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Hypertension subtypes and adverse maternal and perinatal outcomes - a retrospective population-based cohort study

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Abstract

Background This study aims to examine risk of adverse pregnancy outcomes and mothers' characteristics in patients with chronic hypertension, gestational hypertension and preeclampsia.

Methods The study included all births born from women aged 15–45 years, in Lleida, Spain from 2012 to 2018. Pregnancy outcomes were retrieved by regional administrative databases. Logistic regression analysis was used to calculate adjusted odds ratios (OR) (OR 95% CI) for maternal characteristics or neonatal outcomes.

Results Among 17,177 pregnant women, different types of hypertension present varying risks for both the mother and fetus. There is an increased risk of cesarean section in patients with preeclampsia (OR 2.04, 95% CI: 1.43–2.88). For the newborn, a higher risk of preterm birth is associated with maternal chronic hypertension (OR 3.09, 95% CI: 1.91–4.83) and preeclampsia (OR 5.07, 95% CI: 3.28–7.65). Additionally, there is a higher risk of low birth weight in cases of maternal chronic hypertension (OR 3.2, 95% CI: 2.04–4.88), preeclampsia (OR 5.07, 95% CI: 3.34–7.52), and gestational hypertension (OR 2.72, 95% CI: 1.49–4.68). Furthermore, only newborns of patients with preeclampsia had a higher risk of an Apgar score lower than 7 in the first minute (OR 2.95, 95% CI: 1.45–5.38).

Conclusions In the study population adjusted for body weight, the different types of hypertension represent different risks in the mother and foetus. These complications were mostly associated with preeclampsia.

Keywords Hypertension, Pre-eclampsia, Cesarean section, Preterm infant, Low birthweight infant

Introduction

Hypertensive disorders in pregnancy (HDP) are significant contributors to elevated maternal morbidity and mortality rates [1, 2], along with neonatal morbidity [1, 2], as well as neonatal morbidity. HDP refers to gestational hypertension, preeclampsia and eclampsia, chronic hypertension complicated with preeclampsia, and chronic hypertension [3, 4]. According to the International Society for the Study of Hypertension in Pregnancy in 2021, HDP is classified into chronic hypertension, which exists or is diagnosed before 20 weeks' gestation, and de novo hypertension, which typically occurs from 20 weeks' gestation onwards. This second

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one has many manifestations including hypertension alone, known as gestational hypertension; pre-eclampsia (PE), hypertension with proteinuria and maternal organ dysfunction (haematological, liver, renal and neurological) and eclampsia, characterised by seizures [5, 6].

Most guidelines around the world agree on the definition of hypertension in pregnancy, consisting in blood pressure (BP) ≥ 140/90 mmHg. At the same time, there is variability in the threshold for initiating antihypertensive treatment attributable to uncertainty about the maternal benefits of lowering BP and the potential foetal risks from reductions in utero-placental circulation and in utero exposure to drugs [7].

Hypertension in pregnancy is associated with an increased risk of placental abruption, intrauterine growth restriction, preterm birth, renal failure, postpartum haemorrhage, perinatal and maternal death and newborn morbidity [8–10]. In this sense, it has been estimated that hypertension during pregnancy is one of the main causes of maternal and foetal morbidity and mortality in the world [11].

Therefore, the aim of this study is to determine the difference in pregnancy outcomes in women with chronic hypertension, gestational hypertension and preeclampsia compared to women with normal pregnancies using populations data.

Materials and methods

Study design and data collection

A retrospective observational cohort study was conducted among pregnant women in the health region of Lleida from 2012 to 2018.

The data of women who had given birth at the Arnau de Vilanova Hospital between January 1st, 2012 and December 31st, 2018 were obtained through the ("Conjunt Minim de Base de Dades") CMBD database. Data of all the eligible patients assigned to a primary care unit derived from the computerized clinical history database E-CAP of the Catalan Health Institute; and data from Social Security prescriptions obtained from the database of the ServeiCatalà de Salut.

Table 1 Number of births registered in Lleida sample in comparison to the Lleida health region per year

Year	Deliveries in Lleida sample	Deliveries from Idescat	Sample/ Idescat
2012	3635	3788	96%
2013	3370	3535	95%
2014	3308	3592	92%
2015	3162	3426	92%
2016	3180	3283	97%
2017	3034	3197	95%
2018	3001	3029	99%

This article is part of the Iler Pregnancy project, a retrospective cohort study conducted in Lleida with the aim of evaluating the prevalence of chronic pathologies in pregnancy (hypothyroidism, depression, diabetes mellitus and obesity) and therapeutic adherence to prescribed drugs [12, 13].

Study population

Women who have had a birth at the Arnau de Vilanova University Hospital in Lleida between January 1st, 2012, and December 31st, 2018, were included in the study. Women who did not belong to Lleida health region were excluded. To evaluate the representativeness of the sample, we calculated the percentage of pregnant women studied compared to the total of pregnant women in the health region of Lleida. Data was obtained from the database of "Instituto Statistics of Catalonia" (Idescat) (Table 1).

Variables recorded

The following variables were recorded: region of origin (Sub Saharan Africa, Latin America, Asia and the Middle East, West Europe, Eastern Europe, and Maghreb) [12]; body mass index (BMI) which is classified according to low weigh (BMI under 18.5 Kg/m2), overweigh (BMI between 25 and 29.9) and obesity (BMI more than 30); number of pregnancy and twin pregnancy; risk during pregnancy; diabetes and mellitus (code O24.9 at CIE-10.); arterial hypertension (code I10-I16 at l'ICD-10); dyslipidemia (code E78 at l'ICD-10); depression (codes F32.0-F32.9, F33.0-F33.3, F33.8, F33.9, F34.1, or F41.2 at l'ICD-10). Other variables taken into account were risk of the pregnancy; duration of the pregnancy (miscarriage, preterm, term, prolonged); caesarean section; birth weight (< 2500 g = underweight, between 2500 g and 3999 g = normal weight, and ≥ 4000 g = macrosomia), 1-minute and 5-minute Apgar score; and preeclampsia.

Data analysis

We performed a descriptive analysis. Based on delivery status, the cohort was divided into four groups: (1) without HDP, (2) chronic hypertension, (3) gestational hypertension, and (4) preeclampsia. Maternal and neonatal characteristics were compared between groups. Continuous variables were expressed as mean and SD and analyzed using ANOVA with post hoc Scheffé test. Ordinal variables were expressed as median and IQR and analyzed using Kruskal–Wallis H test. Categorical variables were expressed as percentages and analyzed using χ^2 or Fisher's exact test. Relative risks of HDP phenotypes and outcomes were estimated using multinomial logistic regression. The model-building process was conducted in two blocks: the first included HDP, and the second included covariates (maternal age, BMI, hypothyroidism,

maternal diabetes). Adjusted relative risks were expressed as odds ratios (OR) with 95% confidence intervals (95% CI). The "No hypertension" group served as the reference. Superimposed hypertension was excluded from the analysis.

Ethical aspects

This study was approved by the ethics and clinical research committee at the Institut d'Investigació IDIAP Jordi Gol under the code 19/195-P and carried out in accordance with the principles of the Declaration of Helsinki. Information was obtained from electronic medical records stored in the centralized ECAP database and extracted by the Department of Healthcare Evaluation and Research Management. Therefore, it was not necessary to ask participants to sign an informed consent. The variables in the ECAP database were processed anonymously and with full confidentiality guarantees as established by national Spanish law and Regulation 2016/679 of the European Parliament and of the Council on the protection of natural people regarding the processing of personal data, and to the free movement of such data. Ethics committee of (Idiap Jordi Gol i Gurina) waived the need for informed consent due to retrospective observational cohort study.

Results

The study was started with a sample of 21,375 women who had given birth at the Arnau de Vilanova Hospital in Lleida between 2012 and 2018 (both included). From this sample, 1625 patients were excluded because they did not have a personal identification code (CIP), and 2573 because multiple data from the clinical history was missing. The final study sample included 17,177 patients (Fig. 1).

Characteristics of the study population

Among the total sample, 533 (3.10%) women had a diagnosis of high blood pressure. 263 (1.53%) pregnant women were diagnosed of chronic hypertension, 111 (0.65%) pregnant women were diagnosed with gestational hypertension and 134 (0.78%) were diagnosed with preeclampsia. Preeclampsia superimposed on chronic hypertension occurred in 25 cases (0.14%).

It was observed that in pregnant women with chronic arterial hypertension (263), the mean age was 33.9 (±6.00) years, compared to 30.6 (±5.85) years in the non-hypertensive population. Regarding BMI, 38.4% of patients with chronic hypertension were obese, 44.1% of patients with gestational hypertension, and 26.6% in case of preeclampsia. However, only 14% of non-hypertensive women were obese. Among maternal complications, the percentage of caesarean sections was 28.5% in the case of chronic hypertension, 30.8% in preeclampsia, 23.4% in gestational hypertension compared to 17% in non-hypertensive women. Among the newborn complications, 7.6% in the case of mothers with preeclampsia had an Apgar score lower than 7 in the first minute compared to 2.4% in the case of mothers without hypertension. Respect preterm birth, 18.3% were preterm in the case of chronic hypertension, 24.4% in preeclampsia, 10.7% in gestational hypertension and 5.5% in the case of absence

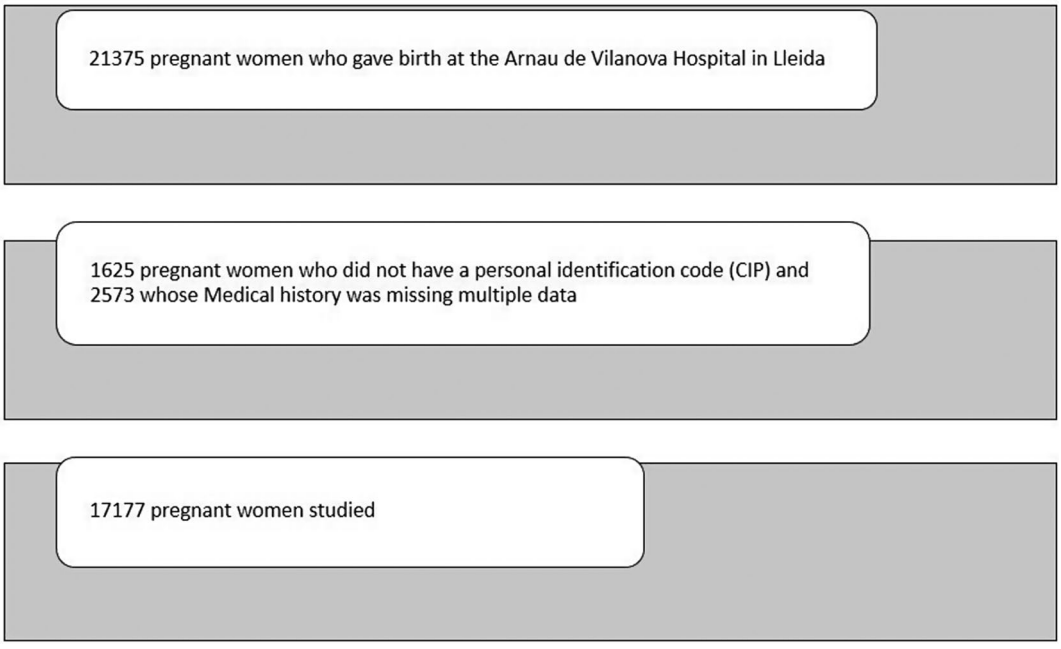


Fig. 1 Sample of pregnant women studied

of maternal hypertension. Low birth weight occurred in 17.6% in cases of chronic hypertension, 14.8% in gestational hypertension, 22.9% in preeclampsia and in 5.6% newborns of mothers without hypertension during pregnancy. In the case of chronic hypertension, it was classified as high or very high risk of pregnancy to a greater extent, affecting 31% and 16.3% respectively (Table 2).

In the multivariate analysis of the different phenotypes of hypertension during pregnancy adjusted for the covariates (maternal age, BMI, hypothyroidism, maternal diabetes) showed statistically significant associations in the risk of cesarean section in patients with preeclampsia (OR 2.04 95% CI: 1.43–2.88). For the newborn, higher risk of preterm birth was associated with maternal chronic hypertension (OR 3.09, 95% CI: 1.91–4.83) or preeclampsia (OR 5.07, 95% CI: 3.28–7.65) and higher risk of low birth weight in case of maternal chronic hypertension (OR 3.2, 95% CI: 2.04–4.88), preeclampsia (OR 5.07, 95% CI: 3.34–7.52) and in the case of gestational hypertension (OR 2.72, 95% CI: 1.49–4.68). On the other hand, only newborns of patients with preeclampsia had higher risk of having an Apgar score lower than 7 in the first minute (OR 2.95, 95% CI: 1.45–5.38). Patients classified as high or very high risk were primarily those who presented chronic hypertension (OR 5.45, 95% CI: 2.77–10.22) and followed by preeclampsia (OR 1.21, 95% CI: 0.36–3.22) (Fig. 2).

Discussion

This study, including 17,177 pregnant women, provides valuable information on the risk factors, prevalence and outcomes of a range of HDP adjusted for body weight, which demonstrates that the different subtypes of hypertension represent different risks to the mother and the foetus. There is an increased risk of caesarean section in patients with preeclampsia (OR 2.04 95% CI: 1.43–2.88). For the newborn, higher risk of preterm birth was associated with maternal chronic hypertension (OR 3.09, 95% CI: 1.91–4.83) or preeclampsia (OR 5.07, 95% CI: 3.28–7.65) and higher risk of low birth weight in case of maternal chronic hypertension (OR 3.2, 95% CI: 2.04–4.88), preeclampsia (OR 5.07, 95% CI: 3.34–7.52) and in the case of gestational hypertension (OR 2.72, 95% CI: 1.49–4.68). On the other hand, only newborns of patients with preeclampsia had higher risk of having an Apgar score lower than 7 in the first minute (OR 2.95, 95% CI: 1.45–5.38). Patients categorized as high or very high risk predominantly include those with chronic hypertension (OR 5.45, 95% CI: 2.77–10.22), followed by those with preeclampsia (OR 1.21, 95% CI: 0.36–3.22).

Analysing risk factors individually, gestational age was significantly higher in patients with chronic hypertension with a median of 33.9 (±6.19) years of age; being 3 years older in comparison to preeclampsia and non-hypertensive women. BMI average for hypertensive women was 28.8 (±6.28) and 25.9 (±5.75) in women with preeclampsia. For the rest of the pregnant women, BMI was 24.8 (±4.85). In a retrospective cohort study carried out in Southern Spain [14], it was concluded that overweight and obesity increase the risk of suffering from hypertensive disorders during pregnancy; the risk is significantly higher as BMI increases. In multiple population studies it was identified that obesity increases 2 to 4 times the risk of developing preeclampsia [15, 16].

Relationship of chronic hypertension (OR 3.09) and preeclampsia (OR 5.07) with a risk of preterm birth in our study has been observed, as described in other publications. According to Sibai et al., the rates of preterm delivery in a large population of women with chronic hypertension while comparing them with those in a healthy control woman, the overall rates of preterm delivery were significantly higher among women with diabetes mellitus (38%) and hypertension (33.1%) than among control women (13.9%) [17]. An et al., in a prospective cohort study done in China, after adjusting for potential confounders, observed higher levels of preterm birth in women with gestational hypertension 1.04 (95% CI 0.98 to 1.11) and pre-eclampsia 1.39 (95% CI 1.25 to 1.55), respect control women [18]. Other medical publications also showed an increased risk of preterm birth in a population with hypertension during pregnancy [19, 20].

Delivery methods studies demonstrate higher rate of caesarean section in all women with hypertension: 28.5% in chronic hypertension, 23.4% in gestational hypertension and 30.8% in preeclampsia; compared to 17% in women without hypertension in pregnancy. A systematic review and meta-analysis of hypertension and pregnancy outcomes showed a combined incidence of cesarean section of 41.4% (35.5-47.7%) higher than the rate observed in our study [21]. Moreover, high incidence of adverse outcomes, were described. Therefore, patient-level analysis should be conducted to assess the reasons for cesarean section to provide and guarantee clear indication in each instance.

Study results are comparable to another study from a maternity hospital in Brazil [22] that reveals the existence of statistically significant differences between the proportion of c-sections, preterm infants and low birth weight infants for pregnant women with and without hypertensive disorders.

All types of hypertensive disorders were associated with low birth weight. The rate observed for patients with chronic hypertension was 17.6%, 22.9% in patients with preeclampsia, 14.8% in patients with gestational hypertension and 5.6% in women not diagnosed with hypertension.

The study conducted by Fang et al. describes similar results comparing women with and without chronic

Table 2 Characteristics of the patients stratified according to the subgroups of arterial hypertension during pregnancy

	Chronic Hypertension	Gestational Hypertension	Preeclampsia	No HDP	*p*.overall
	N **= 263**	***N*** **= 111**	***N*** **= 134**	***N*** **= 16,644**	
Year of delivery:					.
2012	32 (1.17%)	16 (0.59%)	19 (0.69%)	2668 (97.6%)	
2013	37 (1.47%)	18 (0.71%)	17 (0.67%)	2451 (97.1%)	
2014	31 (1.25%)	9 (0.36%)	22 (0.89%)	2423 (97.5%)	
2015	50 (2.07%)	11 (0.46%)	23 (0.95%)	2331 (96.5%)	
2016	31 (1.28%)	16 (0.66%)	30 (1.24%)	2338 (96.8%)	
2017	46 (1.99%)	22 (0.95%)	15 (0.65%)	2231 (96.4%)	
2018	36 (1.62%)	19 (0.86%)	8 (0.36%)	2159 (97.2%)	
Maternal age	33.9 (6.19)	32.7 (5.47)	30.6 (5.46)	30.6 (5.83)	< 0.001
BMI	28.8 (6.21)	29.3 (6.44)	25.9 (5.75)	24.8 (4.85)	< 0.001
BMI (qualitative):		29.3 (6.44)			< 0.001
Low weight	4 (1.57%)	2 (1.80%)	3 (1.95%)	602 (3.70%)	
Normal weight	70 (27.5%)	31 (27.9%)	70 (45.5%)	9184 (56.4%)	
Obesity	98 (38.4%)	49 (44.1%)	41 (26.6%)	2281 (14%)	
Overweight	83 (32.5%)	29 (26.1%)	40 (26.0%)	4216 (25.9%)	
Pregnancy number:					0.165
1	108 (41.1%)	57 (51.4%)	107 (1.04%)	8737 (52.5%)	
2	82 (31.2%)	32 (28.8%)	37 (0.54%)	5030 (30.2%)	
3	39 (14.8%)	16 (14.4%)	7 (4.40%)	1808 (10.9%)	
4	20 (7.60%)	5 (4.50%)	5 (0.47%)	616 (3.70%)	
> 4	14 (5.32%)	1 (0.90%)	3 (1.89%)	453 (2.72%)	
Multiple pregnancy:					1.000
Yes	0 (0.00%)	0 (0.00%)	0 (0.00%)	32 (0.19%)	
C-section:					< 0.001
Yes	75 (28.5%)	26 (23.4%)	49 (30.8%)	2826 (17%)	
Duration of pregnancy (qualitative):					.
Abortion	12 (6.09%)	0 (0%)	0 (0%)	557 (4.44)	
Post-term (Delivered at 37 to before 42 weeks of gestation)	2 (1.02%)	1 (1.19%)	1 (0.79%)	324 (2.58%)	
Preterm (Delivered before 37 weeks of gestation)	36 (18.3%)	9 (10.7%)	31 (24.4%)	693 (5.52)	
Term (Delivered at or after 42 weeks of gestation)	147 (74.6%)	74 (88.1%)	95(74.8%)	10,980 (87.5%)	
High-risk pregnancy:					.
High risk	74 (31%)	26 (25.7%)	35 (18.7%)	2777 (43.87%)	
Medium risk	65 (27.2%)	36 (35.6%)	39 (26.7%)	4387 (29.5%)	
Very high risk	39 (16.3%)	1 (0.99%)	5 (3.42%)	271 (1.83%)	
No risk	61 (25.5%)	38 (37.6%)	67 (45.9%)	7412 (49.9%)	
Hypothyroidism:					0.002
Yes	33 (2.94%)	8 (0.71%)	8 (0.71%)	1075 (95.6%)	
Diabetes mellitus:					< 0.001
Yes	60 (22.8%)	16 (14.4%)	16 (10.1%)	1312 (7.88%)	
Gestational diabetes mellitus:					< 0.001
Yes	40 (15.3%)	13 (11.7%)	11 (6.92%)	1069 (6.42%)	
Dyslipidemia:					< 0.001
Yes	13 (4.94%)	3 (2.70%)	2 (1.26%)	169 (1.02%)	
Region:					.
Africa	44 (5.24%)	12 (1.43%)	20 (2.38%)	764 (91%)	
Latin America	12 (1.67%)	7 (0.98%)	8 (1.12%)	690 (96.2%)	
Asia and the Middle East	3 (1.35%)	4 (1.80%)	1 (0.45%)	214 (96.4%)	
Europe	122 (1.29%)	56 (0.59%)	83 (0.88%)	9200 (97.2%)	
Eastern Europe	17 (1.11%)	8 (0.52%)	17 (1.11%)	1491 (97.3%)	

Table 2 (continued)

	Chronic Hypertension	Gestational Hypertension	Preeclampsia	No HDP	*p*.overall
	N **= 263**	***N*** **= 111**	***N*** **= 134**	***N*** **= 16,644**	
Maghreb	23 (1.03%)	19 (0.85%)	14 (0.63%)	2177 (97.5%)	
Newborn weight	3053 (692)	3054 (682)	2894 (638)	3281 (580)	< 0.001
Newborn weight (categorical):					< 0.001
Low Weight (< 2500 g)	39 (17.6%)	16 (14.8%)	33 (22.9%)	822 (5.61%)	
Macrosoma (≥ 4000 g)	12 (5.43%)	5 (4.63%)	3 (2.08%)	1000 (6.82%)	
Normal weight (2500–3999 g)	170 (76.9%)	87 (8.6%)	108 (75%)	12,838 (87.6%)	
APGAR at 1 min	8.81 (1.51)	8.87 (1.13)	8.76 (1.37)	9.09 (1.07)	< 0.001
APGAR at 1 min (categorical):					< 0.001
APGAR ≥ 7	212 (96.4%)	102 (94.4%)	133 (92.4%)	14,259 (97.6%)	
APGAR < 7	8 (3.64%)	6 (5.56%)	11 (7.64%)	354 (2.42%)	
APGAR at 5 min	9.66 (1.31)	9.81 (0.61)	9.67 (1.06)	9.86 (0.78)	< 0.001
APGAR at 5 min (categorical):					0.051
APGAR ≥ 7	214 (97.7%)	107 (99.1%)	141 (98.6%)	14,508 (99.3%)	
APGAR < 7	5 (2.28%)	1 (0.93%)	2 (1.%)	109 (0.75%)	

hypertension; reporting rates of low birth weight among hypertensive mothers for white (16.8%), black (24.4%), and Hispanic (19.5%) populations respectively. Trends were similar for chronic and pregnancy-related hypertension, as well as preeclampsia/eclampsia [23]. The study completed by Wu et al. evaluates the relationship of stage 1 hypertension detected early in gestation (< 20 weeks) and risks of adverse pregnancy outcomes, stratified by pre-pregnancy BMI. Data indicates that women classified at stage 1a (systolic blood pressure 130–134 mm Hg; diastolic BP, 80–84 mm Hg; or both) and stage 1b hypertension (systolic BP, 135–139 mm Hg; diastolic BP, 85–90 mm Hg; or both) show slightly higher but significant rates and risks of gestational diabetes mellitus, preterm birth, and low birth weight (< 2500 g) in both groups compared with normotensive controls [24].

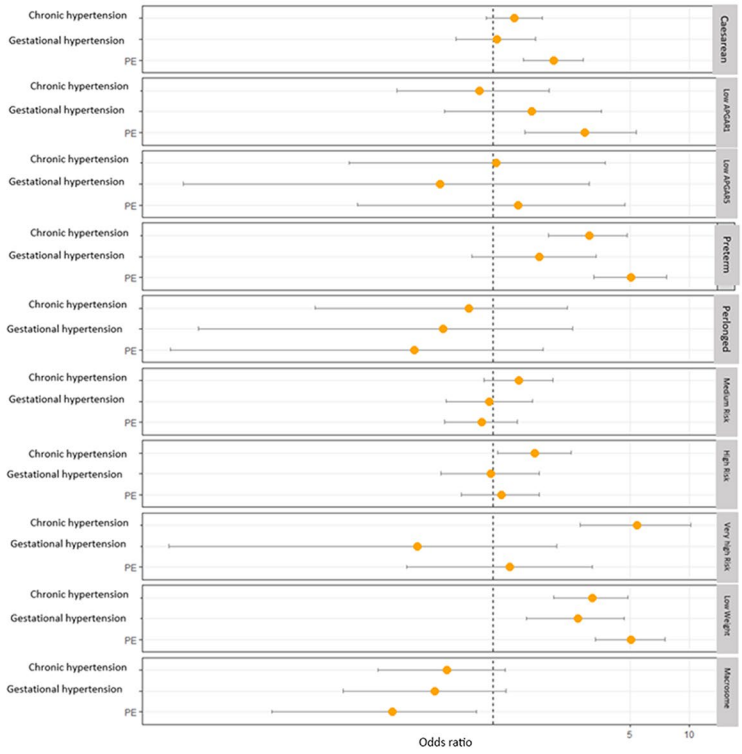
Results of this study show that only newborns of patients with preeclampsia had a higher risk of having an Apgar score lower than 7 in the first minute (OR 3.3). However, this was not observed in other hypertensive disorders, where Apgar score was normalizing at 5 min. In a large Chinese population study both maternal hypertension and preeclampsia increased risks for low Apgar score at 1 min (aRR: 1.20, 95%CI: 1.13–1.27; aRR: 1.53, 95%CI: 1.41–1.67, respectively), and for low Apgar score at 5 min (aRR: 1.30, 95%CI: 1.17–1.45; aRR: 1.70, 95%CI: 1.46–1.99, respectively). The risk for neonatal respiratory disorders increased with severity of maternal hypertension [25]. Moreover, Gu et al. proved that higher diastolic blood pressure was associated with an increased risk of 1-minute Apgar score ≤ 7 when extreme quartiles were compared. However, no significant association was found between systolic blood pressure and 1-minutes or 5-minutes Apgar score ≤ 7, which implies that diastolic blood pressure, has a better prognostic value [26].

Bronfield et al. [27]. found in a retrospective study in 14 US states worse outcomes for both mothers and babies in mothers with preeclampsia or superimposed preeclampsia compared to the non-hypertensive population, the population with chronic hypertension also had a higher risk of childbirth premature birth, respiratory distress, low birth weight compared to women without hypertension, but the risk was lower than that of mothers with preeclampsia and, as a last group, women with gestational hypertension had a somewhat higher risk of complications compared to non-hypertensive women but more similar to the healthy population. These data are similar to those reported in our study.

Limitations

The main limitation of this study if the fact of using a retrospective design based on administrative data, thus reducing important information on both maternal and neonatal outcomes. The effect of different antihypertensive treatments on maternal and perinatal outcomes have not been evaluated.

Adequate blood pressure control can modify these adverse outcomes. Minas et cols. [28] Show that more uncontrollable blood pression patients had superimposed preeclampsia with severe features (54.6% vs. 25.0%; $p = 0.01$) and preterm delivery (40.9% vs. 10.7%; $p = 0.002$) than controlled blood pressure patients. The results of CHAP trial [29] and the meta-analysis carried out by Atta et al. [30] suggest the beneficence of pharmacologic treatment of mild chronic hypertension during pregnancy to a blood pressure goal below140/90 mm



	Chronic hypertension	Gestational hypertension	Preeclampsia
Caesarian	1.29 (0.92-1.78)	1.05 (0.65-1.65)	2.04 (1.43-2.88)
1 minute Apgar <7	0.85 (0.32-1.94)	1.57 (0.56-3.57)	2.95 (1.45-5.38)
5 minuts Apgar <7	1.04 (0.18-3.72)	0.53 (0.03-3.09)	1.34 (0.2-4.7)
Preterm	3.09 (1.91-4.83)	1.72 (0.78-3.36)	5.07 (3.28-7.65)
Post-term	0.75 (0.12-2.39)	0.56 (0.03-2.55)	0.4 (0.02-1.8)
Medium risk	1.35 (0.9-2.02)	0.96 (0.58-1.59)	0.87 (0.57-1.33)
High risk	1.63 (1.05-2.5)	0.97 (0.54-1.73)	1.1 (0.69-1.72)
Very high risk	5.45 (2.77-10.22)	0.41 (0.02-2.11)	1.21 (0.36-3.22)
Weigth < 2500gr	3.2 (2.04-4.88)	2.72 (1.49-4.68)	5.07 (3.34-7.52)

Fig. 2 Multivariate analysis of types of hypertension in pregnancy and outcomes in the mother and baby, adjusted for body weight

Hg, which is also supported by the Society for Maternal-Fetal Medicine (SMFM) [31]. Conversely, in our study, we did not analyze the potential complications of eclampsia or HELLP syndrome in a detailed manner, as these conditions are encompassed within the diagnoses of preeclampsia. Furthermore, superimposed preeclampsia was excluded because it involves patients from two distinct groups. Some instances of gestational hypertension may correspond to previously undetected chronic hypertension due to the presence of masked hypertension. This condition has been associated with an increased risk of developing preeclàmpsia [32].

Finally, another limitation to be considered is the lack of socioeconomic data on the population, which may also influence several factors and health outcomes.

Future research

All types of hypertension have been found to be related to adverse events on pregnancy. This study supports the need to further investigate the pathophysiological knowledge of hypertension in pregnancies to improve the preventive and therapeutic approaches.

Conclusions

Hypertension in pregnancy is associated with higher incidence of adverse pregnancy outcomes. The different types of hypertension represent different risks in the mother and foetus. These complications were mostly associated with preeclampsia. This finding should be interpreted within the limitations of the study.

The use of sensitive diagnostic criteria facilitates solid foundation in epidemiological study, general practise, and clinical research. To address hypertension, Public Health interventions are necessary in addition to clinical management that act at different levels to improve lifestyle habits and early diagnosis before and during pregnancy.

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Author contributions
AB and DP conceptualized the study, analysed the data, and wrote the first draft of the manuscript; MCS, JS, IG contributed to the design of the study, data management, and manuscript development and review; MO also contributed to the design of the study, and to the creation of data bases and data analysis. All authors read and approved the final manuscript.

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Data availability
The data used in this study are only available for the participating researchers, in accordance with current European and national laws. Thus, the distribution of the data is not allowed. However, researchers from public institutions can request data from SIDIAP.

Declarations

Ethical approval
This study was approved by the ethics and clinical research committee at the Institut d'Investigació IDIAP Jordi Gol under the code 19/195-P and conducted in accordance with the principles of the Declaration of Helsinki. Information was obtained from electronic medical records stored in the centralized ECAP (computerized clinical history) database and extracted by the Department of Healthcare Evaluation and Research Management. Accordingly, it was not necessary to ask participants for their informed consent. The variables in the ECAP database were processed anonymously and with full confidentiality guarantees as established by Spanish national law and Regulation 2016/679 of the European Parliament and the Council on the protection of natural persons with regard to the processing of personal data, and to the free distribution of such data. The data used in this study are only available for the participating researchers, in accordance with current European and national laws. Thus, the distribution of the data is not allowed. However, researchers from public institutions can request data from SIDIAP. Ethics committee of (Idiap Jordi Gol i Gurina) waived the need for informed consent due to retrospective observational cohort study.

Consent for publication
Not Applicable.

Competing interests
The authors declare no competing interests.

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