



## Seasonal Variations in the Prevalence of Hypertensive Disorders of Pregnancy among Iranian Women: A Three-Year, Retrospective Study

Sahar Pabarja<sup>1</sup>, MD; Razhan Chehreh<sup>2</sup>, PhD; Zolaykha Karamelahi<sup>2,3,\*</sup>, MSc

<sup>1</sup> Faculty of Nursing and Midwifery, Student Research Committee, Ilam University of Medical Sciences, Ilam, IR Iran

<sup>2</sup> Department of Midwifery, School of Midwifery and Nursing, Ilam University of Medical Sciences, Ilam, IR Iran

<sup>3</sup> Clinical Research Development Unit, 5<sup>th</sup> Azar Hospital, Golestan University of Medical Sciences, Gorgan, IR Iran

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### ABSTRACT

**Background:** Hypertensive disorders of pregnancy increase neonatal and maternal mortality and morbidity. Studies have reported different seasonal patterns of these disorders during pregnancy.

**Objectives:** We aimed to determine the seasonal prevalence of hypertensive disorders of pregnancy among women who gave birth at Ayatollah Taleghani Hospital, Ilam City, between 2017 and 2020.

**Methods:** This descriptive-analytical study involved 10,988 files of children born from June 2017 to May 2020 at Taleghani Hospital, Ilam City. Among them were 389 cases with hypertensive disorders during pregnancy, which were compared against 260 cases without hypertensive disorders (control group). Using a researcher-designed questionnaire, we collected data on demographics, pregnancy history, clinical information, and medical history. Data analysis was done in SPSS (V.16) using chi-squared, Fisher's exact, Mann-Whitney U, and independent t-tests ( $P < 0.05$ ).

**Results:** Out of 389 cases (3.54%) of hypertensive pregnancy disorders, 254 (65.3%) were preeclampsia, 105 (27.0%) were gestational hypertension, 26 (6.7%) were chronic hypertension, and four (1%) were eclampsia. The highest prevalence of hypertensive pregnancy disorders was during winter (4.70%), specifically in February (5.46%) and January (5.05%). The minimum was in autumn (2.57%), specifically in September (2.40%) and November (2.50%). The mean age of the mothers, the mean age of the pregnancy, delivery method, history of abortion, history of stillbirth, incidents and disorders of the placenta and umbilical cord, amniotic fluid, gestational diabetes, thyroid disorders, history of preeclampsia, and history of infertility all had a significant relationship with hypertensive disorders during pregnancy.

**Conclusions:** Hypertensive disorders of pregnancy have a seasonal pattern and are more prevalent during the year's colder months.

### 1. Background

According to the World Health Organization (WHO), the most common high-risk pregnancy disorders are bleeding, preeclampsia, infection, preterm birth, maternal medical complications, and abortion. These are the main reasons for admitting pregnant women to specialized wards. These complications are also the main causes of death among mothers worldwide, constituting half the causes of death in women after delivery in developing countries (1).

Hypertensive disorders of pregnancy are the third cause of maternal mortality, making it essential to diagnose and treat patients promptly (2).

Hypertensive disorders affect 2 – 8% of pregnancies (3, 4). According to the WHO, the prevalence of preeclampsia and eclampsia in developing countries (2.8% of live births) is higher than in developed countries (0.4%), probably due to geographical, demographical, racial, and economic factors (5-7). Preeclampsia and chronic hypertension are responsible for 10 – 15% of maternal mortalities (8).

Factors that increase the risk of hypertensive disorders during pregnancy include an age below 20 or above 35, first

\*Corresponding author: Zolaykha Karamelahi, Clinical Research Development Unit (CRDU), 5 Azar Hospital, Golestan University of Medical Sciences, Gorgan, Iran. Tel: +98-9183408521; Email: mohamad20101@gmail.com.

pregnancy, multiple pregnancies, history of abortion, history of hypertension in the mother or family, history of diabetes, renal diseases, and obesity (9-11). In addition, some studies indicate that hypertensive disorders of pregnancy follow a seasonal pattern, explained based on environmental temperature and humidity (12). Several studies have been conducted on seasonal changes in preeclampsia/eclampsia, and there is an ongoing debate on this matter (13-17).

Magnus et al. studied 1,869,388 birth files in Norway over 30 years and found that preeclampsia peaked during December and decreased in spring and summer; the lowest prevalence was in August (18). A study in India on 29,562 births showed no difference in the prevalence of preeclampsia between wet and dry seasons. However, the prevalence of eclampsia during the wet season was notably higher (19).

Innick et al. studied 11,000 pregnant women in South Africa and showed that the prevalence of preeclampsia peaked in winter (13.6%) (20). Another study showed that the risk of preeclampsia was 70% higher in women who become pregnant during summer than during spring (16). Willington et al. studied 31,207 births and concluded that the lowest prevalence was in autumn (3.89%), and the highest was in winter (4.1%). Moreover, the highest monthly prevalence was in January (4.4%). After forming cohort groups regarding age, race, and other potentially disrupting factors, women hospitalized during autumn for child delivery had 6% less prevalence of preeclampsia than those hospitalized in winter (17).

## 2. Objectives

Since hypertensive disorders can complicate pregnancies and increase maternal and neonatal mortality, we examined these disorders' prevalence and seasonal patterns among pregnant women who gave birth at Ayatollah Taleghani Hospital, Ilam City, between 2017 and 2020.

## 3. Patients and Methods

We conducted a cross-sectional retrospective study to examine the seasonal prevalence of hypertensive disorders during pregnancy and the related factors in women visiting Ayatollah Taleghani Hospital, Ilam City, Iran. After obtaining ethical clearance from the Ilam University of Medical Sciences (IR.MEDILAM.REC.1398.152), we examined 10,988 childbirth files recorded from June 2017 to May 2020 (three years). There were 389 hypertension cases during pregnancy, which were compared against 260 childbirths without hypertension during pregnancy (control group).

We used a researcher-designed checklist to collect information on demographics, past pregnancies (mother's age, number of pregnancies, history of abortion, history of

stillbirth, last childbirth method, and history of infertility), current pregnancy (first day of the last menstruation, date of childbirth, fetus development disorders, amniotic fluid disorders, placental abruption, weight at birth, pregnancy age, and 1<sup>st</sup> and 5<sup>th</sup> min Apgar scores), and medical history (diabetes, hypothyroidism, hypertensive disorders during pregnancy, anemia, and urinary infection).

The inclusion criteria were a singleton pregnancy over 20 weeks gestation with a diagnosed hypertensive disorder (e.g., chronic hypertension, gestational hypertension, preeclampsia, and eclampsia) with delivery at Ayatollah Taleghani Hospital. The collected data were analyzed in SPSS software version 16. Variables were summarized using frequencies and mean values. The chi-squared, Fisher's exact, Mann-Whitney U, and independent t-tests were used to compare groups. P-values below 0.05 indicated statistical significance.

## 4. Results

Of 10,988 childbirth cases in Ayatollah Taleghani Hospital between June 2017 and May 2020, 389 (3.54%) featured hypertensive disorders during pregnancy. Among them, 254 (65.3%) were preeclampsia, 105 (27.0%) were gestational hypertension, 26 (6.7%) were chronic hypertension, and four (1%) were eclampsia (Table 1). Based on the chi-squared test, a significant relationship existed between hypertensive disorders during pregnancy and the seasons ( $P = 0.001$ ) (Table 1). The highest prevalence was in winter (4.70%), specifically in the months of February (5.46%) and January (5.05%). The minimum lowest prevalence was in autumn (2.57%), specifically in September (2.40%) and November (2.50%) (Table 2).

Although 60.7% of the women with hypertensive disorders were in the 21 – 34 age range, according to the Mann-Whitney U test and t-test, the mother's age group ( $P = 0.54$ ) and mean age ( $P = 0.41$ ) were not significantly related to hypertension during pregnancy. The mean age of pregnancy based on pregnancy week ( $P = 0.001$ ) and mean child weight at birth ( $P = 0.001$ ) had a significant relationship with hypertensive disorders during pregnancy. Most women with hypertensive disorders during pregnancy were not nulliparous, and being nulliparous did not have a significant relationship with hypertensive disorders during pregnancy ( $P = 0.07$ ).

The childbirth method in most cases was a C-section, with a significant difference existing between the case and control groups in terms of childbirth method ( $P = 0.001$ ) (Table 3). According to the chi-squared test and Fisher's exact test, history of abortion, stillbirth, preeclampsia, diabetes, infertility, hypothyroidism, oligohydramnios, and placenta/umbilical cord disorders was significantly related to hypertensive disorders during pregnancy ( $P = 0.001$ ) (Table 3).

**Table 1.** Frequency and Seasonal Distribution of Hypertensive Disorders of Pregnancy

Variable	Childbirth without Hypertension Disorders	Childbirth with Hypertensive Disorder during Pregnancy				Total (n = 389)
		Chronic Hypertension (n = 26)	Preeclampsia (n = 254)	Gestational Hypertension (n = 105)	Eclampsia (n = 4)	
Spring	2894 (26.33%)	6 (1.5%)	58 (14.9%)	26 (6.7%)	0(0.0%)	90 (23.1%)
Summer	3036 (27.63%)	7 (1.8%)	71 (18.3%)	36 (9.3%)	1 (0.3%)	115 (29.6%)
Autumn	2529 (23.01%)	3 (0.8%)	40 (10.3%)	20 (5.1%)	2 (0.5%)	65 (16.7%)
Winter	2529 (23.01%)	10 (2.6%)	85(21.9%)	23 (5.9%)	1 (0.3%)	119 (30.6%)

**Table 2.** Seasonal Pattern of Hypertensive Disorders of Pregnancy

Variables	Childbirth without Hypertension Disorders	Childbirth with Hypertensive Disorders during Pregnancy		Seasonal Prevalence
		Frequency (%)	Monthly prevalence	
March	1002	35 (9.0%)	3.49%	3.10%
April	961	26 (6.7%)	2.70%	
May	931	29 (7.5%)	3.11%	
June	1063	39 (10.0%)	3.66%	3.78%
July	937	45 (11.6%)	4.80%	
August	1036	31 (8.0%)	2.99%	
September	915	22 (5.7%)	2.40%	2.57%
October	817	23 (5.9%)	2.81%	
November	797	20 (5.1%)	2.50%	
December	910	34 (8.7%)	3.73%	4.70%
January	950	43 (11.1%)	5.05%	
February	769	42 (10.8%)	5.46%	
Sig.		X2 = 3.945, Df = 3, P = 0.004		

**Table 3.** Frequency of the Factors Related to Hypertensive Disorders of Pregnancy

Variable	Preeclampsia (n = 254)	Eclampsia (n = 4)	Chronic Hypertension (n = 26)	Gestational Hypertension (n = 105)	Control Group (n = 260)	P-value
Mean pregnancy age (weeks)	35.6 ± 3.1	34.2 ± 5.7	37.4 ± 1.7	37.1 ± 2.3	38.3 ± 1.2	0.03
Mean age of mother (years)	32.2 ± 6.5	29.5 ± 5.8	33.6 ± 6.1	31.9 ± 6.7	31.6 ± 4.3	0.41
Mean weight of neonate (g)	2563.81 ± 842.621	2457.50 ± 1376.08	2905.880 ± 594.652	3553.76 ± 138.083	3457.64 ± 135.55	0.001
Age (years)	>20	6 (1.5%)	0 (0.0%)	4 (1.3%)	15 (5.7%)	0.54
	20-34	54 (39.6%)	3 (0.8%)	13 (3.3%)	143 (55.5%)	
	35<	94 (24.2%)	1 (0.3%)	13 (3.3%)	102 (39.2%)	
Number of pregnancies	Nulliparous	106 (27.2%)	2 (0.5%)	7 (1.8%)	42 (10.8%)	0.07
	Non-nulliparous	148 (38%)	2 (0.5%)	19 (4.9%)	63 (16.2%)	
Abortion	Positive	47 (12.1%)	0 (0.0%)	6 (1.5%)	25 (6.4%)	0.001
	Negative	207 (53.2%)	4 (1.0%)	20 (5.1%)	80 (20.6%)	
Childbirth method	Natural	22 (5.7%)	2 (0.5%)	4 (1%)	14 (3.4%)	0.001
	c-section	232 (59.8%)	2 (0.5%)	22 (5.7%)	91 (23.5%)	
History of stillbirth	Positive	22 (5.7%)	0 (0.0%)	4 (1.0%)	11 (2.8%)	0.001
	Negative	232 (59.8%)	4 (1.0%)	22 (5.7%)	94 (24.2%)	
Gestational age (weeks)	>34	67 (17.2%)	1 (0.3%)	2 (0.5%)	11 (2.89%)	0.001
	34-36	73 (18.8%)	2 (0.5%)	5 (1.3%)	23 (5.95%)	
	37-38	73 (18.8%)	0 (0.0%)	15 (3.9%)	45 (11.6%)	
	39-40	41 (10.5%)	1 (0.3%)	4 (1.0%)	26 (6.75%)	
Placental disorders	Positive	8 (3.1%)	1 (25%)	2 (7.7%)	0 (0%)	0.001
	Negative	246 (96.9%)	3 (75%)	24 (92.3%)	105 (100%)	
Amniotic fluid disorders	Oligohydramnios	45 (17.7%)	2 (50%)	3 (11.5%)	2 (1.9%)	0.0001
	Polyhydramnios	12 (4.7%)	0 (0%)	0 (0%)	2 (1.9%)	
History of preeclampsia	Positive	39 (10%)	1 (0.3%)	2 (0.5%)	9 (2.3%)	0.001
	Negative	215 (55.3%)	3 (0.8%)	24 (6.2%)	96 (24.7%)	
History of infertility	Positive	29 (7.5%)	0 (0%)	3 (8%)	17 (4.4%)	0.0001
	Negative	224 (57.6%)	3 (8%)	24 (6.2%)	89 (22.9%)	
Diabetes	Positive	49 (23.9%)	0 (0%)	7 (3.5%)	16 (7.9%)	0.001
	Negative	205 (80.1%)	4 (100%)	19 (73.5%)	144 (55.5%)	
Thyroid disorders	Positive	44 (21.5%)	0 (0%)	13 (6.4%)	1 (0.5%)	0.001
	Negative	210 (82.5%)	4 (100%)	13 (50.5%)	159 (60.5%)	

## 5. Discussion

This study examined the seasonal prevalence of hypertensive disorders of pregnancy among women who gave birth at Taleghani Hospital, Ilam, Iran, over a three-year period. The prevalence of hypertensive disorders of pregnancy was 3.54%, with preeclampsia representing the most prevalent type. Consistent with our results, Zibaenezhad et al. (2010) reported that the prevalence of hypertension disorders during pregnancy was 2.32% (21), while Zareian et al. (2004) reported this figure at 3.3% (22), and Tavakoli et al. (2019) reported it at 6% in Isfahan (2). Prevalence rates of 4.6% (15) and 4.6% (23) were recorded in Japan and Sudan, respectively. Shahidfar et al. (2012)

reported a range of 1 - 8% (24). Variations across different regions may be due to differences in race, ethnicity, lifestyle, nutrition, environment, and geographic factors.

The present study found that seasonal changes had a significant relationship with hypertensive disorders during pregnancy, which were more prevalent in winter (January and February) and less prevalent in summer (July) and autumn. Consistent with our findings, Morikawa et al. (2014), Cuma et al. (2019), and Ali et al. (2015) reported that the highest prevalence of hypertensive disorders of pregnancy was in winter, followed by summer (12, 15, 23). The elevation in daytime blood pressure in winter and nighttime blood pressure in summer is documented (25).

The reasons behind the increase in hypertensive disorders of pregnancy and preeclampsia in winter may be a decrease in temperature and its effect on venous contraction (9), a decrement in plasma vitamin D level due to reduced sunlight (12, 26, 27), an increase in the risk of infections, a decrease in physical activity (27, 28), and the dry climate affecting the agricultural products and hence nutrition of people (29).

The lowest prevalence of hypertensive disorders of pregnancy was in autumn, specifically in November and December. This is in agreement with similar studies (17, 23). In Japan, Morikawa et al. recorded the minimum prevalence in late spring (17). Apparently, spring and autumn with mild weather conditions decrease the prevalence of hypertensive disorders during pregnancy. Inconsistent with our results, some studies have reported the lowest prevalence in late summer (August and July) (12); such discrepancies may be due to differences in study design and seasonal climate patterns.

While our results indicated no significant relationship between the mother's age and hypertensive disorders during pregnancy, disorders like preeclampsia, eclampsia, and gestational hypertension appeared more commonly in the 20 to 34 age group. Shambel et al. (2016) showed that women aged 20 - 34 years had a higher risk of hypertensive disorders during pregnancy (30). Another study indicated no significant relationship between mothers' age and hypertensive disorders (12). The inconsistent results can be due to race, ethnicity, lifestyle, and nutrition. The present study also indicated no significant relationship between the number of pregnancies and the prevalence of hypertension disorders during pregnancy. It appears, however, that non-nulliparous women are at a higher risk of such disorders (31, 32). Getinet et al. (2016) found that the risk of hypertensive disorders during pregnancy in nulliparous women was lower than that of non-nulliparous women (33).

We found a significant relationship between hypertensive disorders of pregnancy and the mean pregnancy age (weeks) as well as the mean weight of the neonate at birth. In the case of neonates whose mothers had hypertensive disorders during pregnancy, the mean age of the pregnancy and the mean weight at birth were lower than those of the control group. In addition, the values of these parameters were lower in mothers with more severe disorders such as preeclampsia and eclampsia than in mothers with chronic hypertension and gestational hypertension. In line with our findings, prior studies found that the probability of giving birth before the 34<sup>th</sup> week of pregnancy with < 2500 g weight at birth was significantly higher in patients with hypertensive disorders during pregnancy and preeclampsia in particular (12, 15, 24).

There was a significant relationship between hypertensive disorders of pregnancy and a history of abortion and stillbirth. Other studies have also shown a significant relationship between hypertensive disorders during pregnancy and a history of abortion (2, 9) or stillbirth (15, 34). In line with the literature, we also linked hypertensive disorders of pregnancy with placental abruption and oligohydramnios (12). Other associated factors included a history of diabetes, hypothyroidism, or preeclampsia, as

reported in similar studies (12, 18, 24-32, 35).

Pregnant women with background autoimmune diseases such as diabetes, hypothyroidism, and preeclampsia are at a greater risk of hypertensive disorders during pregnancy (36). Monseur et al. (2019) conducted a study in the USA and showed that women with a history of infertility treatment, regardless of the type of infertility, had a higher risk of hypertensive disorders during pregnancy (37). Women with a history of infertility are usually older, have a higher chance of a multiples pregnancy, and may have background diseases (e.g., hormonal disorders due to polycystic ovarian and insulin resistance); these factors may explain their greater risk of hypertensive disorders during pregnancy (38, 39).

### 5.1. Limitations

Notable limitations of the present study include incomplete childbirth records and the lack of data about the mother's education level, employment status, body mass index, and treatments received before pregnancy.

### 5.2. Conclusion

Seasonal changes affect the prevalence of hypertensive disorders during pregnancy. A history of preeclampsia, diabetes, hypothyroidism, abortion, stillbirth, and infertility are among the factors affecting the prevalence of these disorders. Our findings can be used to plan timely prevention and therapeutic measures for women susceptible to hypertensive disorders of pregnancy, thereby minimizing the risks to the mother and fetus.

### 5.3. Ethical Approval Code

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The present study was based on a research plan approved by the Student Research Committee, Ilam University of Medical Sciences (ethics code: IR.MEDILAM.REC.1398.152). The authors wish to express their gratitude to the Department of Research and Technology for the approval of the research plan and financial support, and to the Clinical Research Development Department and the officials of Taleghani Hospital, Ilam, Iran.

### Authors' Contribution

Study concept and design: Z.K., R.C., and S.P. Sample recruitment: S.P. Drafting of the manuscript: Z.K. Critical revision of the manuscript: R.C. Statistical analysis: Z.K., R.C., F.T. Administrative, technical, and material support: Z.K.

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The authors have no financial interests related to the material in the manuscript.

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