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Original Research Article

Correlation of gender with neonatal outcome in babies born to mothers with hypertensive disorder of pregnancy

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ABSTRACT

Background: Hypertensive disease of pregnancy (HDOP) has a prevalence of 6.9%. The study analysed the correlation between gender and neonatal outcomes in mothers with HDOP.
Methods: A retrospective descriptive study analysed 203 neonates born to mothers with HDOP in a tertiary care hospital.
Results: During the study period 3259 deliveries were conducted of which 203 deliveries met our inclusion criteria (106 male and 97 female). In 142 neonates (69.95%) mode of delivery was LSCS with male gender being significantly higher ($p<0.05$). Of 203 neonates, 65 (32.02 %) needed NICU care. Respiratory distress syndrome (61.11%) was the commonest morbidity. The mean period of gestation in male neonates was 262.17 days and 262.29 in females. The mean birth weight for male neonates was 2186.52 grams, while for female neonates was 2507.53 grams ($p<0.05$). Of the 203 neonates in our study, 93 were found to be small for gestational age. The mean duration of NICU stay for neonates was 5.08 days for males and 1.55 days for females. ($p<0.05$). The mean duration of hospital stay for male neonates was 13.52 days and for female neonates was 7.74 days ($p<0.05$). The mean placental weight for the female gender was 386.29 g and for the male gender was 390.69 g.
Conclusions: Male gender showed statistically significant positive correlation ($p<0.05$) for low birth weight, mode of delivery and duration of both NICU and Hospital stay.

Keywords: Gender, Hypertensive disease of pregnancy, Neonatal outcomes

INTRODUCTION

The cardiovascular system adapts significantly throughout pregnancy in order to support and accommodate the growing foetus.[1] The persistent variations in cardiovascular load throughout pregnancy and/or pre-existing maternal cardiovascular impairment are believed to be the cause of the maternal hemodynamic abnormalities linked to hypertensive disease of pregnancy (HDOP) Between 1990 and 2019, the incidence of HDOP grew globally from 16.30 million to 18.08 million, representing a total rise of 10.9% over 20 years.[2,3] The prevalence of HDOP among the Indian population is 6.9%.[4] HDOP is categorised by the American College of Obstetricians and Gynaecologists (ACOG) into four types of diseases, namely, gestational hypertension (GH), chronic hypertension (CH), pre-eclampsia (PEC) /eclampsia (EC), preeclampsia superimposed on chronic hypertension (PEC-CH).[5-7]

Gestational hypertension is defined as a systolic blood pressure of 140 mmHg or more or a diastolic blood pressure of 90 mmHg or more or both, on two occasions at least 4 hours apart after 20 weeks of gestation in a

woman with a previously normal blood pressure. Women with gestational hypertension with severe range blood pressures (a systolic blood pressure of 160 mm Hg or higher or diastolic blood pressure of 110 mm Hg or higher) should be diagnosed with preeclampsia with severe features.[8] Recent studies have begun to explore the nuanced effects of foetal gender on pregnancy outcomes. Foetal gender-based disparities in perinatal outcomes have long been documented, with male neonates often associated with poorer outcomes in high-risk pregnancies.[9]

These differences are thought to stem from divergent patterns of placental gene expression, immune response and adaptation to in utero stress.[10-13] In hypertensive disorders of pregnancy, where uteroplacental perfusion is already compromised, such sex-specific vulnerabilities may be further accentuated, warranting a targeted investigation into foetal gender as a potential modulator of neonatal morbidity.

Existing literature primarily addresses the pathogenesis and risks associated with HDOP.[13-16] Despite the growing body of evidence, significant gaps remain regarding the specific impact of foetal gender on the outcomes of neonates born to mothers with HDOP.[17,18] Understanding these gender-based discrepancies is crucial, as they could aid in risk assessments for both mothers and their newborns. This study aims to fill this knowledge gap by investigating the correlation between foetal gender and neonatal outcomes among mothers diagnosed with HDOP.

METHODS

Type of study: A retrospective descriptive study from July 2022 to August 2024 including all mothers with HDOP who delivered a live baby at a tertiary care teaching hospital in Western Maharashtra, India. All clinical and demographic data were obtained from the institutional database of a tertiary care teaching hospital in Western Maharashtra for the period of July 2022 to August 2024.

Inclusion criteria

All women with HDOP who delivered a live-born neonate were included.

Exclusion criteria

Stillbirth or intrauterine death were excluded.

Definitions

Gestational hypertension

Gestational hypertension is persistent de novo hypertension that develops at or after 20 weeks' gestation in the absence of features of pre-eclampsia.

Pre-eclampsia

Pre-eclampsia is gestational hypertension accompanied by one or more of the following new-onset conditions at or after 20 weeks' gestation proteinuria, other maternal organ dysfunction, including: Acute kidney injury (AKI) (creatinine ≥90 µmol/l, 1 mg/dL) liver involvement (elevated transaminases e.g., ALT or AST>40 IU/l (with or without right upper quadrant or epigastric abdominal pain), neurological complications (examples include eclampsia, altered mental status, blindness, stroke, clonus, severe headaches, persistent visual scotomata), haematological complications (thrombocytopenia–platelet count below 150,000/µl, DIC, haemolysis). Uteroplacental dysfunction (such as foetal growth restriction, abnormal umbilical artery doppler wave form analysis, or stillbirth).

Eclampsia

A severe form of preeclampsia associated with generalized tonic-clonic seizures.

HELLP syndrome

A severe form of preeclampsia characterized by haemolysis, elevated liver enzymes and low platelets "HELLP, haemolysis, elevated liver enzymes and low platelets and ≥300 mg proteinuria in 24-hour urine test.[19,20]

In the study, gender was correlated with neonatal morbidity outcomes like mode of delivery, birth weight, placental weight, total NICU stay, neonatal complication and the overall duration of stay in the hospital.

Sample size calculation

A total of 3259 deliveries were conducted during our period of study of which 203 deliveries met our inclusion criteria and formed the study group.

Statistical analysis

Patient characteristics were reported as mean or counts and percentages for categorical variables. Shapiro Wilk Test was done and it showed that All p values <0.05. This tells us that the entire data is not normally distributed. The association between the Neonates Gender and Mode of delivery was assessed by Fischer's exact test (2 sided). Similarly, Fischer's exact test (2 sided) was done for the binary outcomes of gestational age (Preterm/Term) and appropriateness for gestational age (SGA/AGA) with neonatal gender. The association of neonatal gender with non-normally distributed continuous variables such as Birth Weight, NICU length of Stay and Total hospital Stay was assessed using Mann Whitney U Test. A p-value of <0.05 was considered significant for all statistical tests. All data analyses were performed using IBM SPSS Statistics for Windows, version 21.0.

Ethical approval

An institutional database was used for the collection of data after obtaining written approval from the Institutional Ethics Committee.

RESULTS

During the study period 3259 deliveries were conducted of which 203 deliveries met our inclusion criteria. Of these 106 (52.2%) were male and 97 (47.8%) were female. There was no association of gender with any specific cause for HDOP. Mode of delivery was LSCS In 142 neonates (69.95%) and vaginal in 61(30.05%) (Table 1). Figure 1 presents the distribution of mothers according to gestational age. The classification of mothers by parity is provided in Figure 2.

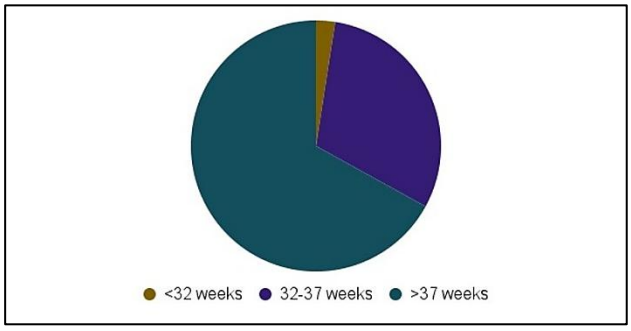

Figure 1: Distribution of mothers by gestational age.

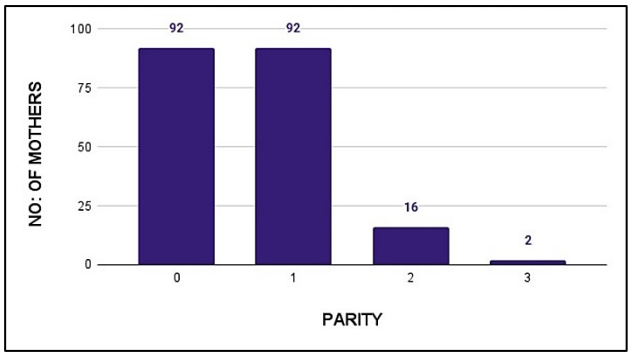

Figure 2: Distribution of mothers by parity.

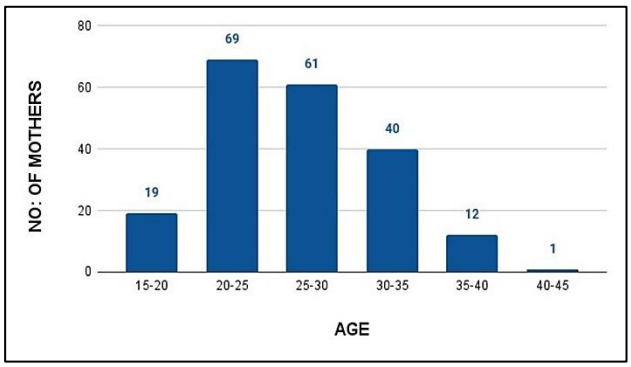

Figure 3: Distribution of mothers by age group.

Figure 3 outlines the distribution of mothers across different age groups. In babies delivered by LSCS 83 (58.45%) were male and 59 (41.5%) were female. The gender difference was statistically significant (p=0.004) in babies born by LSCS with male preponderance (Refer Table 1).

In our study the most common morbidity resulting in NICU admission was RDS in 33 neonates (61.11%) (20 male, 13 female). Other morbidities included hypoglycaemia 08 (Male: 3, Female 5), Meconium Stained Liquor (MSL) 6 (Male:2, Female: 4), tachypnoea 02 (Male: 2, Female: 0), Grunting 02 (Male: 2, Female: 0), Low birth weight (LBW) 07 (Male:3, Female: 4), Intrauterine growth retardation (IUGR) 4 (Male:3, Female:1) and Birth Asphyxia (BA) 02 (Male:1, Female:1). The mean period of gestation (POG) in male neonates was 262.17 days and 262.29 days in females. The difference in POG between genders was not found to be statistically significant (Table 1). The mean birth weight for male neonates was 2186.52 grams, while for female neonates was 2507.53 grams (p=0.000 i.e., $p<0.05$). The males in our study were born with a lower birth weight as compared with females and this was statistically significant (Table 1). Of the 203 neonates in our study, 93(45.81%) were seen to be SGA while 110 (54.18%) were found to be AGA. In the male gender 52 (25.62%) were SGA while the female gender had 41 (20.20%) SGA. The AGA group had 54 (26.60%) males and 56 (27.59%) females. Shapiro Wilk Test was done and it showed that All p values <0.05. This tells us that the entire data is not normally distributed. The association between the neonatal gender and mode of delivery was assessed by Fischer's exact test (2 sided) which was found statistically significant with a p value of 0.006. Similarly, Fischer's exact test (2 sided) was done for the binary outcomes of gestational age (Preterm/Term) and appropriateness for gestational age (SGA/AGA) with Neonatal Gender. This was found to be not statistically significant. In the study gender was not found to be statistically significant in the SGA and AGA distribution (Table 1). In the study of the 203 babies 65 (32.02%) babies required NICU admission while 138 (67.98%) did not need NICU admission. Of the 65 babies admitted to NICU 43 (66.15%) were male and 22 (33.85%) were female. The association of neonatal gender, in babies born to mothers with HDOP, with Birthweight was found to be statistically significant (p=0.000) using the Mann Whitney U test.

Statistically significant association was confirmed between NICU length of stay and Neonatal gender (p=0.001) as also Total hospital stay with Neonatal gender (p=0.000) as assessed by Mann Whitney U test. The number of male neonates admitted to NICU was more than female neonates but the number was not statistically significant. Thus, gender did not affect the probability for NICU admission in a statistically significant manner in study. The mean placental weight for female gender was 386.29 gm and for male gender

was 390.69 gm Although the mean placental weight for female gender was less it was not found to be statistically significant (Refer Table 1). The mean duration of NICU stay for male neonates was 5.08 days and female neonates was 1.55 days (p=0.001). The difference in duration of stay was statistically significant with males requiring longer NICU care (Refer Table 2). The mean duration of hospital stay for male neonates was 13.52 days and for female neonates was 7.74 days (p=0.000 i.e., p<0.05). The overall hospital stay was significantly more for the male gender (Table 2).

Table 1: Neonatal gender stratified comparison of gestational age, mode of delivery, placental weight, SGA/AGA status and birth weight.

Variable	Gender (n=203)			
	Male (n=106)	Female (n=97)	Mean	P value
Mean period of gestation (in days)	262.17	262.29	262.23	0.62
Mode of delivery and weight of placenta				
Vaginal	23	38	61	0.004*
LSCS	83	59	142	
Weight of placenta (mean weight in grams)	390.69	386.29	388.59	0.815
Growth as per gestational age				
SGA	52 (25.62%)	41 (20.20%)	93 (45.81%)	0.335
AGA	54 (26.60%)	56 (27.59%)	110 (54.18%)	
Mean neonatal birth weight (in grams)	2186.52	2507.53	2339.91	0.000*

*Statistically significant at p<0.05.

Table 2: Correlation of gender with duration of NICU and hospital stay.

Mean duration of NICU stays (in days)	Gender (n=203)		Mean	P value
	Male (n=106)	Female (n=97)		
	5.08	1.55	3.39	0.001*
Mean duration of hospital stay (in days)	13.52	7.74	10.76	0.000*

*Statistically significant at p<0.05.

DISCUSSION

Existing literature primarily addresses the pathogenesis and risks associated with HDOP, with less focus on how foetal gender may modulate these risks in the perinatal period for the neonate.[21] A similar type of study was done by Cidade-Rodrigues et al where it was found that male neonates born to mothers with gestational diabetes had a 26% higher risk of neonatal hypoglycaemia, 29% higher risk of NICU admission, 35% higher risk of respiratory distress syndrome (RDS) and nearly double the risk of macrosomia compared to female neonates.[22] The study was aimed to fill this knowledge gap by analyzing the relation between fetal gender and neonatal outcomes among mothers diagnosed with HDOP.

During the study period 3259 deliveries were conducted of which 203 deliveries met the inclusion criteria and formed our study population. The study did not reveal any association of gender with any specific cause for HDOP. Similar conclusions were found in a study done by Shah et al.[23] Of the 203 neonates included in the study, 106 (52.2%) were male and 97(47.8%) were female. Obsa et al in their study found 62.7% cases were male.[24] In babies delivered by LSCS 83 (58.45%) were male and 59 (41.5%) were female. The gender difference was statistically significant (p=0.007) in babies born by LSCS with male preponderance. Similar male preponderance was also seen for LSCS in mothers with HDOP in other studies.[25,26] Mode of delivery was LSCS In 142 neonates (69.95%) and vaginal in 61(30.05%). In a study by Moura et al caesarean delivery was the most common mode of delivery in 68.5% of hypertensive pregnancies.[27,28]

Placental weight

The mean placental weight for female gender was 386.29 gm and for male gender was 390.69 gm Although the mean placental weight for female gender was less it was not found to be statistically significant. Lower placental weight in HDOP is an established outcome. This was also seen in a study by Jain et al where mean placental weight was found to be significantly lower in hypertensive pregnancies.[29] The mean period of gestation (POG) in male neonates was 262.17 days and 262.29 days in females. The difference in POG between genders was not found to be statistically significant. Callias et al in their study also did not find any correlation between gender and period of gestation in mothers with HDOP.[30] The mean birth weight for male neonates was 2186.52 grams, while for female neonates was 2507.53 grams (p=0.000 i.e., p<0.05). The males in our study were born with a lower birth weight as compared with females and this was statistically significant. In the study of the 203 babies 65 (32.02%) babies required NICU admission while 138

(67.98%) did not need NICU admission. The risk of NICU admissions was found to be higher in mothers with HDOP by Bromfeld et al.[13]

Of the 65 babies admitted to NICU 43 (66.15%) were male and 22 (33.85%) were female. The number of male neonates admitted to NICU was more than female neonates but the number was not statistically significant. Thus, gender did not affect the probability for NICU admission in a statistically significant manner in our study. Callais et al in their study also found that NICU admission rates were similar among both gender groups.[30] The mean duration of NICU stay for male neonates was 5.08 days and female neonates was 1.55 days ($p=0.001$ i.e., $p<0.05$). The difference in duration of stay was statistically significant with males requiring longer NICU care. Callais et al in their study found that NICU admission rates were similar among both gender groups for duration of NICU stay.[30]

In the study the most common morbidity resulting in NICU admission was RDS in 33 neonates (61.11%) (20 male, 13 female). Other morbidities included Hypoglycaemia, Meconium-Stained Liquor), Tachypnoea Grunting, Low birth weight (LBW) Intrauterine growth retardation and Birth Asphyxia. Bromfeld et al also had similar morbidity patterns in their study.[13] The mean duration of hospital stay for male neonates was 13.52 days and for female neonates was 7.74 days ($p=0.000$ i.e., $p<0.05$). The overall hospital stay was significantly more for the male gender. The increased duration of hospital stays overall for male gender maybe due to the increased NICU admissions for male gender and lower birth weight (Table 1).

CONCLUSION

Male gender showed statistically significant positive correlation ($p<0.05$) for low birth weight, mode of delivery (LSCS) and duration of both NICU and total hospital stay. Thus, gender significantly impacts neonatal outcomes in babies born to mothers with HDOP.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Chowdhury Collins HE, Alexander BT, Care AS, Davenport MH, Davidge ST, Eghbali M, et al. Guidelines for assessing maternal cardiovascular physiology during pregnancy and postpartum. Am J Physiol Heart Circ Physiol. 2024;1;327(1):191-220.
2. Poon LC, Nguyen-Hoang L, Smith GN, Bergman L, O'Brien P, Hod M, et al. FIGO Committee on Impact of Pregnancy on Long-term Health and the FIGO Division of Maternal and Newborn Health. Hypertensive disorders of pregnancy and long-term cardiovascular health: FIGO Best Practice Advice. Int J Gynaecol Obstet. 2023;160(1):22-34.
3. Qu H, Khalil RA. Vascular mechanisms and molecular targets in hypertensive pregnancy and preeclampsia. Am J Physiol Heart Circ Physiol. 2020;319(3):661-81.
4. Mathew R, Devanesan BP, Srijana, Sreedevi NS. Prevalence of hypertensive disorders of pregnancy, associated factors and pregnancy complications in a primigravida population. Gynecol Obstet Clin Med. 2023;3(2):119–23.
5. Cunningham FG, Leveno KJ, Dashe JS, Hoffman BL, Spong CY, Casey BM. Preeclampsia syndrome. Am J Obstet Gynecol. 2022;6:74.
6. Dhinwa M, Gawande K, Jha N, Anjali M, Bhadoria AS, Sinha S. Prevalence of hypertensive disorders of pregnancy in India: a systematic review and meta-analysis. J Med Evid. 2021;2(2):105–12.
7. Garovic VD, White WM, Vaughan L, Saiki M, Parashuram S, Garcia-Valencia O, et al. Incidence and Long-Term Outcomes of Hypertensive Disorders of Pregnancy. J Am Coll Cardiol. 2020;12;75(18):2323-34.
8. Gestational Hypertension and Preeclampsia: ACOG Practice Bulletin, Number 222. Obstet Gynecol. 2020;135(6):237-60.
9. Hercus JC, Metcalfe KX, Christians JK. Sex differences in growth and mortality in pregnancy-associated hypertension. PLoS One. 2024;19(1):296853.
10. Lorente-Pozo S, Parra-Llorca A, Torres B, Torres-Cuevas I, Nuñez-Ramiro A, Cernada M, et al. Influence of Sex on Gestational Complications, Fetal-to-Neonatal Transition and Postnatal Adaptation. Front Pediatr. 2018;23:63.
11. Zhou C, Yan Q, Zou QY, Zhong XQ, Tyler CT, Magness RR, et al. Sexual Dimorphisms of Preeclampsia-Dysregulated Transcriptomic Profiles and Cell Function in Fetal Endothelial Cells. Hypertension. 2019;74(1):154-63.
12. Jeong DS, Lee JY, Kim MH, Oh JH. Regulation of sexually dimorphic placental adaptation in LPS exposure-induced intrauterine growth restriction. Mol Med. 2023;18;29(1):114.
13. Bromfield SG, Ma Q, DeVries A, Inglis T, Gordon AS. The association between hypertensive disorders during pregnancy and maternal and neonatal outcomes: a retrospective claims analysis. BMC Pregnancy Childbirth. 2023;14;23(1):514.
14. Taylor BD, Ness RB, Klebanoff MA, Tang G, Roberts JM, Hougaard DM, et al. The impact of female fetal sex on preeclampsia and the maternal immune milieu. Pregnancy Hypertens. 2018;12:53-57.
15. Antonakou A, Papoutsis D. The Effect of Fetal Gender on the Delivery Outcome in Primigravidae Women with Induced Labours for all Indications. J Clin Diagn Res. 2016;10(12):22-5.
16. van Esch JJA, van Heijst AF, de Haan AFJ, van der Heijden OWH. Early-onset preeclampsia is

associated with perinatal mortality and severe neonatal morbidity. J Matern Fetal Neonatal Med. 2017;30(23):2789-94.
17. Broere-Brown ZA, Adank MC, Benschop L, Tielemans M, Muka T, Gonçalves R, et al. Fetal sex and maternal pregnancy outcomes: a systematic review and meta-analysis. Biol Sex Differ. 2020;11(1):26.
18. Funaki S, Ogawa K, Ozawa N, Hosoya S, Okamoto A, Urayama KY, et al. Association between fetal sex and pregnancy outcomes among women with twin pregnancies: a multicenter cross-sectional study. Arch Gynecol Obstet. 2023;307(5):1397-405.
19. Lee JY, Lee SH. Hypertensive disorders of pregnancy: advances in understanding and management. Clin Hypertens. 2025;2:31.
20. Brown MA, Magee LA, Kenny LC, Karumanchi SA, McCarthy FP, Saito S, et al. International Society for the Study of Hypertension in Pregnancy (ISSHP). The hypertensive disorders of pregnancy: ISSHP classification, diagnosis & management recommendations for international practice. Pregnancy Hypertens. 2018;13:291-310.
21. Di Renzo GC, Rosati A, Sarti RD, Cruciani L, Cutuli AM. Does fetal sex affect pregnancy outcome? Gend Med. 2007;4(1):19-30.
22. Cidade-Rodrigues C, Chaves C, Melo A, Novais-Araújo A, Figueiredo O, Gomes V, et al. Association between foetal sex and adverse neonatal outcomes in women with gestational diabetes. Arch Gynecol Obstet. 2024;309(4):1287-94.
23. Shah S, Gupta A. Hypertensive Disorders of Pregnancy. Cardiol Clin. 2019;37(3):345-54.
24. Obsa M, Wolka Woticha E, Girma Weji B. Neonatal and Fetal Outcomes of Pregnant Mothers with Hypertensive Disorder of Pregnancy at Hospitals in Wolaita Zone, Southern Ethiopia. Journal of Midwifery and Reproductive Health, 2019;7(2):1636-40.
25. Sheiner E, Levy A, Katz M, Hershkovitz R, Leron E, Mazor M. Gender does matter in perinatal medicine. Fetal Diagn Ther. 2004;19(4):366-9.
26. Aibar L, Puertas A, Valverde M, Carrillo MP, Montoya F. Fetal sex and perinatal outcomes. J Perinat Med. 2012;40(3):271-6.
27. Rocha de Moura MD, Margotto PR, Nascimento Costa K, Carvalho Garbi Novaes MR. Hypertension induced by pregnancy and neonatal outcome: Results from a retrospective cohort study in preterm under 34 weeks. PLoS One. 2021;16(8):255783.
28. Chang KJ, Seow KM, Chen KH. Preeclampsia: Recent Advances in Predicting, Preventing and Managing the Maternal and Fetal Life-Threatening Condition. Int J Environ Res Public Health. 2023;20(4):2994.
29. Jain A, Sharma D, Sharma V, Baweja S, Jain R. Study of placental weight in normal and pre-eclamptic pregnancies and its correlation with birth weight. Int J Med Res Rev. 2016;4(4):562-8.
30. Callais NA, Morgan JA, Leggio BA, Wang Y. Association of fetal gender and the onset and severity of hypertensive disorders of pregnancy. J Matern Fetal Neonatal Med. 2022;35(12):2260-5.

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