels was observed with the progression of gestational age and associated with the incidence of different PRMCs, including pre eclampsia and GDM.[28,29] Moreover, different lipid panels are increasing during the last two trimesters, with the maximum increase observed during the third trimester compared to the second trimester. It is also accompanied by a decrease in HDL level in the third trimester compared to the second trimester.[30] A systematic review and meta-analysis study by González-Clemente et al.[29] showed that women who develop pre eclampsia have elevated TC, non-HDL, and triglycerides levels during all trimesters of pregnancy alongside lower HDL levels during the third trimester.

An interesting potential confounder detected during this study was the significant incidence of different PRMCs among pregnant women having the blood phenotype O. These results were in agreement with earlier literature and meta-analysis studies which reported that ABO blood group phenotypes might be associated with several different medical conditions, including preeclampsia, bleeding, and neoplastic diseases.[31,32] Recently, genetic studies found a possible support to the relationship between ABO blood group phenotypes and CV risk. These studies reported that the ABO locus was associated with the overexpression and activation of different inflammatory markers such as tumor necrosis factor-alpha (TNF-α), vascular adhesion molecule 1 (VCAM-1), and E-selectin levels.[33,34] However, due to the small sample size recruited in this study, data from other prospective cohort studies to show the possible correlation between the incidence of PRMCs with different blood group phenotypes is important.

Strengths and limitations
The study has some limitations that should be taken into account. The primary limitation was the small sample size of the participants who were recruited during this relatively short period of the study. Additionally, the FRS was originally developed using older populations, and in this study may not be directly applicable to our participants due to limitations involving its retrospective design, young population, and conduction over a relatively short duration. Therefore, we indirectly apply this CV scoring system through the use of its variables alongside non-HDL that were added to other maternal and obstetric variables to predict the potential confounders available in pregnant women with PRMCs. This could be considered one of the strengths of this study facing the earlier limitations. Another important strength was the inclusion of maternal blood characteristics and weighing them against the incidence of PRMCs which could be a starting point for other large prospective cohort studies to further explore this potential.

Conclusion
The findings of this study revealed that GH and DM were the most common PRMCs. This study also highlighted that certain potential confounders related to maternal, obstetric, and clinical characteristics could be suggested as additional involvements to predict the risk and influence of these conditions during pregnancy. The identification of the role of these confounders could further provide an opportunity for lifestyle changes and other interventions implemented earlier in the life course of pregnant women.

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Conflicts of interest
There are no conflicts of interest.

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