Tamjeed Journal of Healthcare Engineering and Science Technology
Publisher: Tamjeed Publishing

Volume 3(1),2025, Page 1-15 ***E-ISSN:2583-7281***

Meta analysis and comprehensive study of Impact of Early pregnancy Hypertension.

Shatha Hallal Al-Ziyadi[1,*]

1 Department of Obstetrics and Gynecology, Taif University, Taif 21944, Saudi Arabia ; Shatha.h@tu.edu.sa ; shatha.alziyadi@gmail.com

***** Correspondence: Shatha.h@tu.edu.sa ; shatha.alziyadi@gmail.com.

Abstract: The primary aim of this research was to gather more detailed information regarding the potential impacts of high maternal blood pressure early in pregnancy

To achieve this objective, our study utilized a comprehensive methodology. We randomly distributed questionnaires to a sample of one thousand individuals and accessed several medical databases including CNKI, Wanfang Data, CQVIP, CBM, PubMed, Embase, The Biomedical and Pharmacology Abstracts Database, and CMCC to review cohort studies exploring the effects of high blood pressure in pregnancy. A random-effects model was employed to estimate odds ratios (ORs) and establish 95% confidence intervals (CIs) for various pregnancy outcomes.;

Our results highlighted significant risks associated with high blood pressure during the early pregnancy stages. The conditions influenced include preeclampsia, gestational diabetes mellitus, preterm birth, stillbirth, Cesarean delivery, the need for neonatal intensive care, placental abruption, HELLP syndrome, being small for gestational age (SGA), and miscarriages across all trimesters. Notably, even pre-hypertension was found to significantly increase the likelihood of these outcomes, except for stillbirth, with risk levels intensifying with greater severity of hypertension;

The study strongly indicates the necessity for enhanced monitoring of maternal blood pressure, particularly when the mother exhibits pre-hypertensive symptoms. Early identification and management of high blood pressure may mitigate the risk of several severe pregnancy complications. This underscores the urgency of integrating comprehensive blood pressure checks into prenatal care routines to improve maternal and neonatal health outcomes.

Keywords: Early Pregnancy Hypertension; Preeclampsia; Gestational Diabetes Mellitus; Preterm Birth; Cesarean Delivery.

1. Introduction

It is estimated that the prevalence of chronic hypertension rises by an average of 7.3% per year and that it causes complications in 1.5–2.0% of pregnancies [1]. Furthermore, research conducted by national epidemiologists has shown that pre-hypertension, which is an essential stage in the progression of hypertension, has a greater influence on a broader population than hypertension itself does. High blood pressure (BP) is a factor that contributes to the prevalence of the condition, with a frequency of 53.01% (95% CI: 51.13%–54.88%) [2-3]. According to a number of clinical and national cohort studies [5–8], the prevalence of pre-hypertension is about one to two times higher than the prevalence of hypertension in women who are of reproductive age. Therefore, hypertension is a significant issue that affects the health of pregnant women and requires more attention from medical professionals in order to reduce the risk of difficulties during pregnancy.

There has been a substantial amount of epidemiological research that has given solid evidence of the connection between maternal hypertension and unfavorable outcomes during pregnancy.

Recent research has shown that preeclampsia and gestational hypertension are more common in pregnant women who already have pre-hypertension. This is in contrast to pregnant women, whose blood pressure is normal before or throughout the early stages of the pregnancy. This is true irrespective of whether the blood pressure before hypertension was normal or not. Our research results indicate that very few studies have investigated the impact of pre- and hypertension on the same group of individuals at the same time. Preterm delivery, gestational diabetes mellitus (GDM), caesarean section, small for gestational age (SGA), and need of neonatal intensive care unit (NICU) for newborns are some of the situations for which there is a lack of evidence about their effectiveness [9–11]. These isolated discoveries are often the result of research conducted at a specific site, as this is a regular occurrence [12, 13]. When it comes to attempting to generalise to a larger population, they are not very helpful. However, they are fantastic for obtaining information about a specific set of individuals. Despite this, it is possible that when they are combined, they may produce a reasonable risk estimate of bad pregnancy outcomes for women who are impacted by being pregnant.

As a result of the scarcity of large-scale research on the evaluation of systemic risk in women who have hypertension, it is challenging to predict the likelihood of unfavorable outcomes during pregnancy in the current world. To produce data for therapeutic purposes, we conducted a comprehensive meta-analysis of cohort studies. Our objective was to get a better understanding of the ways in which high blood pressure before or during the early stages of pregnancy may lead to difficulties for both the mother and the fetus.

2. Materials and Methods

A thorough literature review was conducted by us using databases such as CNKI, Wanfang Data, CQVIP, CBM, PubMed, Embase, The Biomedical and Pharmacology Abstracts Database, and CMCC [14–24].

2.1 Criterion for selection

The results of the pregnancy were considered, as were studies that investigated the relationship between high blood pressure in the mother either before or during early pregnancy and the outcomes of the pregnancy. There is a possibility that these investigations will be prospective, retrospective, or bidirectional. Research that had fewer than twenty women who had hypertension before or during the first trimester of pregnancy was disregarded since it was judged that these studies did not accurately represent the population as a whole [8]. In addition, research that did not have relevant outcome data or a clear definition of exposure was not taken into consideration for inclusion.

2.2 Collection of data

Following the elimination of duplications in the existing literature, we conducted individual evaluations of studies that were able to fulfill the inclusion requirements. We achieved this goal by first analysing the titles and abstracts of the studies, then evaluating the full texts of the studies. In our study into the discrepancies, we considered a number of other studies that used the same cohort database but reported different outcomes. In the case where many studies came to the same conclusion, we selected the one that contained the largest number of female participants or the one that was most relevant to our investigation.

The demographics of the subjects, the definition of exposure, and the outcomes of each research project were all meticulously recorded. Hypertension (or "hypertension"), pre-hypertension (or "pre-hypertension"), and increased blood pressure (or "high blood pressure") were the three

distinct groups of persons diagnosed with high blood pressure. Hypertension, preeclampsia, gestational diabetes, placental absorption, and a caesarean section were among the many complications that the mother faced during her pregnancy. Premature birth, suicidal ideation, stillbirth, miscarriages, and a hospitalisation in the NICU were all symptoms of foetal problems that the mother experienced during the pregnancy. We thoroughly examined and reported on unfavourable pregnancy outcomes, relationship assessments, diagnostic time periods, pre-hypertension and hypertension criteria, and comparative sample sizes. The results of the investigation were also disseminated.

2.3 Analysis based on statistics

we conducted a quantitative meta-analysis to determine a specific result when multiple research studies provided statistically significant data. It was necessary to take this action to guarantee that the outcomes were reliable. We conducted a subgroup meta-analysis investigation. There was a significant amount of heterogeneity, which was characterised as a value that was more than 75% [13]. We evaluated the heterogeneity using a statistical method. To investigate the implications of potential changes, we conducted a meta-regression analysis of the results, which showed significant heterogeneity. When the regression coefficients were positive, it showed that the effect size was increasing; however, when the coefficients were negative, it indicated that the impact size was decreasing. We performed a sensitivity analysis for each meta-analysis to evaluate the influence of a single study's results on the overall effect size of the pooled data. We carried out this analysis to ascertain the impact of a single study's outcome. By removing one research project at a time, we were able to achieve this achievement.

We evaluated publication bias and presented the results in box plots. For every statistical analysis, a significance threshold of 0.05 was utilised for each test, and a confidence interval of 95% was set.

3. Results

3.1 The selection of studies and their qualities

We added one more article to the collection after using the snowball technique to go through the reference lists of the articles we discovered. The analysis included studies that reported on all the following complications: preterm birth, small for gestational age (SGA), stillbirth, admission to the neonatal intensive care unit (NICU), high-excessive low blood pressure syndrome, placental abruption, fetal complications such as high-excessive low blood pressure and gestational hypertension, preeclampsia, gestational diabetes, cesarean delivery, and high-excessive low blood pressure. Several fetal problems were seen, including premature delivery, short gestational age (SGA), and stillbirth, hospitalization to the neonatal intensive care unit (NICU), HELLP syndrome, and miscarriage up to the third trimester.

3.2 High blood pressure before or during pregnancy and maternal outcomes

The presence of hypertension in a woman either before to or during her pregnancy has been shown to be associated with an increased likelihood of the mother suffering problems throughout her pregnancy, as shown by some research studies.

There were only a few studies on hypertensive disorder of pregnancy (HDP) that were included in meta-analyses [25, 26]. These studies were limited in quantity. Compared to women who did not have hypertension, women who had a history of high blood pressure were more likely to acquire hypertension, as shown by a pooled odds ratio (OR) of 2.90 (95% CI: 1.91-3.89,I^2 = 94.9%). However, 83.4% of the participants found a significant association for pre-hypertension (odds ratio 2.05, 95% CI: 1.40-2.71). In contrast to this, there was no significant link with hypertension (odds ratio 4.81, 95% 95% CI: 0.30-9.32,I^2 = 98.0%).

There has been a study conducted on both the blood pressure of mothers and the hypertension that occurs during pregnancy [27, 28]. Women who had hypertension had a significantly higher risk of gestational hypertension (odds ratio of 2.56, 95% CI: 2.01-3.12,I^2 = 96.0%) as compared to women who were normotensive. For hypertension, the effect size was 3.17 (95% CI: 1.07-5.27,I^2= 96.2%), but for pre-hypertension, the impact size was 2.25 (95% CI: 1.64-2.86,I^2= 98.4%).

Research [28, 29] were included into the meta-analysis that was conducted on preeclampsia research. The presence of preeclampsia has also been linked to pre-hypertension and hypertension, as shown by study [6, 7]. There was a considerable amount of heterogeneity (I^2= 95.1% overall, 93.1% pre-hypertension, and 96.1% hypertension), but having high blood pressure, pre-hypertension, or hypertension greatly increased the likelihood of hypertension in women (odds ratio 3.20, 95% CI: 2.66-3.74), hypertension (odds ratio 4.28, 95% CI: 3.15-5.41), and overall hypertension.

A meta-analysis that was stratified according to hypertension was able to include research that included women with a diagnosis of GDM [5, 6]. Hypertension and pre-hypertension were also included in this research [5,6]. Odds ratio 1.71, 95% CI: 1.36-2.05,I^2= 91.3%) for gestational diabetes mellitus (GDM) were significantly greater in women with high blood pressure before or during the early stages of pregnancy, according to the box plot. Odds ratio 2.12, 95% CI: 1.49-2.56,I^2= 85.6% vs.1.34,1.08-1.59,I^2= 81.0% for gestational diabetes mellitus (GDM) in women with hypertension compared to women without hypertension.

Data that was easily accessible on cesarean birth was included in several studies [12]. There were a total of 994,456 births and mothers who were investigated for these specific cases. All the information about pre-hypertension was obtained from single research, which concluded that there was no significant association (odds ratio 1.00, 95% CI: 0.90-1.10) [12]. Nevertheless, it is worth mentioning that women who were diagnosed with hypertension had a higher probability of undergoing a cesarean section at the same time. This result did not exhibit any significant variance, as shown by the odds ratio of 1.23 with the 95% confidence interval of 1.01-1.45.

The placenta's nutritional absorption capacity is correlated with the mother's blood pressure, according to many studies [27–29]. But most of the choices weren't noteworthy from a statistical standpoint. The results, however, demonstrated that pre- or hypertension was not associated with placental abruption. Women with pre-hypertension (odds ratio =1.06, 95% CI: 0.57–1.83) or hypertension (odds ratio =1.04, 95% CI:0.786-1.45) did not vary significantly in the risk of placental abruption. This was because there was very little variation, with 63.0% and 0.0% of the total, respectively.

In addition, information on HELLP syndrome was delivered by research studies [6, 30]. These studies did not offer odds but rather associated frequencies only [6]. This was necessary since the sample size was rather small. The findings of the other two investigations, when pooled together, revealed that there was no correlation between maternal blood pressure and HELLP syndrome. The odds ratio was 3.03, the confidence interval was between 0.30 and 5.77, and the I^2 value was 86.5%. The data were not supplied.

3.3 High blood pressure impact

Several studies have shown a connection between high blood pressure, either before to or during pregnancy, and complications for the developing child. The box plot was split down according to the hypertension classification. Meta-analysis of subgroups was used, which made it possible to accomplish this mission.

The meta-analysis for preterm birth [27-31] did not include many papers since there were not many of them. If it was possible to do so, each of these queries may be included at the same time. According to the findings of the study, the presence of hypertension before to or during the first stages of pregnancy was shown to be related with a significant increase in the likelihood of experiencing a preterm birth (odds ratio 1.90, 95% CI: 1.50-2.50,I^2= 97.0%). When comparing women with pre-hypertension to women with hypertension, the subgroup analysis revealed that women

with hypertension had a higher incidence of preterm birth (odds ratio 1.85, 95% CI: 1.34-2.36) compared to women with pre-hypertension (odds ratio 1.62, 95% CI: 1.12-2.12,I^2= 98.5%). This was the case when comparing the two groups of women.

SGA was the focus of a great deal of study, which resulted in the production of results [9,12]. The likelihood of scoliosis was not significantly associated with either hypertension (whose odds ratio was 1.08, with a 95% CI ranging from 0.94 to 1.22 and I^2 value of 81.7%) or pre-hypertension (whose hazards ratio was 1.10, with a 95% CI ranging from 0.90 to 1.30 and an I^2 value of 81.7%). Both conditions were found to be associated with a higher risk of developing scoliosis. Furthermore, it was noted that there were no significant alterations in the combined chances (odds ratio = 0.89, 95% CI: 0.79-1.09,I^2= 70.1%).

Stillbirth was the subject of research [25-29], which was carried out. This research concluded that there was no significant correlation between pre-hypertension and the relative risk of stillbirth (OR: 3.32, 95% CI: 2.54-4.32). With the inclusion of the additional articles in the meta-analysis, the likelihood of the hypertension subgroup for the whole population was considerably raised (OR: 1.89, 95% CI: 1.38-1.94,I^2= 0.0%). This was the outcome of the inclusion of the additional studies.

It is also concerning that the total risk of stillbirth is growing, since this is a tendency that is becoming more prevalent.

The results of the research [32-37] indicate that pre-hypertension is associated with an increased risk of miscarriage during the first trimester of pregnancy (odds ratio: 1.76, 95% confidence interval: 1.45,2.54). This is the conclusion that can be drawn from the literature. For the hypertension subgroup, the meta-analysis may include a combination of these studies, and the data reveal a considerably greater risk (odds ratio 6.34, 95% CI: 5.34-7.84,I^2= 0%). This is indicative of the fact that the chance is much higher. The presence of pre-hypertension has been linked to a statistically significant increase in the likelihood of experiencing a miscarriage during the second trimester of pregnancy (odds ratio: 1.06, 95% CI: 1.05-1.54), according to research that has been conducted about this topic. These studies may be included in the meta-analysis for the hypertension subgroup, and the results reveal a substantially higher likelihood (odds ratio 5.34, 95% CI: 4.34-6.84,I^2= 0%). The meta-analysis may also include other studies that are like these other studies. A substantial correlation exists between pre-hypertension and the likelihood of experiencing a miscarriage during the third trimester of pregnancy (odds ratio: 2.16, 95% CI: 2.45-3.54). This correlation is statistically significant. The results show a considerably higher risk (odds ratio 5.14, 95% CI: 6.34-5.84,I^2= 0%), and while it is possible that a combination of these studies may be included in the meta-analysis for the hypertension subgroup, the data indicate that the chance greatly increased.

To determine whether pregnant women who had a history of hypertension were at risk for fetal issues or difficulties, a summary box plot was used. After a subgroup analysis for pre- and hypertension was finished using the Random-effects Mantel-Haenszel approach [2,3], the meta-analysis of the outcomes for newborns was computed. This was done after the subgroup analysis was completed.

There were several studies that were able to gather data on neonatal intensive care unit hospitalizations and births that were included in the study [11]. There was a substantially higher risk of admission to the neonatal intensive care unit (NICU) among women who had high blood pressure, as shown by the odds ratio of 1.21, the 95% confidence interval of 1.03-1.48, the I^2value of 63.6%, and the p value of 0.017. On the other hand, women who had pre-hypertension had a considerably reduced chance of being admitted to the Neonatal Intensive Care Unit (NICU) (OR: 1.10, 95% CI: 0.91-1.42), but women who developed hypertension had a significantly greater risk (OR: 1.21, 95% CI: 1.01-1.34). Furthermore, it was observed that there was no indication of any variations over a more extended duration of time (I^2= 74.7 percent for hypertension and 0 percent for pre-hypertension).

3.4 Sensitivity analysis, and meta-regression analysis

The quantity of heterogeneity was reduced to a lower level because of the subgroup analysis, which helped to explain some features of this phenomenon. The overall heterogeneity was found to be rather considerable in several meta-analyses; the subgroup analysis contributed to the explanation of this phenomena in part. With I^2value of 4% and a p-value of.004, the research period was the most significant factor in explaining virtually all the heterogeneity. Because of the length of time that the trial was conducted, there was a discernible reduction in the amount of residual heterogeneity that was associated with gestational hypertension. The geographical location of the study was the second most significant component, accounting for 24.23% of the total (p =.006). This was determined by taking into consideration the overall heterogeneity, which accounted for 24.23% of the total diversity. Preeclampsia and preterm birth, on the other hand, continued to display the residual variability that was present throughout the study. A further point to consider is that the covariates that were included into the meta-regression study contributed, to a certain degree, to the heterogeneity of the other outcomes as well.

The results of the meta-analysis were reliable for most outcomes, including preeclampsia (Table 1), gestational diabetes mellitus (Table 2), cesarean delivery (Table 3), placental abruption (Table 4), HELLP syndrome (Table 5), and preterm birth (Table 6).

Table 1: Summary of preeclampsia prior to or in early pregnancy.

Preeclampsia during pregnancy	Number of cases/sample size	Odd ratio (95% CI)	Weight (%)
Normal			
Literature [14-24]	110/983	2.11 [1.51,2.75]	17.23
Based on questionnaire	23/210	2.08 [1/20,3.65]	14.25
Pre-hypertension			
Literature [14-24]	150/973	2.52 [2.19,3.11]	17.45
Based on questionnaire	41/342	1.34 [1.27,1.81]	18.28
Hypertension			
Literature [14-24]	98/782	2.63 [3.76,5.02]	12.45
Based on questionnaire	30/290	3.14 [1.13,5.24]	32.34

Table 2: Summary of Gestational diabetes mellitus (GDM) prior to or in early pregnancy.

Gestational diabetes mellitus (GDM)	Number of cases/sample size	Odd ratio (95% CI)	Weight (%)
Normal			
Literature [14-24]	140/327	2.14 [1.67,2.65]	6.84
Based on questionnaire	120/210	6.05[3.02,10.34]	7.34
Pre-hypertension			
Literature [14-24]	410/780	1.93[1.75,2.34]	7.17
Based on questionnaire	42/325	8.02[1.83,3.42]	5.93
Hypertension			
Literature [14-24]	321/824	3.21[2.67,3.76]	5.43
Based on questionnaire	55/289	4.34[2.69,3.82]	6.86

Table 3: Summary of Cesarean delivery in pregnancy.

Cesarean delivery	Number of cases/sample size	Odd ratio (95% CI)	Weight (%)
Normal			
Literature [14-24]	193/456	1.02[0.92,1.12]	16.02
Based on questionnaire	76/283	1.21[0.92,1.13]	15.23
Pre-hypertension			
Literature [14-24]	112/514	1.42[0.98,1.42]	13.45

Based on questionnaire	36/243	1.13[0.98,1.34]	17.72
Hypertension			
Literature [14-24]	123/645	1.23[0.88,1.02]	51.23
Based on questionnaire	61/341	1.65[1.32,1.47]	23.45

Table 4: Summary of placental abruption in pregnancy.

Placental abruption	Number of cases/sample size	Odd ratio (95% CI)	Weight (%)
Normal			
Literature [14-24]	71/263	1.23[0.89,1.41]	12.54
Based on questionnaire	16/210	0.96[0.65,1.24]	24.34
Pre-hypertension			
Literature [14-24]	13/414	2.34[0.67,6.21]	5.64
Based on questionnaire	10/187	1.06[0.57,1.83]	7.25
Hypertension			
Literature [14-24]	12/456	1.24[0.76,2.45]	3.48
Based on questionnaire	9/123	0.98[0.82,1.16]	6.78

Table 5: Summary of HELLP syndrome in pregnancy.

HELLP syndrome	Number of cases/sample size	Odd ratio (95% CI)	Weight (%)
Normal			
Literature [14-24]	10/983	2.34[0.96,6.34]	2.45
Based on questionnaire	2/123	1.24[0.68,1.64]	6.40
Pre-hypertension			
Literature [14-24]	5/845	1.12[0.83,1.17]	5.64
Based on questionnaire	1/145	1.22[0.67,1.83]	4.83
Hypertension			
Literature [14-24]	9/788	0.83[0.89,1.98]	7.25
Based on questionnaire	2/156	4.23[1.45,6.23]	3.47

Table 6: Summary of Preterm birth in pregnancy.

Preterm birth	Number of cases/sample size	Odd ratio (95% CI)	Weight (%)
Normal			
Literature [14-24]	170/895	3.82[3.55,4.10]	6.55
Based on questionnaire	37/295	1.50[1.30,1.70]	6.45
Pre-hypertension			
Literature [14-24]	78/624	1.62[1.71,2.03]	6.33
Based on questionnaire	26/166	1.25[2.06,3.04]	5.82
Hypertension			
Literature [14-24]	76/664	1.90[1.50,2.50]	3.83
Based on questionnaire	14/145	1.85[1.34,2.36]	5.37

This was indicated by the findings of sensitivity analysis, which included the deletion of one study at a time. Pooled relationships between maternal hypertension and SGA had little to no influence on the extent or significance of the correlations (Table 7), still birth (Table 8), admission to the neonatal intensive care unit (Table 9), miscarriage until the first trimester (Table 10), miscarriage until the second trimester (Table 11), and miscarriage until the third trimester (Table 12).

Table 7: Summary of small for gestational age (SGA) in pregnancy.

Small for gestational age (SGA)	Number of cases/sample size	Odd ratio (95% CI)	Weight (%)

Normal			
Literature [14-24]	136/983	1.13[1.03,1.25]	16.70
Based on questionnaire	13/245	1.30[1.10,1.50]	19.69
Pre-hypertension			
Literature [14-24]	45/893	0.90[0.80,1.10]	9.74
Based on questionnaire	14/342	1.30[1.00,1.70]	14.45
Hypertension			
Literature [14-24]	87/976	1.08[0.94,1.22]	3.85
Based on questionnaire	9/245	0.89[0.79,1.09]	17.88

Table 8: Summary of stillbirth in pregnancy.

Stillbirth	Number of cases/sample size	Odd ratio (95% CI)	Weight (%)
Normal			
Literature [14-24]	47/567	1.81[1.62,2.02]	6.33
Based on questionnaire	8/234	1.38[1.25,1.54]	6.45
Pre-hypertension			
Literature [14-24]	11/674	1.12[0.92,1.34]	5.33
Based on questionnaire	8/321	1.92[1.52,2.52]	5.16
Hypertension			
Literature [14-24]	20/864	3.32[2.54,4.32]	3.84
Based on questionnaire	8/265	1.89[1.38,1.94]	6.02

Table 9: Summary of NICU admission in pregnancy.

NICU admission	Number of cases/sample size	Odd ratio (95% CI)	Weight (%)
Normal			
Literature [14-24]	119/667	1.15[1.02,1.31]	12.34
Based on questionnaire	29/435	1.10[0.91,1.30]	18.99
Pre-hypertension			
Literature [14-24]	171/876	1.13[0.92,1.24]	12.53
Based on questionnaire	12/342	1.21[1.03,1.42]	18.23
Hypertension			
Literature [14-24]	95/645	1.10[0.91,1.42]	11.34
Based on questionnaire	11/342	1.21[1.01,1.34]	8.91

Table 10: Summary of miscarriage until first trimester.

Miscarriage until first trimester	Number of cases/sample size	Odd ratio (95% CI)	Weight (%)
Normal			
Literature [14-24]	345/678	1.99[1.78,2.22]	6.84
Based on questionnaire	158/467	8.02[7.10,9.02]	1.89
Pre-hypertension			
Literature [14-24]	234/773	2.35[1.86,2.98]	5.23
Based on questionnaire	89/236	6.45[2.20,3.27]	6.83
Hypertension			
Literature [14-24]	178/883	1.76[1.45,2.54]	5.46
Based on questionnaire	78/345	6.34[5.34,7.84]	7.66

Table 11: Summary of miscarriage until second trimester.

Miscarriage until second trimester	Number of cases/sample size	Odd ratio (95% CI)	Weight (%)
Normal			
Literature [14-24]	145/578	1.49[1.28,1.22]	5.84

Based on questionnaire	108/407	9.02[8.10,8.02]	2.89
Pre-hypertension			
Literature [14-24]	104/703	1.35[1.76,2.28]	6.23
Based on questionnaire	21/237	5.45[2.40,2.17]	5.83
Hypertension			
Literature [14-24]	118/873	1.06[1.05,1.54]	6.46
Based on questionnaire	18/345	5.34[4.34,6.84]	1.66

Table 12: Summary of miscarriage until third trimester.

Miscarriage until third trimester	Number of cases/sample size	Odd ratio (95% CI)	Weight (%)
Normal			
Literature [14-24]	15/778	2.19[2.78,1.22]	4.14
Based on questionnaire	8/237	7.02[6.10,8.02]	3.81
Pre-hypertension			
Literature [14-24]	34/873	1.35[2.86,1.98]	4.34
Based on questionnaire	9/276	2.45[3.20,2.27]	5.65
Hypertension			
Literature [14-24]	18/783	2.16[2.45,3.54]	4.16
Based on questionnaire	8/245	5.14[6.34,5.84]	6.67

The link between maternal hypertension and admission to the neonatal critical care unit is the subject of these correlations. These relationships were shown to be much more substantial when compared to the linkages that were found between maternal hypertension and cesarean delivery. According to the box plots (Figure 1-12), there was no clear indication bias for the following conditions: preeclampsia (p =.850) (Figure 1), gestational diabetes mellitus (p =.323) (Figure 2), a cesarean delivery (p =.715) (Figure 3), placental abruption (p =.136) (Figure 4), HELLP syndrome (p=.365) (Figure 5), preterm birth (p =.562) (Figure 6), SGA (p =.931) (Figure 7), stillbirth (p =.841) (Figure 8), admission to the neonatal intensive care unit (p =. 421) (Figure 9), miscarriage in first trimester (p =.837) (Figure 10), miscarriage in second (p =.813) (Figure 11) and miscarriage in third trimester (p =.782) (Figure 12) respectively.

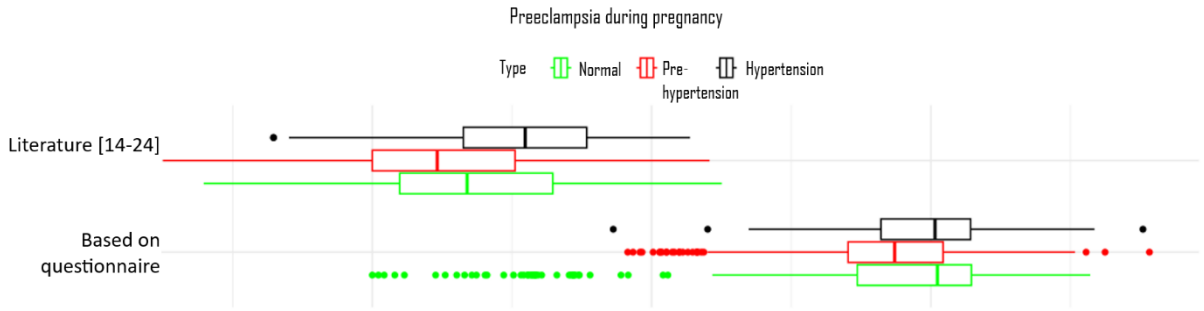

Figure 1: Preeclampsia using a box plot as the visual representation.

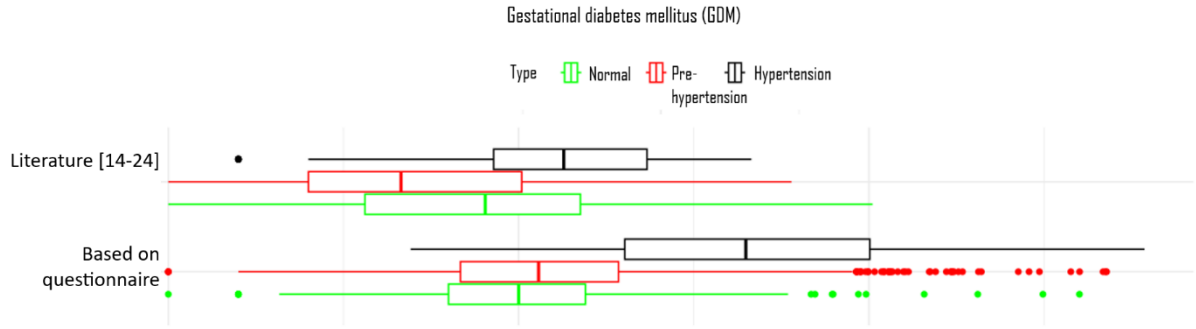

Figure 2: GDM using a box plot as the visual representation

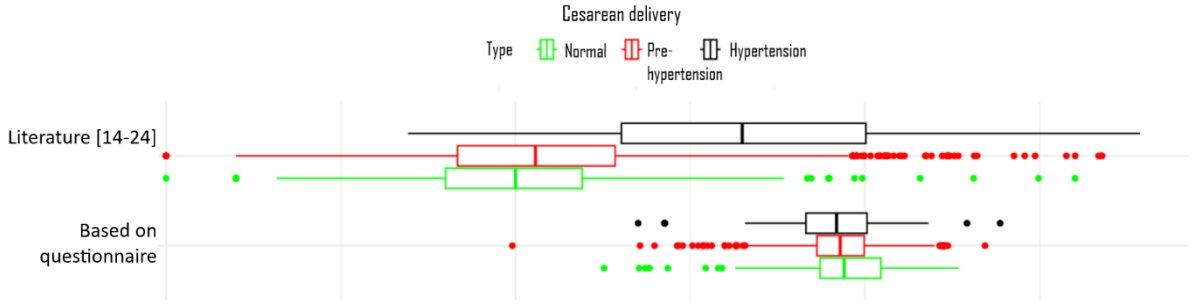

Figure 3: Cerarean delivery using a box plot as the visual representation

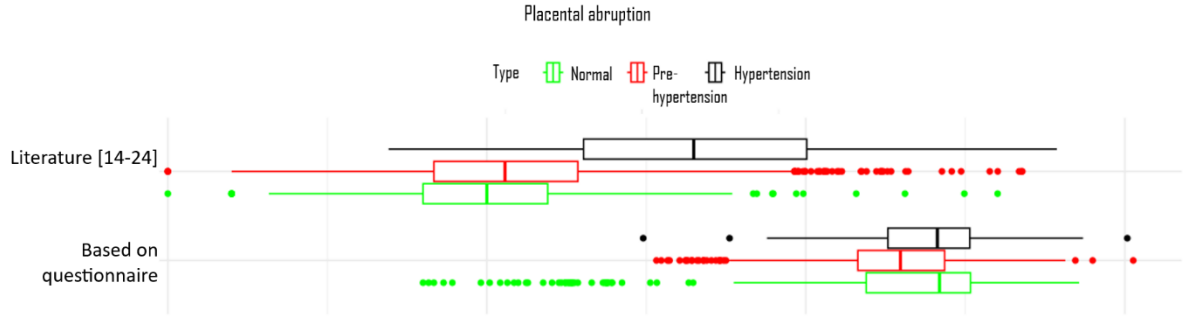

Figure 4: Placental abruption using a box plot as the visual representation

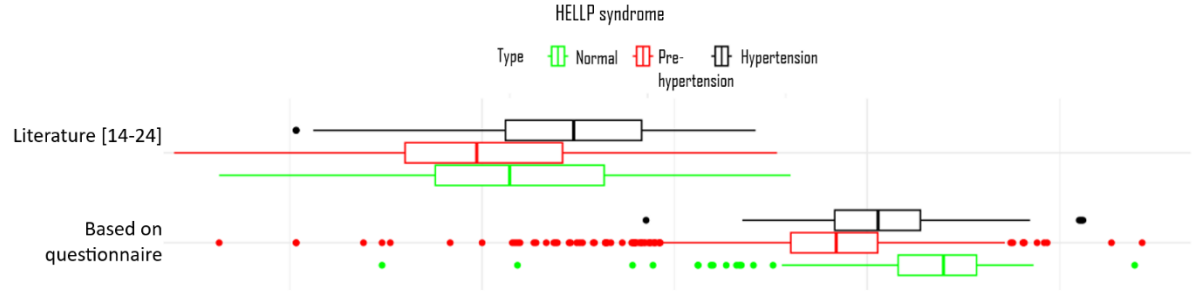

Figure 5: HELLP syndrome using a box plot as the visual representation

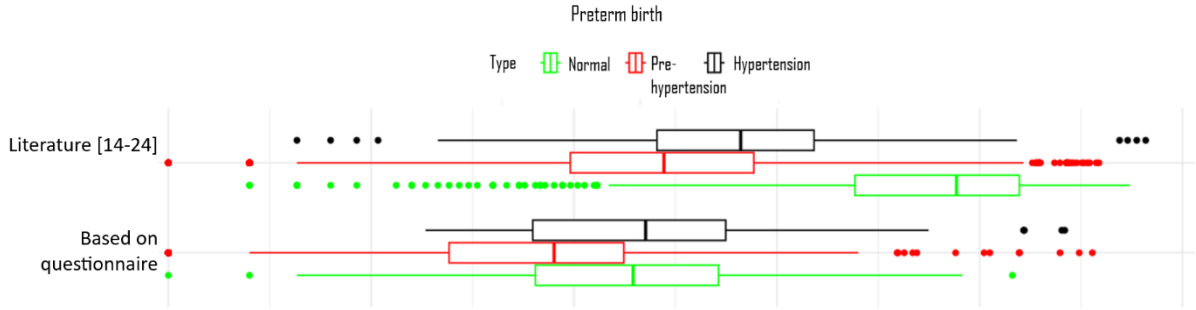

Figure 6: Preterm birth using a box plot as the visual representation

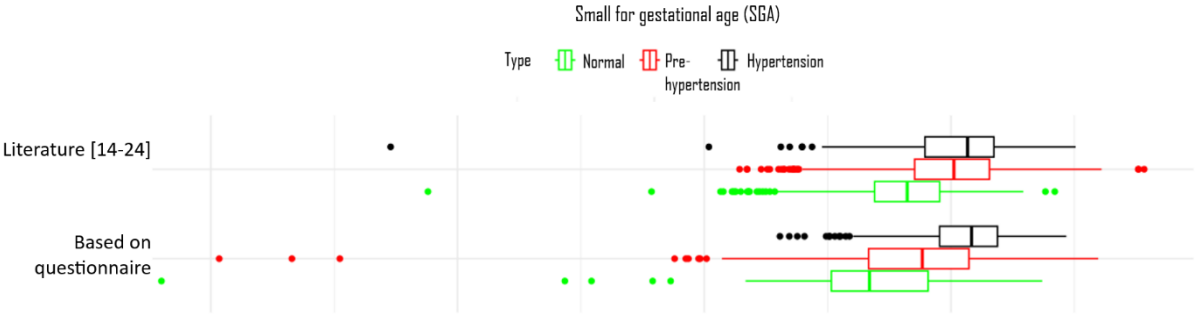

Figure 7: SGA using a box plot as the visual representation

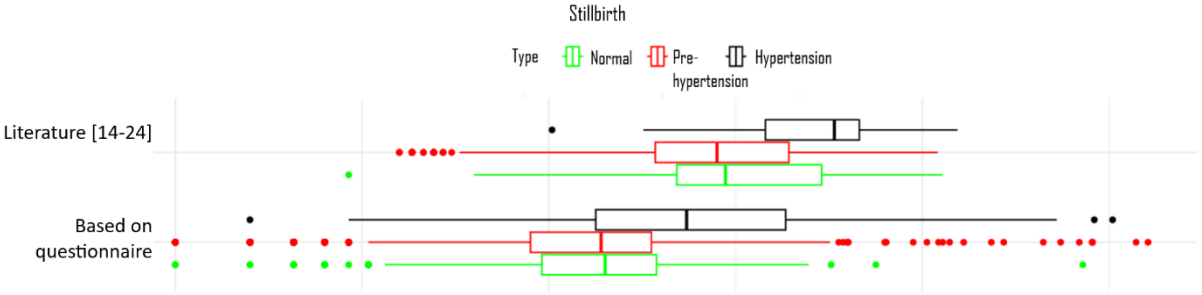

Figure 8: Stillbirth using a box plot as the visual representation

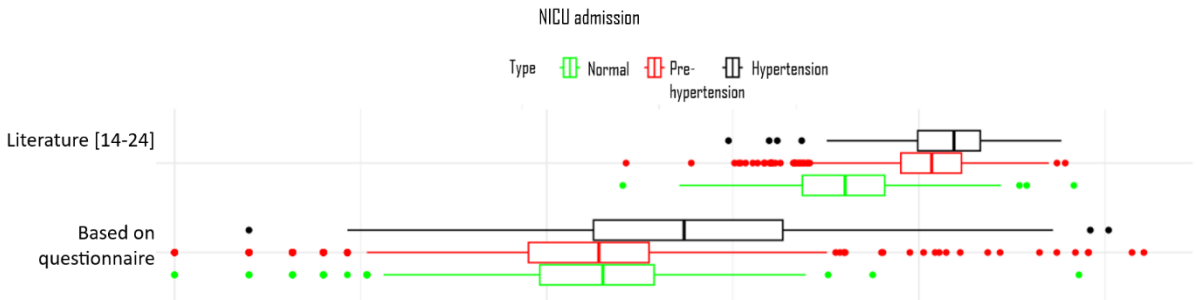

Figure 9: NICU admission using a box plot as the visual representation

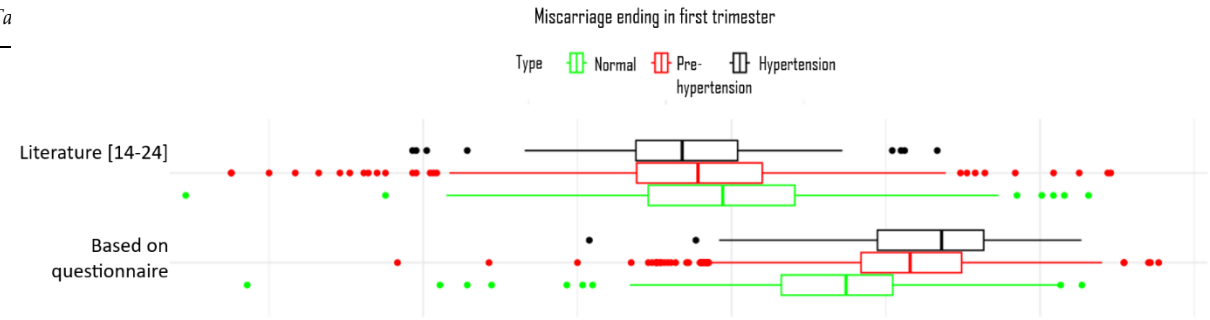

Figure 10: Miscarriage ending in first trimester: A box plot as the visual representation

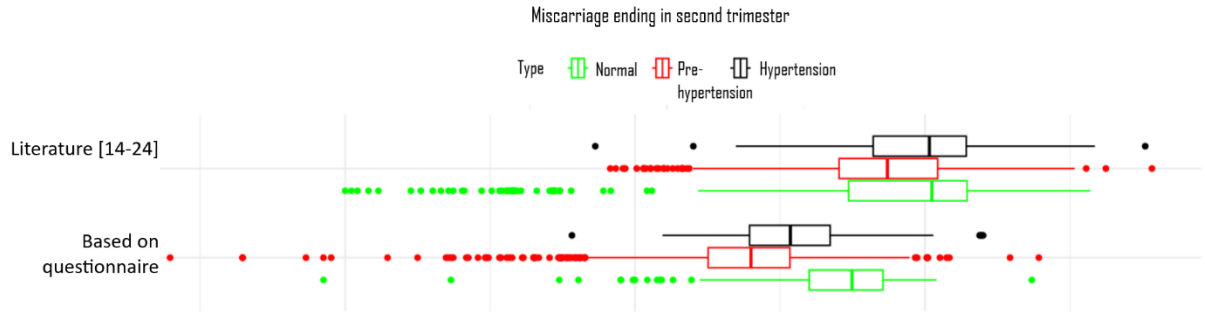

Figure 11: Miscarriage ending in second trimester: A box plot as the visual representation

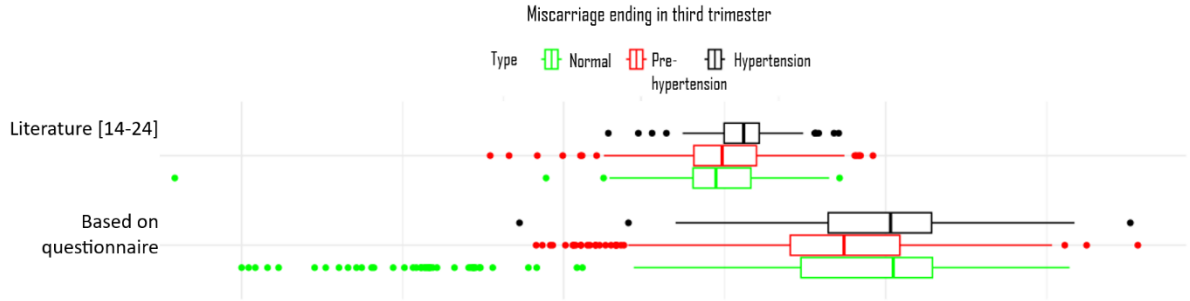

Figure 12: Miscarriage ending in third trimester: A box plot as the visual representation

4. Discussion

We included papers with prospective or retrospective cohort designs in both the meta-analysis and the comprehensive review. Women with a history of hypertension or high blood pressure were more likely to have complications during pregnancy, including hypertension, preeclampsia, gestational diabetes, and premature delivery, stillbirth, and NICU admission. Here, we cover all types of hypertensions, including pregnancy-related hypertension, stage 1 and 2 hypertension, and any other kind of hypertension. Although the overall chances were lower than in hypertensive women, the risk of each of these events was substantially higher in pre-hypertensive women, except for high-dose preterm delivery and stillbirth. The concept linking hypertension to these complications is doubtful due to a lack of data and an absence of correlation between HELLP, caesarean birth, placental abruption, and SGA.

Women with persistent hypertension were more likely to have adverse pregnancy outcomes after pooling data from randomized controlled trials, cohort studies, and population studies [7]. By combining data from prospective and retrospective cohort studies, we examine a causal relationship between the two sources that is quite close to the actual one. Furthermore, we focused on the pre-hypertensive population because mounting evidence suggests that this condition requires strict management due to its potential global health consequences [38, 39]. Experts recommend evaluating women with high blood pressure before or during the first trimester of pregnancy and closely

monitoring them throughout to prevent any complications. Our study's results are in line with these recommendations. We also stressed the need to incorporate prehypertensive women at high risk into the monitoring program. We did this to ensure earlier and more efficient monitoring.

Most of the observed heterogeneity might be due to differences in study duration and site, even though the hypertension-stratified subgroup analysis showed some variation. Regardless of the sample size, we found gestational hypertension. Studies [40–42] suggest a multitude of primary causes for hypertension and other pregnancy complications during the peri-conceptional phase. All of the following are considered: factors that pertain to the mother include her age, BMI, ethnicity, education level, parity, health, smoking habits, eating habits, socioeconomic situation, and degree of physical activity. The method can't find more underlying causes of heterogeneity because there isn't enough research, the criteria aren't clear, and there aren't enough papers that meet the requirements for meta-regression. Possible causes of the disparity include different definitions of hypertension and outcomes, differences in the methods used to adjust for confounding factors, and other similar issues. These factors are very important for establishing the results' reliability. These discrepancies drastically diminish the dependability of the findings.

Analysis of the available evidence has identified multiple possible explanations for the associations between hypertension and worse pregnancy outcomes [43]. Alterations to the immune system and inflammation within the immune system are leading causes of hypertension [44]. Furthermore, the strongest evidence for the origin of cardiovascular illness is the correlation between hypertension and vascular endothelium dysfunction [45]. Vascular dysfunction during the preconception period causes the woman's problems throughout her pregnancy. This problem can lead to poor crosstalk between the mother and the fetal interface, incomplete remodeling of the spiral arteries, and a faulty placentation [46, 47]. Because both hypertension and adverse pregnancy outcomes share underlying pathogenic pathways, the public likely understands a biological link between the two conditions. More theoretical research is required to prove these processes.

There are many benefits to the extensive study and investigation that we have undertaken. Two separate researchers, who were not associated with each other thoroughly searched, selected the articles, extracted the data, and graded the quality. The studies that were considered also had large enough samples (in terms of both women and births) to be useful for comparing the effects of different hypertension stages on various pregnancy outcomes in the same group of people.

Most studies did collect basic demographic data, but they failed to inquire about the populations' habits, including whether they smoked, drank, or were physically active. It was difficult to determine the source of heterogeneity since the relationships between demographic variables, including mother's age, income, and degree of education, were not continuous. One drawback of the tests was this: not only that, but the procedures used to measure blood pressure (BP) were not consistent, and neither were the findings' definitions. The limited quantity of relevant data prevented meta-regression from investigating the influence of these alterations. In summary, most of the research in this review focused on immediate outcomes, like pregnancy complications or the effects of childbirth. Future research may focus on the years leading up to or during pregnancy to see whether hypertension affects the individual's long-term health.

5. Conclusions

Hypertension during pregnancy greatly increases the likelihood of many unpleasant consequences. This is a very dangerous pregnancy condition characterized by organ damage and elevated blood pressure. It is also associated with an increased risk of both immediate and delayed neonatal health problems. High blood pressure may prevent the placenta from receiving enough blood, potentially affecting the fetus's growth and development. The purpose of this meta-analysis is to synthesize the results of several investigations into a single research question. This provides a more credible evaluation of the effect when compared to independent studies. This meta-analysis should assess the quality of the included articles and address any biases. The study measures the effect magnitude (increased risk) and assesses the consistency of findings from other studies.

When it comes to the risk of poor outcomes for both the mother and the baby, having high blood pressure before or during the early stages of pregnancy significantly increases the chance of these consequences occurring. When compared to women who did not have hypertension, the chance was significantly higher among women who had hypertension. We should interpret our findings with care, given the heterogeneity of the included research and the limited number of studies examined. This would allow for early identification of any risks to both the mother and the fetus. In the future, a thorough understanding of the pathophysiology of abnormal blood pressure, particularly pre-hypertension, will be required. This is an urgent requirement. This knowledge must guide the development of diagnostic and prognostic tools and strengthen therapy methods for hypertension-associated pregnancy difficulties, ensuring their success.

Author Contributions: The author solely conceptualized, designed, and executed the study, collected and analyzed the data, and drafted and revised the manuscript. All work was carried out independently by the author.

Funding: This research received no external funding.

Institutional Review Board Statement:

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Taif University (protocol code HA-02-C-005, approved on April 15, 2024).

Informed Consent Statement: Not applicable.

Data Availability Statement: The data used to support the findings of this study are included within the article.

Acknowledgments: This paper and the research behind it would not have been possible without the exceptional support of my institution and my mentors who helped me during my journey as a health worker, in both my clinical and education career, Represented by Taif University, Faculty of medicine, obstetrics and gynecology department.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. McLaren, R.A., H.B. Al-Kouatly, and H. Minkoff. “Change in Prevalence of Chronic Hypertension in Pregnancy after the Updated ACC/AHA Hypertension Guidelines.” *Pregnancy Hypertens* 29 (2022): 61–63. https://doi.org/10.1016/j.
2. Balouchi, A., M. Rafsanjani, and K. Al-Mutawaa. “Hypertension and Pre-Hypertension in Middle East and North Africa (MENA): A Meta-Analysis of Prevalence, Awareness, Treatment, and Control.” *Curr Probl Cardiol* 2022;47(7):101069 (2021). https://doi.org/10.1016/j.cpcardiol.
3. Xiong, P., Z. Liu, and M. Xiong. “Prevalence of High Blood Pressure under 2017 ACC/AHA Guidelines: A Systematic Review and Meta-Analysis.” *J Hum Hypertens* 35, no. 3 (2021): 020-00454–58. https://doi.org/10.1038/s41371-.
4. Sutton, E.F., S.C. Rogan, and S. Lopa. “Early Pregnancy Blood Pressure Elevations and Risk for Maternal and Neonatal Morbidity.” *Obstet Gynecol* 136, no. 1 (2020): 139. https://doi.org/10.1097/aog.0000000000003885.
5. Greenberg, V.R., M. Silasi, and L.S. Lundsberg. “Perinatal Outcomes in Women with Elevated Blood Pressure and Stage 1 Hypertension.” *Am J Obstet Gynecol* 224, no. 5 (2021): 10 049. https://doi.org/10.1016/j.ajog.2020.
6. Li, N., H. An, and Z. Li. “Preconception Blood Pressure and Risk of Gestational Hypertension and Preeclampsia: A Large Cohort Study in China.” *Hypertens Res* 43, no. 9 (2020): 956–62. https://doi.org/10.1038/s41440-020-0438-9.
7. Reddy, U.M., S.K. Laughon, and L. Sun. “Prepregnancy Risk Factors for Antepartum Stillbirth in the United States.” *Obstet Gynecol* 116, no. 5 (2010): 1119–26. https://doi.org/10.1097/AOG.0b013e3181f903f8.
8. Bramham, K., B. Parnell, and C. Nelson-Piercy. “Chronic Hypertension and Pregnancy Outcomes: Systematic Review and Meta-Analysis.” *BMJ* 348, no. 7 (2014): 2301. https://doi.org/10.1136/bmj.g2301.
9. Li, N., Z. Li, and R. Ye. “Preconception Blood Pressure and Risk of Low Birth Weight and Small for Gestational Age: A Large Cohort Study in China.” *Hypertension* 68, no. 4 (2016): 116 07838. https://doi.org/10.1161/HYPERTENSIONAHA.
10. Yang, Y., Y. He, and Q. Li. “Preconception Blood Pressure and Risk of Preterm Birth: A Large Historical Cohort Study in a Chinese Rural Population.” *Fertil Steril* 2015;104(1):124–130 (2015). https://doi.org/10.1016/j.fertnstert.
11. Delker, E., G. Bandoli, and Y. LaCoursiere. “Chronic Hypertension and Risk of Preterm Delivery: National Longitudinal Study of Adolescents to Adult Health.” *Paediatr Perinat Epidemiol* 36, no. 3 (2022): 370–79. https://doi.org/10.1111/ppe.12858.

12. Tesfalul, M.A., J.D. Sperling, and C. Blat. "Perinatal Outcomes and 2017 ACC/AHA Blood Pressure Categories." *Pregnancy Hypertens* 28 (2022): 134–38. https://doi.org/10.1016/j.
13. Broekhuijsen, K., A.C. Ravelli, and J. Langenveld. "Maternal and Neonatal Outcomes of Pregnancy in Women with Chronic Hypertension: A Retrospective Analysis of a National Register." *Acta Obstet Gynecol Scand* 94, no. 12 (2015): 12757. https://doi.org/10.1111/aogs.
14. C.N.K.I. "China National Knowledge Infrastructure," n.d. https://www.cnki.net/.
15. "Wanfang Data," n.d. http://www.wanfangdata.com/db_search.asp.
16. "CQVIP (Chongqing VIP Information," n.d. https://www.cqvip.com/.
17. "CBM (Chinese Biomedical Literature Database," n.d. https://lib.ccmu.edu.cn/Englishversion_3126/Collections_3182/SearchDatabases_3185/index.htm.
18. PubMed, n.d. https://pubmed.ncbi.nlm.nih.gov/?db=PubMed.
19. Embase. "The Biomedical and Pharmacology Abstracts Database," n.d. https://www.elsevier.com/en-in/solutions/embase-biomedical-research.
20. "BMJ Best Practice," n.d. https://bestpractice.bmj.com/info/.
21. "ClinicalKey," n.d. https://www.clinicalkey.com/.
22. "Chinese Medical Current Contents (CMCC)" n.d. http://202.204.190.39:1011/cmcc/home.htm.
23. SinoMed, n.d. http://www.sinomed.ac.cn/index.jsp.
24. "Chinese Clinical Trial Registry," n.d. http://www.chictr.org/.
25. "CALIS (China Academic Library & Information System," n.d. http://opac.calis.edu.cn/simpleSearch.do.
26. Jung, Y.M., G.C. Oh, and E. Noh. "Pre-Pregnancy Blood Pressure and Pregnancy Outcomes: A Nationwide Population-Based Study." *BMC Pregnancy Childbirth* 22, no. 1 (2022). https://doi.org/10.1186/s12884-022-04573-7.
27. Zile, I., I. Ebela, and I. Rumba-Rozenfelde. "Maternal risk factors for stillbirth: a registry-based study." *Medicina* 55, no. 7 (2019). https://doi.org/10.3390/medicina55070326.
28. Gonzalez-Valencia, D.P., S.Y. Valero-Rubio, and C. Fernando Grillo-Ardila. "Prehypertension as a Risk Factor for the Development of Perinatal Complications: Retrospective Cohort Study." *Pregnancy Hypertens* 21 (2020): 203–7. https://doi.org/10.1016/j.preghy.2020.04.016.
29. Macheku, G.S., R.N. Philemon, and O. Oneko. "Frequency, Risk Factors and Feto-Maternal Outcomes of Abruptio Placentae in Northern Tanzania: A Registry-Based Retrospective Cohort Study." *BMC Pregnancy Childbirth* 15, no. 1 (2015). https://doi.org/10.1186/s12884-015-0678-x.
30. Conde-Agudelo, A., and J.M. Belizan. "Risk Factors for Preeclampsia in a Large Cohort of Latin American and Caribbean Women." *BJOG* 107, no. 1 (2000): 1111 1471-0528 2000 11582.
31. Malmstrom € O, Morken NH. "HELLP Syndrome, Risk Factors in First and Second Pregnancy: A Populationbased Cohort Study." *Acta Obstet Gynecol Scand* 97, no. 6 (2018): 709–16. https://doi.org/10.1111/aogs.13322.
32. Berger, H., N. Melamed, and B.M. Davis. "Impact of Diabetes, Obesity and Hypertension on Preterm Birth: Population-Based Study." *PLOS One* 15, no. 3 (2020): 0228743. https://doi.org/10.1371/journal.pone.0228743.
33. Kessous, R., I. Shoham-Vardi, G. Pariente, R. Sergienko, G. Holcberg, and E. Sheiner. "Recurrent Pregnancy Loss: A Risk Factor for Long-Term Maternal Atherosclerotic Morbidity?" *Am J Obstet Gynecol* 211, no. 4 (2014). https://doi.org/10.1016/j.ajog.2014.05.050.
34. Li, L., P.C. Leung, T.K.H. Chung, and C.C. Wang. "Systematic Review of Chinese Medicine for Miscarriage during Early Pregnancy." *Evidence-Based Complement Altern Med* 2014 (2014).
35. G, No R.G.Top. *The Investigation and Treatment of Couples with Recurrent First-Trimester and Second-Trimester Miscarriage*. London, UK: RCOG, 2011.
36. Vahid, F., D. Rahmani, S.H. Davoodi, and A. Hekmatdoost. "The Association among Maternal Index of Nutritional Quality, Dietary Antioxidant Index, and Odds of Miscarriage Incidence: Case-Control Study." *J Am Nutr Association* 41, no. 3 (2022): 310–17. https://doi.org/10.1080/07315724.2021.1880987.
37. Yuksel, S., and F. Ketenci Gencer. "Serum Kisspeptin, to Discriminate between Ectopic Pregnancy, Miscarriage and First Trimester Pregnancy." *J Obstet Gynaecol* 42, no. 6 (2022): 2095–99. https://doi.org/10.1080/01443615.2022.2028747.
38. Ha, S., R. Sundaram, G.M.B. Louis, C. Nobles, I. Seeni, and S. Sherman. "Ambient Air Pollution and the Risk of Pregnancy Loss: A Prospective Cohort Study." *Fertil Steril* 109, no. 1 (2018): 148–53. https://doi.org/10.1016/j.fertnstert.2017.09.037.
39. Li, R., J. Lodge, and C. Flatley. "The Burden of Adverse Obstetric and Perinatal Outcomes from Maternal Smoking in an Australian Cohort." *Aust N Z J Obstet Gynaecol* 59, no. 3 (2019): 356–61. https://doi.org/10.1111/ajo.12849.
40. Han, M., Q. Li, and L. Liu. "Prehypertension and Risk of Cardiovascular Diseases: A Meta-Analysis of 47 Cohort Studies." *J Hypertens* 2019;37(12):2325–2332. doi (hjh.0000000000002191 1097): 10.
41. Ribeiro, M.M., A. Andrade, and I. Nunes. "Physical Exercise in Pregnancy: Benefits, Risks and Prescription." *J Perinat Med* 50, no. 1 (2022): 4–17. https://doi.org/10.1515/jpm-2021-0315.
42. Allehdan, S., A. Basha, and D. Hyassat. "Effectiveness of Carbohydrate Counting and Dietary Approach to Stop Hypertension Dietary Intervention on Managing Gestational Diabetes Mellitus among Pregnant Women Who Used Metformin: A Randomized Controlled Clinical Trial." *Clin Nutr* 41, no. 2 (2022): 11 039. https://doi.org/10.1016/j.clnu.2021.
43. Laine, K., G. Murzakanova, and K.B. Sole. "Prevalence and Risk of Pre-Eclampsia and Gestational Hypertension in Twin Pregnancies: A Population-Based Register Study." *BMJ Open* 9, no. 7 (2019). doi: 10.1136/ bmjopen-2019-029908.
44. Deshmukh, H., and S.S. Way. "Immunological Basis for Recurrent Fetal Loss and Pregnancy Complications." *Annu Rev Pathol* 14, no. 1 (2019): 185–210. https://doi.org/10.1146/annurevpathmechdis-012418-012743.
45. Xiao, L., and D.G. Harrison. "Inflammation in Hypertension." *Can J Cardiol* 2020;36(5):635–647 (2020). https://doi.org/10.1016/j.cjca.
46. Fuchs, F.D., and P.K. Whelton. "High Blood Pressure and Cardiovascular Disease." *Hypertension* 75, no. 2 (2020): 285–92. https://doi.org/10.1161/hypertensionaha.119.14240.
47. Qu, H., and R.A. Khalil. "Vascular Mechanisms and Molecular Targets in Hypertensive Pregnancy and Preeclampsia." *Am J Physiol Heart Circ Physiol* 319, no. 3 (2020): 681. https://doi.org/10.1152/ajpheart.00202.2020.
48. Jasper, R., and K. Skelding. "Cardiovascular Disease Risk Unmasked by Pregnancy Complications." *Eur J Intern Med* 57 (2018): 1–6. https://doi.org/10.1016/j.ejim.2018.07.020.